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Traditional European Breads

An Illustrative Compendium of Ancestral Knowledge and Cultural Heritage

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Preface

Bread is one of the most widely consumed staple foods in the world and one of the oldest forms of processed foods, with evidences of bread-like food remains and fermentation utensils developed by our ancestors dating back to the Neolithic era in multiple locations around the world, including Europe and Asia, and the oldest evidences of bread production discovered dating back 4000 years before this Neolithic period. The process of bread-making has been gradually and constantly improved, aiming to adapt to the new demands and changes in preference of the population and to improve the efficiency of the processes and expand the distribution of the products. Not only that, but wide varieties of breads have also been developed over the centuries in multiple countries to incorporate in their recipes special seeds, cereals and other ingredients that were locally produced in these regions, as well as seasonal ingredients produced in these agricultural regions. This led to the development of a wide variety of products (i.e. variable shapes, colours and sensorial profiles), all of them commonly referred to as "bread", that could be consumed with different types of meals on a day-to-day basis, as well as speciality breads associated to particular seasons or even products tightly linked to different festivities, celebrations and religious rituals all over the world. All these traditions and know-how of both bread-making process and bread were developed over centuries in different countries, and even specific geographical areas within the same country, reflecting cultural differences and commonalities between human populations that can also be linked to other food consumption preferences.

This book was originally born from the ambition and interest of the members of the network SOURDOMICS (COST Action 18101 – *Sourdough biotechnology network towards novel, healthier and sustainable food and bioprocesses*) and the project expanded beyond this network to multiple researchers that developed valuable contributions when compiling the current knowledge on the rituals, traditions and recipes of ancestral processes of bread-making in multiple countries in Europe. This book includes multiple figures, pictures and illustrations that are not easy to access or not compiled currently in any other manual in relation to the history and tradition of both bread and/or bread-making processes. This includes pictures and illustrations related to bread-making process, including primitive ovens, tools and products that are currently exhibited in various museums in different countries that exemplify the differences in the ways of living and traditions in different European countries. Furthermore, each chapter also provides the readers with detailed scientific and technological background on these bread-making processes and information on consumer trends in different countries that can be used to evaluate the current situation and future market scenario for bread and bread-related products across Europe.

The book starts with a first chapter, conceptualized by one of the editors, summarising briefly the history of bread-making, bread and bakery products globally; reflecting also on the wide variety of shapes, flavours and tastes of bread and the current "know-how" and scientific literature explaining the complex reactions (physical, chemical and microbiological reactions) that occur at various stages of the bread-making process for the creation of some of the most widely consumed types of bread globally. Moreover, the chapter also covers the current technologies and scientific developments to improve several stages of the bread-making process that allowed the intensification and widespread production of bread and the expansion of shelf-life of the products that allowed an increase in exports and global consumption of several breads. Following this initial chapter, the book continues by describing different aspects of bread-making, traditions and beliefs associated with this product, as well as market trends, current consumption, recipes and research of different varieties of bread produced and consumed locally in various European countries. Each of these 17 chapters, developed by researchers and experts in the field of food science, focused on the bread-making processes and bread products and traditions of one country and/or region, covering in the present edition the contributions of authors from the Baltic countries (Estonia, Latvia, Lithuania), Bulgaria, Croatia, Cyprus, Germany, Greece, Hungary, Italy, Latvia, Malta, Poland, Portugal, Romania, Spain, Turkey and Ukraine.

The readers of this book will discover the history and evolution of bread, a current and ancestral staple food product that developed alongside the human race, resulting in a wide variety and range of interesting traditions and ways of bread-making that were preserved and passed on through generations in different countries and that led to the current wide variety of clearly distinctive products locally produced in different regions in Europe. Intriguing associations and beliefs associated with the process of bread-making and consumption, including myths, religious rituals and oral traditions in different regions, mix in this book with scientific knowledge on the changes occurring in flour for the creation of different bread products. A book in which tradition mixes with scientific knowledge and ancestral know-how that is passed on from generations and still pervades in different regions, coming to the present to enrich our knowledge and understand the present and future direction of this food product that will forever be linked and continue to evolve together with the humankind.

I hope the science and stories curated in this book can help to preserve and keep these traditions, myths, legends and products alive, so future generations can discover, enjoy and benefit from this ancestral knowledge.

Dublin, Ireland
January 2023

Marco Garcia-Vaquero

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Chapter 1
The Fundamentals of Bread Making: The Science of Bread

Rahel Suchintita Das, Brijesh K. Tiwari, and Marco Garcia-Vaquero

1 Introduction

Bread in its countless forms is considered as one of the most widely consumed staple foods by humans (Cauvain and Young 2007). The most commonly perceived variety of bread is prepared by heating a shaped and molded dough formed by kneading and mixing cereal flour, typically wheat flour, with water, salt, and a leavening agent mainly yeast which is universally used as the chief biological leavening or rising agent in bread manufacture. The role of yeast in bread is to ferment sugars in the flour into small amounts of ethanol and most importantly, carbon dioxide gas (CO_2) that causes the dough to rise during baking. During baking the bread acquires their characteristic crumb and crust. The crust appears as a continuous, compact envelope developed around the bread during baking operation, and the crumb is characterized by a cellular structure (Della Valle et al. 2012). An essential component of bread is the formation of gluten, a process which does not occur in other bakery products, such as cakes, to any significant degree (Cauvain and Young 2006). Most biscuits and pastries also have limited gluten formation compared to bread

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products. In laminated products, gluten formation is encouraged to some extent and bakers use a specialized layering technique to incorporate fat but without disrupting the gluten (Cauvain and Young 2007). Dewettinck et al. (2008) has decribed bread as a fermented confectionery product produced primarily from wheat flour, water, yeast, and salt by a series of processes involving mixing, kneading, proofing, shaping, and baking. Certain types of bread are manufactured with a chemical leavening agent such as baking soda instead of yeast and some without any leavening agent which do not rise and appear flat. Moreover, varieties of bread of different sizes, shapes, flavors, textures, prepared from diverse ingredients, processed under different conditions exist across many continents (Zhou and Therdthai 2006).

The wide variety of shapes, flavours and taste of bread and multiple procedures for the production of this product is currently considered a "know-how" preserved and maintained for generations mainly as part of their oral tradition, but also art and traditional artifacts that were still maintained and used in rural areas or private households as seen in the multiple chapters of this book focusing on the traditions related to bread across all European countries. As the science evolves, the complex processes of bread making and the differences in the process of bread production, that enable the bakers to produce such a huge variety of clearly distinguishable products, have been investigated and in most cases elucidated. This chapter summarises the science behind bread making and the complex reactions, including the physical, chemical and microbiological reactions, that occur in most cases simultaneously at various stages of the bread making process in several bread varieties. Due to the wide varity of breads in Europe, but also around the globe, this chapter also emphasises the main disoveries in bread manufacturing and the opportunities to bring the traditional know-how of different breads in Europe at industrial scale by the use of several technological aids and scientiffic improvements.

2 Brief History of Bread Consumption

Bread has been stated to be one of the oldest, if not the oldest 'processed' food. In its earliest forms bread would have looked quite distinct from how it is available in modern times, post industrialization (Cauvain and Young 2007). Traditionally the production of bread was mainly linked to fully fledged agricultural population of the Neolithic period in Europe and southwest Asia. However, the recent discovery of charred food remains at Shubayqa 1 by Natufian hunter-gatherers in northeastern Jordan (see Fig. 1.1), empirically dates the production of bread-like foodstuffs to 4000 years before Neolithic agriculture emerged in southwest Asia (Arranz-Otaegui et al. 2018).

The effort taken by our ancestors to improve the digestibility of the wild grass seed precursors of early wheat varieties, by cooking or baking stands testimony to a great step in the evolution of food production by mankind. They comprehended the unique ability of the proteins in wheat to form a cohesive mass of dough after crushing the grains and wetting it followed by subjecting the mix to the mechanical energy of kneading. The formation of this cohesive mass has been attributed by

Fig. 1.1 Picture of the site of Shubayqa 1 showing the oldest fireplaces on the site with bread-like remains. (Image taken from Arranz-Otaegui et al. (2018) originally published by PNAS)

scientists and bakers to the protein 'gluten' developed in wetted wheat flour during kneading which has the ability to trap gases produced by fermentation leading to dough expansion during baking. Gradually through the portals of evolution, the actions of wild yeasts and portions of old dough which is now referred as the starter or mother dough were acknowledged that ultimately paved the way for production of specialized bakers' yeasts we use today. Over the centuries, bakers from every corner of the world have crafted and experimented with traditional bread varieties using their hard gained experience to achieve appreciable bread quality. In recent times, scientific studies and technical advancement have catered to provide efficient, faster and more cost effective ways of bread production that can be integrated with the traditional recipes of craft bakers to satisfy consumers' demand for fresh, wholesome and palatable products as well as to maximize profits of the bread manufacturing industries (Cauvain and Young 2007). Recently, the market report "Bread market – growth, trends, and forecasts (2020–2025)" (Mordor Intelligence 2020) estimated that the global bread market is projected to register an annual growth rate of 1.43% during the period, 2019–2024 as bread dough is a versatile matrix that can be derived into a wide variety of products after processing. Traditionally, bread has been perceived as a staple food, with a ubiquitous consumption worldwide and with time there has been an increased demand of multiple varieties of ethnic breads and whole-meal, multigrain breads, with oats, bran, seeds, etc. Moreover, the bread manufacturers are also promoting the production of regional bread specialties to diversify their products, with fortified, clean label and organic breads being amongst the most demanded bread types amongst health conscious consumers.

3 Types of Bread

There are innumerable varieties of bread around the world with multiple and differentiated characteristics, such as those made from different grains, breads including diverse ingredients and also products produced through varied techniques to avail for multiple shapes and sizes. However, in general bread can be broadly classified into 3 main types (El Sheikha 2015).

3.1 Yeast Breads

These breads are leavened by yeasts and have medium-high rise or volume. The gases released by yeast fermentation get entrapped in the dough which develops a sponge-like microstructure when baking, with air cells enclosed by walls with starch granules embedded in a fibrillar gluten matrix. Yeast breads are eaten globally and most significantly by people in the United States, Canada, and many European nations. White pan bread is the most common variety, but others are gaining commercial popularity crossing the geographical boundaries of their countries of origin. Baguette (French bread), brioche (French buns), Boule (French bread), ciabatta (Italian white bread), Michetta (Italian bread), Challah (Jewish braided bread), Bagel (Polish/ Jewish ring shaped bread), Kugelhopf (Austrian and French bread), Bara Brith (fruit bread of Wales), hamburger and hot dog buns, croissants, sourdough and loaves such as whole wheat, cracked wheat, pumpernickel, rye, and rolled oats, are few examples of yeast bread (Callejo 2011; Chapman 2012; Di Monaco et al. 2020; El Sheikha 2015; Hayakawa et al. 2010; Schlegel-Zawadzka et al. 1933; Wilder 1933).

3.2 Flat Breads

Flat breads may be yeast leavened or unleavened and they have lower specific volume than that of pan bread (Gocmen et al. 2009). They are prepared using batters or kneaded dough and are easily mixed and quick to cook. Flat breads include tortillas (Mexico); Jewish matzah; crepes and crepe like chickpea flour bread (France); dosas, chapatis and parathas (India); Mandarin pancakes and scallion bread (China); okonomiyaki (Japan); pita bread and Lebanese wrapper bread (Middle East) and many varieties crackers. Pita and Lebanese wrapper breads are made from yeasted dough and flattened to rise before baking (El Sheikha 2015).

3.3 Quick Breads

Most quick breads contain baking soda and/or baking powder, to make them rise. They can be made quickly through simple steps. Quick breads include quick loaves such as corn bread or banana bread, muffins, biscuits, coffee cakes, scones, pancakes and waffles (El Sheikha 2015). Today consumers are progressively cosmopolitan in their taste for bread influenced by international travel and cultural exchanges, leading to a broader acknowledgement of the endless varieties of bread. In Europe, for instance, Italian ciabatta, Indian chapattis and French baguette are eaten along with sliced pan bread (Cauvain and Young 2007).

4 The Process of Bread Making

With time, the global market has been flooded with a plethora of bread varieties and thus, multiple bread making processes, almost all of them with the common objective of converting raw flour into a leavened food product mostly via fermentation have been practised. The standard process of bread making to produce pan or loaf-type bread includes major sequential operations described below (Cauvain and Young 2007).

4.1 Sieving Flour and Other Dry Ingredients

This process aims to eliminate any extraneous matters and coarse particles. Moreover, this process also contributes to partially incorporate air and make the flour more homogeneous and free of lumps (Patel et al. 2019).

4.2 Weighing Ingredients

Weighing of different ingredients is carried out as per formulated recipe in appropriate ratios. The formulation for bread varies from bakery to bakery depending on factors such as the cost of ingredients and consumer preference with respect to quality of bread. Salt, sugar, flour improvers, such as oxidizing agents, are added in solutions; while yeast is added as a suspensions (Bhatia 2016). Generally shortening and salt are added after the clean-up stage to reduce the dough mixing time as the sequence in which ingredients are added influences the dough characteristics (Khetarpaul 2005).

4.3 Mixing Ingredients and Dough Formation

The mixing process aims to uniformly distribute all the ingredients to allow the development of gluten in the dough, thus having optimum physical characteristics, with respect to elasticity, resistance to deformation, extensibility, viscosity and stickiness of the dough (Cauvain and Young 2007). All of these factors will influence the pore structure of the bread (Therdthai and Zhou 2014). When the ingredients are mixed with water, hydration occurs at the surface of the flour particles due to the mechanical energy input provided through progressive mixing. This combined action of hydration and continued mixing leads to the gradual formation of the gluten network in the dough depending on the applied shear and elongation forces during the mixing process. Conventional mechanical mixers generally deliver combined deformation flows through blending, stretching, combining, pushing, compressing and folding the dough (Therdthai and Zhou 2014). At a chemical level, mixing allows the polymerization and cross-linking of proteins present in the wheat flour (glutenin and gliadin), generating a 3D structure or gluten network characterized by the oxidation of their sulfhydryl groups (-SH) and cross-linking and rearrangement of previously existing disulfide bonds that will impart the strength of the dough (Ortolan and Steel 2017). An image of the chemical changes due to the formation of gluten and the microscopic appearance of the gluten network are represented in Fig. 1.2.

The dough system on further mixing becomes more cohesive forming a viscoelastic mass with elastic and viscous properties generally attributed to glutenin and gliadin, respectively (Xu et al. 2007). Excessive shear and mechanical energy due to continued or excessive mixing beyond this stage will cause break-down of the reasonably stable molecular interactions between gluten-forming proteins, depolymerization of large gluten aggregates and disruption of the dough network (Hamer et al. 2009; Bhatia 2016). However, under-mixing may cause small unmixed patches that interfere at the later proofing stage (Rosell 2011). Other effects that occur during mixing involve the incorporation of air that will be essential to provide oxygen for the processes of oxidation and yeast activity. Moreover, this air will generate gas bubble nuclei for the carbon dioxide that will be released by yeast fermentation and the gluten network will prevent the losses of carbon dioxide gas during baking (Cauvain and Young 2007).

The process of mixing can be performed industrially using multiple equipments which are able to mimic a hand-mixing action of compressing and stretching operations (kneading) at high speed, reducing the time of this operation to only few minutes (Marsh and Cauvain 2007). Few of the commercial equipment commonly used at this stage include low speed, spiral (allow both fast and slow speed mixing) and high speed mixers (planetary, horizontal and continuous type mixers).

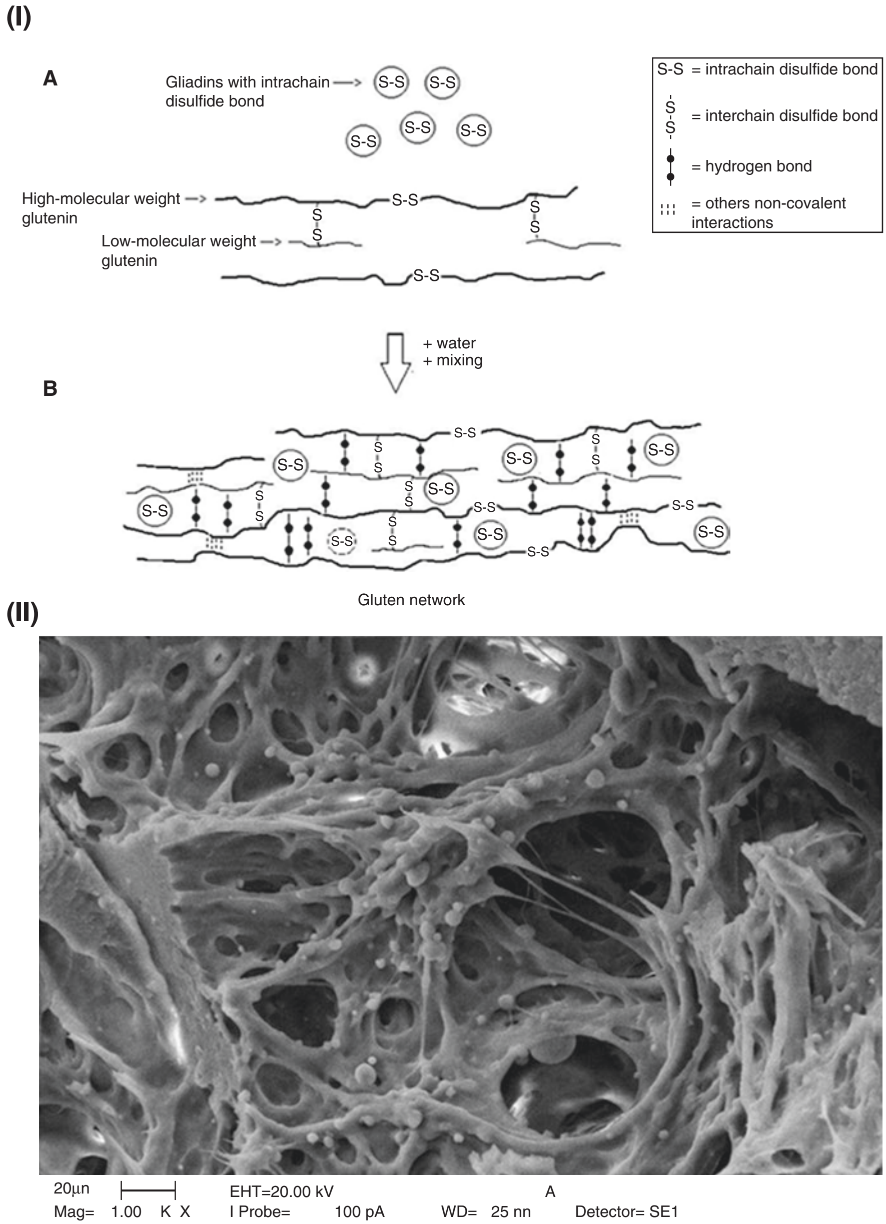

Fig. 1.2 Image of the molecular interpretation of gluten network and the effects of water addition and mixing (**I**) and a scanning electron micrographic image of the gluten network (**II**). (These images were published by Ortolan and Steel (2017) and reproduced with permission from John Wiley and Sons)

4.4 Fermentation Process

The mixed dough should be fermented for a suitable length of time to obtain a light aerated porous loaf of bread (Rao 2017). Fermentation is achieved by adding yeast cultures *(Saccharomyces cerevisiae*) or other cultures, such as lactic acid bacteria (LAB) in case of sourdough, at an appropriate ratio and mixed in the dough (Struyf et al. 2017; Teleky et al. 2020). The key role of the yeast in bread-making is acting as leavening agents. The enzymes in the flour and yeast breakdown starch to sugars which are then fermented by the yeast, primarily to CO_2 and alcohol, and small amounts of glycerol and various compounds (alcohols, esters, aldehydes and organic acids) that contribute to the flavor and aroma of fermented bread-dough (Struyf et al. 2017). The CO_2 gas bubbles produced during fermentation leavens the dough into a foam structure that when baked will generate the aerated structure of bread-crumb (Dobraszczyk et al. 2005).

The leavening process relies on sufficient gas-production that will be influenced by the availability of soluble, fermentable sugars, and on the retention of that gas in the dough that will depend mainly on the amount and properties of the dough (Stear 2012). The fermentation process will depend on multiple parameters with a variable time estimated in 2–6 h or even longer depending on the concentration of yeast added, method of baking and variety of flour used (El Sheikha 2015). The temperature and relative humidity conditions are critical for yeast activity with temperatures ranging from of 30–35 °C and relative humidity of 85% and higher ensuring good yeast activities, while above 40 °C the yeast's performance decreases. The optimum pH range for yeast is 4–6 and below pH 4 the yeast activity begins to diminish and it is inactivated below pH 3 (Bhatia 2016). Presence of nutrients in the form of vitamins and essential mineral compounds also affects the activity of yeast (Broach 2012). The process of fermentation produces multiple and interlinked chemical and physical changes that can be appreciated microscopically in the dough (see Fig. 1.3).

The changes appreciated during fermentation include:

1. Hydrolysis of starch to simpler sugars, that will be then fermented by yeast. The enzyme diastase present in wheat flour begins to breakdown starch in the flour to maltose. Maltase enzyme converts maltose into glucose, invertase enzyme transforms any added sucrose into glucose and fructose and zymase complex converts the glucose and fructose, in the absence of oxygen, to carbon dioxide gas, alcohol and other flavor and aroma organic compounds (Kamel and Stauffer 2013; Rao 2017). The release of CO_2 is accompanied by the growth of air bubbles previously incorporated during mixing and the alcohol will mainly evaporate during baking (Rosell 2011).
2. Lactic acid bacteria produce acids from sugars, subsequently lowering the pH of the dough from 5.5 to 4.7 (Rao 2017), as recorded in sourdough (Teleky et al. 2020).
3. Proteolytic enzymes from flour and yeast also contributes to increase the extensibility and elasticity of the gluten, helping in the retention of gas as the gluten network will expand without rupturing (Rao 2017).

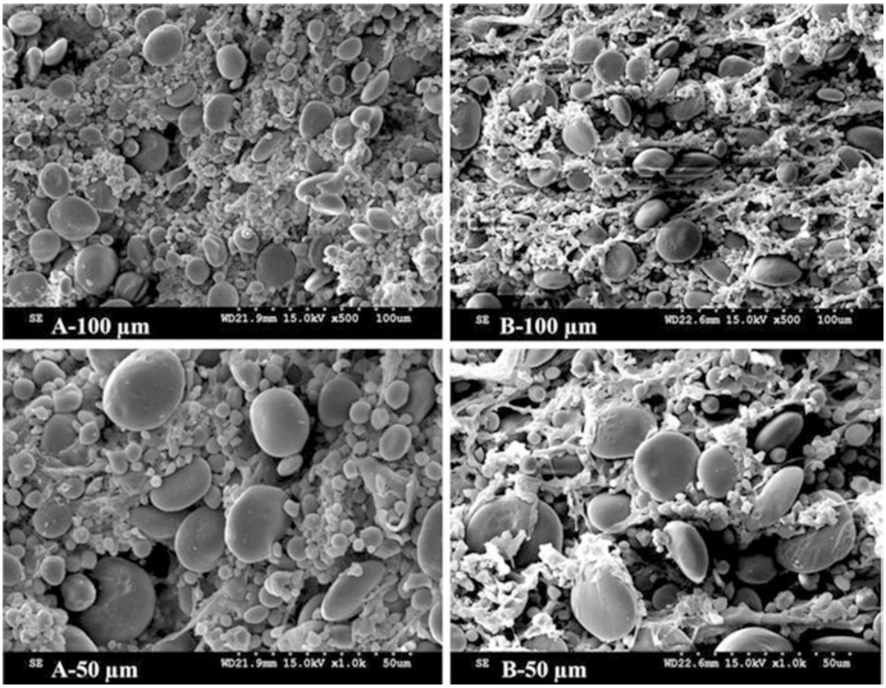

Fig. 1.3 Physical changes in the dough due to the effect of *Saccharomyces cerevisiae* at the beginning (**a**) and end (**b**) of the fermentation stage of dough. (The images were published by Zhang et al. (2018) and reproduced here with permission from Springer Nature)

4.5 Knock Back or Re-mixing of Dough

Kneading or remixing of the dough facilitates expulsion of large gas bubbles and re-dispersion of gas forming smaller, more regular and uniformly distributed bubbles within the dough (Hutkins 2008; Rosell 2011). Punching or knock back of dough in between the fermentation periods enhances the gas retaining capacity of the dough (Kumar 2018).

Knock back also helps in (1) the equalisation of the temperature throughout the dough which assures more uniform proofing, (2) the redistribution of yeast cells and nutrients such that more substrate is available to the yeast for fermentation (Hutkins 2008); and (3) the incorporation of atmospheric oxygen to stimulate yeast activity and the mechanical development of the gluten by the stretching and folding action. The accurate time for the first punch is usually determined by inserting the hand into the dough, withdrawing quickly and observing the behaviour of the dough. If the dough reshapes itself, it is ready for the first punch. This point is normally reached when 60% of the fermentation time is completed (Rao 2017).

4.6 Dough Make-Up

The operations constituting dough make-up aims to transform the fermented bulk dough into appropriate molded dough portions which when baked after final proofing yield bread with desirable properties (Bhatia 2016). This stage involves multiple operations:

4.6.1 Dividing (Scaling)

The bulk dough is divided into uniform individual pieces of predetermined weight and size depending on the final weight of the bread required. Generally, 12% extra dough weight is taken to compensate for any baking loss. Dividing should be done quickly to ensure uniform weight and to prevent any change in the density of the dough due to the produced CO_2 which may cause variation in the weight. If there is a delay in dividing, corrective steps should be taken, such as by degassing the dough. Where the dough comprises of evenly distributed uniform sized bubbles, the density of the dough remains constant and dividing is more accurate (Rao 2017). Dough is generally divided with portions of a given size, cut either by filling a chamber with dough and cutting off the excess namely piston dividing or by forcing the dough through an orifice at a fixed rate and cutting billets at regular intervals from the end in a process known as extrusion dividing. Moreover, some dividers are coupled with pressure compensators to prevent breakdown of dough bubble structure (Marsh and Cauvain 2007). Mechanical damage can occur when dough faces aggressive tearing between machine parts during this operation and thus, different dividers should be used for different dough types to optimise accuracy and minimal compression damage. For example, typically ‘strong’ North American bread dough can withstand high compression loads, whereas more delicate dough for French baguettes can be easily damaged.

4.6.2 Rounding

When the dough piece exits the divider, it is irregular in shape having sticky cut surfaces through which gas can easily diffuse. The function of the rounder is to shape it into a ball and impart a thick continuous surface skin that will retain the gas and ease the handling or machinability of the dough (Matz 1991).

In traditional hand moulding methods, baker kneads the dough with a rotary motion on the make-up table to produce a ball-shaped piece with smooth skin, except one spot on the base. When two pieces are moulded (one in each hand) using circular motion of one piece against the other, it often helps in imparting the round shape. There are some industrial equipment for high-speed or large-scale rounding in bakeries including:

1. Conical rounder: It consists of a cone which is rotated about a vertical axis with the track of the fixed moulding surface located in a spiral pattern about the outside of it. It is ideal for rounding both soft and medium dough. The cone rolls the dough along the concave spiral-shaped way and enables production of spherical loaves (Marsh and Cauvain 2007).
2. Belt rounder: This equipment can be classified as 'V'-type, vertical and horizontal types. In horizontal type, a track or bar is placed upon or across a conveyor with its axis in the horizontal plane. The belt and straight rounding bar or track set at an angle. The friction generated between rounding bar and the dough causes the dough to get rounded, while it is conveyed on the belt. V type has two belts orientated in a V fashion. One of the belts is driven at a higher speed. The difference in the speed of the belts generates shear and friction. These factors help in shaping the dough and converts the irregular dough into a proper rounded ball (Marsh and Cauvain 2007).
3. Cylindrical rounder: This uses a track around a cylindrical drum to mould the dough pieces (Marsh and Cauvain 2007).

4.6.3 Intermediate Proofing

Dividing and rounding dough causes a drop in its pliability, elasticity and extensibility and thus, the dough may tear easily. It is necessary to let the dough piece rest while fermentation proceeds to restore these properties, so that it recovers from strains and stresses caused by previous operations (Bhatia 2016). This is known as intermediate proofing which is a short rest period of 2–20 min between dough-dividing and the final moulding. During, this process a continued fermentation and a structural relaxation of the gluten take place (Bhatia 2016; Lai and Lin 2006). The length of the intermediate proofing time influences the final bread cell structure, with longer proof times required in products like French baguette that have an open cell structure (Marsh and Cauvain 2007).

Suitable proofing conditions include controlled temperatures (26.7–29.4 °C) and a relative humidity of 75%. Higher temperatures decrease the gas-holding capacity of the dough, producing a sticky mass, while lower temperatures below that range will not allow proper gas expansion due to a slowdown of the fermentation process. Lower relative humidity will harden the dough pieces leading to hard curls and streaks in the bread crumb. If the relative humidity is too high, moisture condensation will occur on the dough surface (Pyler 1988). The changes in dough properties during this period are influenced by other factors such as reducing agents or proteolytic enzymes that have been used to improve dough extensibility (Marsh and Cauvain 2007). There are commercial equipment, such as the pocket-type and conveyor provers for large-scale production bakeries to obtain an optimum intermediate proofing (Marsh and Cauvain 2007).

4.6.4 Moulding

Dough moulding is the terminal step of the dough makeup stage. It is a continuous operation, where the molder receives pieces of dough from the intermediate proving and shapes them according to the bread variety being produced, and makes them ready to be placed in the pans (Bhatia 2016). This process includes 3 basic steps:

1. *Sheeting:* In sheeting, the dough is passed through a series of closely spaced counter-rotating roller heads between which the dough piece is passed to progressively flatten it and reduce the thickness up to one-tenth while the surface area gets enhanced by a factor of more than three. Some systems employ consecutive sheeting rollers of fixed but increasingly narrowing gaps, while other systems use larger drum and roller sheeting where the dough piece is reduced once between a non-stick roller and a drum (Cauvain 2012a; Marsh and Cauvain 2007). Sheeted dough can be easily handled in the later stages of moulding. During sheeting, large gas bubbles within the dough can be subdivided to improve the bubble distribution in the dough and thereby yield a fine structure of breadcrumb.
2. *Curling:* The sheeted dough is carried by a belt conveyor under a flexible woven mesh chain that rolls into a cylindrical form. The rolling operation should produce a relatively tight curl that will prevent air entrapment that can lead to the formation of unwanted holes in the baked loaf. The ellipse that has been created by sheeting is curled through trapping the leading edge underneath a static chain, which creates a roll of dough. The curled dough piece finally passes under a pressure board to eliminate any gas pockets within and to seal the same (Marsh and Cauvain 2007; Rao 2017).
3. *Final moulding:* The final moulder is, basically, a forming conveyor which gives the dough piece its final loaf-type or cylinder shape by exerting downward/outward pressure and forcing the dough against side bars. This operation de-gasses the dough pieces resulting in uniform, tight, and sealed cylinders (Cauvain 2012b). Modern high-speed moulders have several variable speed drives for their different rollers and belts so that they can be fine-tuned for faster or slower production rates.

4.6.5 Final Proofing/Proving

A dough piece which has undergone the processes of sheeting and molding appears degassed and lacks in volume. During this final resting period the fermentation of dough continues in the baking pan for desired dough height. During final proofing, organic acids are formed through yeast activity and contribute to flavour development and increased shelf life. Sufficient time is necessary to enable the dough pieces to relax; otherwise it can result in poor volume and a dense texture. This process is regularly performed at 30–35 °C and 85% relative humidity. The temperature, humidity and time of proofing will depend on the variety of factors such as flour strength, dough formulation with respect to oxidants, dough conditioners, type of shortening, degree of fermentation and type of product desired (Bhatia 2016; Rao 2017).

4.7 Baking

The dough can undergo certain pre-treatments before the final bake, including glazing and scoring. Glazing is a surface coating method for enhancement of the quality factors of bakery products such as increasing the shine or even modify the color of the crust (Jahromi et al. 2012). Glazes which are applied before baking are typically made of whole eggs, skim milk, shortening and may contain various sugars, gums, and starches (Chin et al. 2011; Jahromi et al. 2012). Scoring is the process of making "cuts on their surface" and is one of the characteristics of bread made in different countries as seen in multiple examples in the traditional breads mentioned in this book. By scoring the loaves, the baker creates precise paths for carbon dioxide to escape when the pressure becomes too great inside the dough during oven spring. Consequently, scored dough will expand more during the oven spring and the loaf will increase in volume. The choice of the technique will depend on the type of dough, the type of bread, and the desired final appearance (Suas 2012).

With respect to the baking process, the temperature of this process normally ranges between 220 and 250 °C with variations depending on the oven and product types. The well aerated bread dough coming out of the final proofer has a typical internal temperature close to that of the proof box, around 35 °C. As the dough pieces enter the oven, their surface temperature begins to increase and heat slowly gets transferred towards the core of the product. During baking, the temperature of dough center reaches to about 92–96 °C to ensure that the product structure is fully set (Cauvain 2012b). Baking involves simultaneous heat and mass transfer phenomena (Zheleva and Kambourova 2005). Heat transfer occurs through several mechanisms such as convection through hot air, radiation from heat sources such as flames, conduction through heated surfaces accompanied by condensation of steam and evaporation of water. While heat travels from the surrounding air into the interior of the dough, moisture and other liquid compounds diffuse from the core towards the exterior or surrounding air due to evaporation (Fellows 2009). A series of physicochemical changes occur which are responsible for transforming the raw dough into a baked good with a firm, dry crust and a soft crumb (Jusoh et al. 2013; Rathnayake et al. 2018). As the baking process of the dough starts in the baking oven, it undergoes several physical and biochemical changes which are described below:

1. *Physical changes of the dough during baking*. There is a steady increase in pressure during early baking stages together with other changes in the dough.

   Oven-spring: This change consists in the sudden dough expansion at the initial stages of baking due to an increase in internal pressure of the dough. The following events occur simultaneously to produce the oven spring

- Yeast reaches its maximum fermentation rate and generates CO_2 (CO_2 is also produced by chemical leavening). The yeast activity decreases as the dough warms and the yeast is inactivated at 55 °C.
- Release of CO_2 from the saturated liquid dough phase into the surrounding gas cells.
- Expansion of the gasses trapped in cells (nitrogen from air and CO_2) and generated during mixing, makeup, and proofing.
- Evaporation of water/ethanol mixture.

Crust formation: The dough develops a skin and forms a crust as moisture evaporates from surface of dough during heating. The crust provides the strength of the loaf.

Alcohol evaporation: Low boiling point alcohol formed by the yeast's fermentation evaporates when the temperature is around 80 °C. The alcohol vapours increase the internal pressure which helps in further oven rise.

2. *Biochemical changes during baking*

Starch gelatinization: Starch begins to gelatinize at about 60 °C. The dough now has limited water to completely gelatinize the starch. This limited gelatinization of dough helps in gas retention and setting of bread texture. Gelatinization commences when the temperature is at around 74 °C, and continues until the end of the baking process.

Gluten coagulation: At 74 °C the gluten starts to coagulate, and the chains of protein begin to solidify. This process is called gluten coagulation. Gluten matrix surrounding the individual cells is transformed into a semi-rigid film structure.

Enzyme activity: The action of amylase on starch increases with temperature approximately doubling for every 10 °C rise. Simultaneously, heat inactivation of the enzymes also begins. β-amylases are denatured at lower temperature (57–71 °C) in comparison to α-amylases which denature at higher temperatures ranging from 65 to 95 °C. Inadequate amylase activity can limit loaf volume as the starch can quickly become rigid while excess amylase activity may lead to collapse of loaf.

Browning reaction: The Maillard browning reaction starts at around 150 °C. Under high temperature, reducing sugars react with amino acids of protein or other nitrogen containing substance forming dark colored compounds, known as melanoidins (Wang et al. 2011). This reaction also imparts colour to the crust and flavour to the bread. Pyrazines and pyrroles contribute significantly to bread aroma, notably ethyl pyrazines and 2-acetyl-1-pyrroline (Cho and Peterson 2013; Prost et al. 2012).

Caramelization of sugars: When sucrose is heated to around 170 °C the molecules polymerize to form coloured substances called caramels. This reaction known as caramelization, can only take place in the crust because of the internal loaf temperature never exceeds 100 °C. The caramelized products impart colour and flavour to the baked product (Bhatia 2016; Rao 2017).

4.8 Cooling, Slicing and Packaging

Bread has to be cooled before slicing and wrapping to facilitate slicing and prevent condensation of moisture in the wrapper. Desirable temperature during slicing is 30 °C. Cooling facilitates in redistribution of moisture from centre to the crust softening this layer. The internal temperature of the bread should be reduced to 35–40 °C towards the end of the cooling cycle and this is normally achieved by applying an external air temperature of 24 °C at a relative humidity of 85%, with an air movement. Bread is normally packaged at the legal limit of 38–42% moisture (Bhatia 2016; Rao 2017).

5 Role of Ingredients and Methods for Dough Preparation

A summary of the overall the roles of different ingredients during the development of bread are compiled in Table 1.1.

The complete sequential process of bread making process has been described above including processes common to most types of bread such as dividing the dough, shaping, proving and baking. However, there is significant variation in the methods used to prepare the bulk dough. These may be classified into broad processing groups although there are numerous variations and steps overlapping between each of the individual groups.

5.1 Sponge and Dough Process

In this process a part flour (generally two-third), part of water and yeast are mixed to form a loose batter or dough (sponge). The sponge is allowed to pre-ferment for up to 5 hours. In the next step, the balance of water and flour is added along with other ingredients in the formulation to the fermented sponge, mixed into fully developed dough, which is divided into pieces to produce bread loaves of chosen weights after baking. Sponge and its unique rheological character are carried through to the dough where they have the effect of producing a softer and more extensible gluten network after the second mixing. These dough pieces are then rounded, provided a relaxation period, sheeted and shaped into elongated dough pieces. Thereafter, they are placed into baking pans and transferred for proofing where they are proofed to optimum heights, baked, cooled, sliced, and wrapped (Cauvain 2015a; Cauvain and Young 2007; Kulp and Ponte 2000).

The sponge and dough process produces soft bread with uniform crumb grain structure with unique flavour and aroma. It is commonly used in pan bread, buns and other bread varieties popular in Asian countries, North America and Central Europe. This method is still popular in small bakeries, although it has been

Table 1.1 Role and details of use of commonly used ingredients in bread

Ingredient	Role	Details of use	Reference(s)
Flour	• Protein (gliadin and glutenin) of wheat flour form gluten with water. Gluten retains gas formed by fermentation and contributes to structure of dough and bread. • Starch with water forms a viscous paste on gelatinization that sets to a gel after baking.	High protein (11–13%) patent flour having gluten strength: medium to strong is chosen for bread Bread flour is generally made from the protein-rich endosperm of hard red spring or hard red winter varieties. Some may have a 50–50 blend of hard winter and spring wheat or hard white wheat blended into the mix Several types of bread flour are commercially available, namely, all-purpose flour, enriched flour, gluten flour and self-rising flour. Bread flour is available bleached or unbleached and may contain added malted barley flour and nutrients to improve yeast activity. Flours used in typical sponge and dough production will be at least as strong as those used in bulk fermented dough, with protein contents not less than 12% and high Hagberg Falling Numbers signifying α-amylase activity (typically > 250 s). Larger the proportion of damaged starch in the flour, higher the water absorption of the flour.	Kulp and Ponte (2000), Cauvain (2012a), Dencic et al. (2013), and Stauffer (2007)
Water	• Combines (hydrates) protein to form gluten • Hydrates flour gums (pentosans) and damaged starch granules • Acts as the solvent, dispersing agent, and medium for chemical and biochemical reactions • Aids dough mobility	The amount of water added depends on the type of flour and the dough processing technique. But is usually half the weight of flour used. Too little and the dough will be firm and difficult to mold producing breads that have small volume and poor external appearance. Too much and the dough will be soft and will flow in the prover and give poor-quality bread The water should be slightly warm, 36 °C is ideal, to encourage fermentation by yeast. Too high temperature reduces yeast activity. Water should be clean and potable	Kulp and Ponte (2000), Cauvain and Young (2009), and Cauvain (2012a)

Baker's Yeast *Saccharomyces cerevisiae*	• Produces carbon dioxide, ethanol by fermenting sugars that leavens the dough • Biochemically conditions the dough • Forms flavour precursors which are by-products of alcoholic fermentation	**Type & Moisture content of yeast (%)**	**Shelf Life**	**Method of addition to dough mix**	Kulp and Ponte (2000), Cauvain (2012a), Bhatia (2016), Williams and Pullen (2007), Cauvain and Young 2007), and Bhatia (2016)
		Fresh, compressed Cake Crumbled; 67–72	3–4 weeks	Weigh and add with other ingredients or disperse	
		Fresh, cream (liquid); 80–84	10–14 days	Meter and add with other ingredients.	
		Dry			
		Active dry yeast (ADY); 6–8	1–12 months	Must hydrate at 40–43 °C for 10–15 min, then use.	
		Instant dry; 4–6	1 year plus (depending on packaging)	Blend dry with other dry ingredients or delay addition in mixer.	
		Yeasts are selected based on their ability to fulfil the bakery's requirements, bread type, dough system, processing conditions and equipment. The most favoured pH range for yeast activity is 4.5–6.0. Bread doughs normally have a pH of 5.5 Rate of fermentation depends on level and type of yeast added. Salt and sugar increase osmotic pressure that slows down yeast activity			

(continued)

Table 1.1 (continued)

Salt (sodium chloride)	• Helps control fermentation • Toughens dough by interaction with gluten • Extends required dough development (delayed addition in dough mixing decreases mixing time by 10–20%	Salt can be added with the dry ingredients. Many plant bakeries add the salt through a brine system to ensure accurate metering and to facilitate quick dissolution. Recommended usage is 1.8–2%	Kulp and Ponte (2000) and Cauvain (2012b)
Milk	• Protein (high in lysine) and calcium • Flavour enhancement • Milk sugars aid in developing crust colour through browning reaction and caramelization • Provides buffering effect in doughs and liquid ferments	Milk and dairy products category include whole milk or skimmed milk, skim milk powder, whey and whey mixes that can be added to mix	Kulp and Ponte (2000), Madenci and Bilgiçli (2014), Bilgin et al. (2006), and Graça et al. (2019)
Sugar (table sugar or sucrose)	• Contribute fermentable sugars through enzyme hydrolysis • Imparts sweetness • Sugars take part in Maillard browning and caramelization reactions during baking imparting colour to the crust • Extends shelf life through increased hygroscopicity because of the presence of residual sugars • Tenderizes the crumb	In the UK and many other countries, little or no sugar is used in basic breads Around 6% of flour weight may be present in the sponge and dough breads of USA High fructose corn syrups and dextrose can be used to replace or supplement sucrose in bread formulation	Kulp and Ponte (2000) and Cauvain (2012b)

Shortening	• Eases gas cell expansion in doughs • Lubricates slicing blades during bread slicing • Extends shelf life • Tenderizes crust	Compound bakery fats are often used. The level in which it is used varies with type of flour. Wholemeal flours require higher levels of fat addition than white A proportion of the fat should remain solid in bread dough at the end of final proof, i.e. at 45 °C. In recent years there has been a trend moving from using partially or fully hydrogenated fats towards fractionated or inter-esterified oils	Kulp and Ponte (2000), Cauvain (2012b), Williams and Pullen (2007), and Baker and Mize (1942)
Improvers: This term covers any ingredient added to 'improve' the bread making potential of a given flour			
Oxidising agents	• Promote formation of disulphide bonds through the oxidation of thiol groups of gluten. This strengthens the gluten network, and shortens mixing time • Accelerates the natural aging or maturing of the flour • Bleach flour through oxidation of the carotene and xantho-phyll pigments	The use of oxidizing agents depends on legislation, flour quality and production process. Ascorbic acid is added in a level of 2–6 g/100 kg flour and is as fast acting and tolerant to mixing.	De Leyn (2014), Gioia et al. (2017), and Panozzo et al. (1994)
		Potassium bromate ($KBrO_3$) is a slow-acting oxidant that attains its full development in the oven Recently, some reports have associated bromate with possible health risks. Since then, the use of bromate has been reduced or banned.	
		Potassium iodate is a fast-acting oxidant that improves dough consistency immediately after mixing and development	
		Azodicarbonamide is a maturing agent used in a premix. It is fast acting and provides immediate oxidation when water is added	
		Calcium iodate reacts fast in dough. It is also referred to as lautarite and is prepared by passing chlorine into a hot solution of lime ($CaCO_3$) in which iodine has been dissolved	

(continued)

Table 1.1 (continued)

Reducing agents or reductants	• Weaken the gluten structure in the dough by breaking intra and/or intermolecular covalent disulphide (S-S) bonds between proteins. S-S bonds vanish and sulphydryl or thiol groups (S-H) are built. The advantages are improved machinability, shorter mixing time, reduced proofing time. • This is important when bakeries receive high-protein flours or need to process strong doughs in a short time to reduce energy consumption	L-cysteine is the most common reducing agent added to flour makes dough more extensible and less strong. Usual doses are between 10 and 30 g, 10% l -cysteine/100 kg flour Other reductants in use are sodium bisulphite and sodium metabisulphite	De Leyn (2014) and Gioia et al. (2017)

Emulsifiers	• Some act as dough strengtheners by promoting aggregation and cross-linking of gluten-forming proteins or conditioners while some act as crumb softeners and reduces staling • Improve dough handling properties, increases gas retention capacity for better volume, and extends shelf-life	DATEM (diacetyl tartaric acid esters of monoglycerides) are added to white pan bread, variety bread or buns produced with straight or no-time dough systems. They are added to pre-ferments, like sponges and flour brews, for optimum dispersion. The optimum dosage lies between 0.25 and 0.50%	Gioia et al. (2017), Nunes et al. (2009), De Leyn (2014), and Stauffer and Beech (1990)
		Calcium stearoyl-2-lactylate aids to make crumb structure finer and uniform, extends shelf-life, and improves machinability of the dough. Optimal dosage is 0.25–0.50% on a flour basis	
		Glyceryl monostearate boosts crumb softness. It also retards starch retrogradation. Optimal dosage is 0.2% relative to flour base. It must be emulsified in water before it is added to dough	
		Distilled monoglycerides are used as anti-staling agents as hydrates which are suspensions of monoglyceride crystals (beta -form), usually 20–25% in water having a creamy texture making them dispersible in dough. Blended fine powder of saturated and unsaturated monoglycerides are available which can be added to the dough directly	
		Lecithin produces a finer crumb grain, greater loaf volume, better gluten stability, better fat emulsification, extended shelf-life, and improved water hydration. Pure lecithin is insoluble in water and has to be made soluble. Addition of 0.2% pure lecithin (relative to flour base) gives the maximal improvement possible, depending on the flour quality	
Hydrocolloids	• They augment dough-handling properties, improve the quality of fresh bread • Extend the shelf-life of stored bread • Increase water retention and loaf volume, and decreases firmness and starch retrogradation	Carboxy Methyl Cellulose (CMC) contributes to yielding high volume and retarding staling. Both CMC and guar gum have proven to be beneficial in the formulation of gluten-free breads They must be used in small quantities (<1% flour basis)	Gioia et al. (2017)

(continued)

Table 1.1 (continued)

Wheat gluten	• Increases dough strength (1% gluten increases protein content by 0.6%) • Increases water absorption [1% added gluten (flour basis) enhances absorption by 1.5% (flour basis)] • Improves dough mixing of fermentation tolerance • Increases bread loaf volume	In whole-meal flour or bread having higher quantity of fibers or germs, addition of 5% or more vital gluten leads to good volume and a better texture Vital gluten can absorb almost twice its weight in water (140–180% water) The quality of dry vital gluten is assessed using the Brabender farinograph	Kulp and Ponte (2000) and De Leyn (2014)
Diastatic malt	• Contributes fermentable sugar- maltose • Contains amylases, which convert starches to sugar • Augments flavour. • Improves crust colour • Improves dough handling • Extends shelf life	Diastatic malt is an enzymatic malt produced from sprouted grains, typically barley. Diastatic malt powder contains active amylase that is a constituent of the sprouting process. There are two forms of amylase; alpha and beta. Both of which turn starches into sugars, creating food for the yeast Degrees Lintner is used to measure the diastatic power of malt. The higher the Litner value, the higher the ability of the malt to reduce the starch to sugars	Kulp and Ponte (2000), De Leyn (2014), Doerry (1995), Bera et al. (2018), and Anderson and Sallans (1937)
Enzymes: One of the major reasons behind the revival of enzyme use in the baking industry is the “clean label” trend wherein consumer demands for more natural products with lesser chemical additives. From a regulatory standpoint, enzymes are denatured during baking and, therefore, do not have to be declared on ingredient labels. Those that survive are required to be only labelled as “enzymes.” (Yada 2015)			

Amylases	• Convert starches to sugars. • Aids in crust colour • Improve dough handling • Extend shelf life by retarding staling	Heat stable, bacterial, and intermediate heat-stable bacterial/fungal amylases are available. Fungal amylases are preparations produced by molds, such as *Aspergillus oryzae, Aspergillus niger, Rhizopus oryzae, or Rhizopus delemar.* Their activity is much stronger than that of malt flour, but it is less heat stable than cereal amylases and they are inactivated before starch gelatinizes in the oven	Singh and Verma (2013), Kulp and Ponte (2000), Cauvain (2012b), Bonet et al. (2006), Primo-Martin et al. (2003), Yazar and Tavman (2012), Yada (2015), Olesen et al. (2000), Doerry (1995), De Leyn (2014), Moayedallaie et al. (2010), Lai et al. (1989), Courtin and Delcour (2002), De Leyn (2014), Bock (2015), and Bhardwaj et al. (2019a, b)
Lipases	• Lipases improve loaf volume and crumb structure • It has also been proposed that lipases may serve an additional function as anti-staling agents	Olesen et al. 2000 (Patent 6110508) discloses a method for improving dough properties through the addition of microbial lipases from *Humicola lanuginosu, Rhizomucor miehei, Pseudomonas cepacia,* and *C. pastase, Rhizomucor miehei*	

(continued)

Table 1.1 (continued)

Proteases	• Very strong flours have to be supplemented with proteases to obtain a certain degradation of the gluten structure. This leads to better machinability of the dough and lesser energy input. Loaves having bigger volumes and crusts do not develop cracks and blisters	Proteases are present in wheat flour in small quantities. Endo-peptidases attack inter-SS-bonds and modify the viscoelastic characteristics of dough. Exo-peptidases split off terminal amino acids such as leucine and phenylalanine, which influence colour, flavour, and taste of the baked product. Bacterial proteases originate from *Bacillus subtilis* and show mainly endopeptidase activity. *Aspergillus oryzae* is a source of fungal proteases	
Glucose oxidase	• Strengthens gluten network in low protein or weak flours to withstand machining during processing • Improved loaf volume at low levels and enhance crumb properties	Produced from fungi mainly from *Aspergillus niger* It is used at 50–100 ppm along with ascorbic acid to enhance their synergistic reaction pathways in order to decrease the quantity of vital wheat gluten required in a formulation It is also used in combination with xylanases to decrease the stickiness caused by the degradation of arabinoxylans	

Endoxylanases	• Water-unextractable arabinoxylans in the flour have an undesirable effect on bread quality. Addition of endoxylanases with the selectivity for the water-unextractable arabinoxylans supports to solubilize them, aiding in better gas retention, improved oven spring and loaf volume, and superior crumb structure • Addition of endoxylanases in an optimum dose reduces dough stiffness and dryness and improves dough elasticity and extensibility	Can be isolated from *Aspergillus niger, Aspergillus oryzae, Trichoderma reesei and Bacillus spp*. Fungal-derived xylanase is less temperature tolerant than bacterial-derived xylanase Stickiness is a problem with this enzyme, however, glucose oxidase is frequently used in combination with xylanase to produce a drier dough with enhanced machinability Overdosing abolishes the water binding capacity of the arabinoxylans and leads to dough stickiness	
Enzyme active soy flour	• Possess lipoxygenase enzyme, which helps in: • Whitening of bread crumb • Improving shelf-life • Increasing dough strength and mixing dough tolerance • Soy increases protein content	Baking experiments showed that the required resting time could be reduced to zero by adding 3% enzyme-active soy flour	

gradually replaced in commercial bakeries by faster production systems such as the straight or no-time dough. Other pre-ferments made with domestic baker's yeast are currently available as starters, such as biga and poolish used in Italian and French bakeries, respectively. Traditionally, a biga is made using flour, water and yeast. The quantity of water used is around 50–60% based on flour amount. Generally, 0.8–1% of fresh commercial yeast is used. It is then held at around at 20 °C for 18 h at 60% of hydration. A poolish is a pre-ferment made with 100% of hydration, which refers to equal parts of flour and water, and some or total amount of the yeast in the recipe with no salt. The quantity of yeast depends on the amount of flour into the poolish and varies according to the time for which the poolish is allowed to ferment. Generally, the poolish is allowed to ferment for period that ranges from 2 to 24 h at room temperature (Balestra et al. 2015).

5.2 Straight Dough or Bulk Fermentation Method

Breads made using this method are usually manufactured in retail operations. Mixing is done in a single step by combining all formula ingredients in the mixer. The mixing is continued to a full gluten development, until the dough develops a smooth finish texture. The dough consistency is kept firm to allow for softening of dough during the following bulk fermentation period. The dough is fermented until mature with or without degassing by punching while fermentation proceeds. The completely fermented dough then goes for dividing and machining in the same process as in the sponge and dough process. The aim of the straight dough process is to gain a high-quality and standardized batch of bread in a very short period of time (Kulp and Ponte 2000; Kumar 2018).

5.3 Liquid Fermentation or Brew Method

The principle of this process is basically the same as that of the sponge and dough method, except that it uses a liquid instead of a plastic sponge. The consistency of the liquid sponge allows its transfer as it can be easily pumped. The liquid sponges are formulated to contain the entire quantity of water in the formula without flour (water sponge) and approximately 40–60% of total formula flour. Breads and products (e.g., hamburger buns, rolls, etc.) manufactured by this process are usually of comparable quality as those of the conventional sponge and dough process. The liquid sponge can be produced by either batch or continuous method (Kulp and Ponte 2000).

5.4 Delayed Salt Method

This method is a slight modification of sponge and dough method. Here, the entire quantity of recipe flour for a batch is taken at the first mixing stage itself, so it is referred as a 100% sponge method. After first mixing, bulk fermentation is provided for 2–3 h depending upon flour quality. After fermentation, the dough is given second mixing during which all the recipe's salt is added towards the end of the mixing period or at the knock-back stage. As salt reduces the yeast's performance, adding salt at the end will speed up the fermentation initially in salt-free dough and reduce the fermentation time. The mixed dough is then given floor time and further processed as usual (Kumar 2018).

5.5 No-Time Dough Method

This method is fundamentally a straight dough method where the dough mixing is achieved mechanically by spiral mixers. The dough is prepared using comparatively higher quantity of yeast - almost double the quantity along with the addition of yeast nutrients. The dough temperature is also kept moderately higher at about 28–30 °C. The fully mixed doughs are given short or no bulk fermentation time and are then divided, rounded, moulded, proofed, and baked. This method is mostly used in times of emergency when dough has to be manufactured for processing in a very short period of time. This method is also suitable for frozen dough manufacturing and retail bakeries. After mixing, the dough is sent immediately for further processing (Kulp and Ponte 2000).

5.6 Activated Dough Development Method (ADD)

This process was developed in the USA in the early 1960s and gained popularity in smaller bakeries in the USA and the UK later on. Its essential features were addition of:

- a reducing agent, usually; L -cysteine hydrochloride;
- oxidizing agents;
- fat or an emulsifier;
- extra water in the dough to compensate for the lack of natural softening;
- extra yeast to maintain normal proving times.

Since its first use, this method has undergone a number of modifications and now is rarely used in its 'classic' form. Since the dough development process in ADD is typically chemically induced, low-speed mixers could be engaged. A short period of bulk fermentation before dividing, normally less than 30 min, has been shown to be beneficial for ADD product's quality (Cauvain 2015a).

5.7 Continuous Bread Processes

This production method refers to a system in which the dough is manufactured continuously and automatically in an enclosed chamber. This process was introduced in US in the 1950s and is represented by two systems: (1) the Do-Maker process based on patents granted to John C. Baker and (2) the Amflow process introduced by American Machine and Foundry Co. (Kulp and Ponte 2000). Continuous bread making system decreases processing time, floor space and labour. These methods are used for large scale production involving 2000–3000 kg of dough per hour (Kumar 2018).

The Do-Maker Process
In this process, a brew is prepared by stirring mixture of water, sugar, yeast, yeast food, salt, and mold inhibitor. The brew is fermented for 3–4 h during which temperature and pH drops from 6.5 to 4.7. The fermented brew, other ingredients, flour and remaining water are added into a mixer and the dough is mixed and pumped to a dough developer. After an intense energy input in the developer, the dough is pumped and extruded into the greased baking tin where it is proofed and baked as per the conventional procedure (Kumar 2018).

The Amflow Process
In this process, higher amount of oxidants are required to balance the high amount of mechanical dough abuse during mixing and extrusion operations. Initially, both potassium bromate and potassium iodate were used, but the iodate was later partially or totally replaced by azodicarbonamide (ADA) and ascorbic acid. The Amflow method uses a flour based brew/liquid sponge instead of non-flour brew as in the do-maker process. The brew consists of some amount of flour, water, yeast, yeast food, salt and sugar. After fermentation for about 2–3 h, the ferment is pumped into the pre-mixer along with melted fat, oxidants, sugar solution, remaining flour, water and other ingredients. The mixed dough is pumped into the developer, proofed and baked (Kulp and Ponte 2000; Kumar 2018).

Continuous operations occupied 45% of total bread production in the 1950s and 1960s, but it lost its popularity due to low consumer acceptance and got replaced in most plants by the conventional sponge and dough processes and partly by introduction of the liquid fermentation procedure (Kulp and Ponte 2000).

5.8 The Chorleywood Process

This process originated in the UK and it is used extensively throughout the world. This process is named after the Flour Milling and Baking Research Association at Chorleywood in Hertfordshire. The Association then merged with the Campden Research association and has now shifted to Chipping Campden in Gloucestershire. The dough development is achieved by a combination of high mechanical energy and chemical action rather than through a prolonged resting period. The process is commonly a batch process but may be used in continuous applications. This method uses specially designed high speed mixers capable of completing the dough development in a much shorter mixing time of 3–5 min. The method involves addition of all the flour, water and other ingredients into the mixers and straight mixing for approximately 3 min. The dough must contain a higher level of ascorbic acid and azodicarbonamide (ADA) as oxidant, yeast and water than a bulk fermentation dough would, as well as high-melting-point fat, emulsifier, or fat and emulsifier combination (Cauvain 2015a; Chin and Campbell 2005; Kulp and Ponte 2000; Kumar 2018).

5.9 Other Processes (Sourdough Process)

Sourdough is a type of dough produced by lactic acid bacteria (LAB) and yeast fermentation and used as sponge for leavening in bread making. Its use is one of the oldest biotechnological processes in cereal food production. Many traditional products are based on the use of sourdough to produce baked goods such as panettone (originated in Milan), San Francisco sourdough, French breads and soda crackers (Siepmann et al. 2018).

The cereals used to make sourdough include hard wheat, durum wheat and rye (Liu 2014; Paterson and Piggott 2006). LAB mainly participate in acidification of the sourdough, along with the synthesis of exo-polysaccharides (EPS), antimicrobial substances (i.e. organic acids, hydrogen peroxide and bacteriocins) (Messens and De Vuyst 2002; Schnürer and Magnusson 2005) and diverse enzymes. These enzymes provide valuable effects on the texture and flavour development of the sourdough, decrease the anti-nutritional factors, improve digestibility and reduce staling of bread (Behera et al. 2015). The sourdough yeasts are essential for the production of CO_2 that leavens the dough, and production of flavour compounds for a well-balanced bread flavour in combination with the acids. The yeasts present in sourdough are usually acid-tolerant. The population of LAB in sourdoughs are 10^8–10^9 CFU/g and yeasts are 10^6–10^7 CFU/g, respectively; with a LAB: yeast ratio generally of around 100:1 (Hansen 2004; Liu 2014; Ottogalli et al. 1996).

The LAB species isolated from sourdoughs are those from the genera *Enterococcus, Lactobacillus*, *Lactococcus, Leuconostoc, Lactococcus, Pediococcus* and *Weissella*; being the dominant LAB species and strains the lactobacilli (De Vuyst and Neysens 2005; Liu 2014; Weckx et al. 2010). Typical sourdough lactobacilli include *Lb. sanfranciscensis*, *Lb. brevis, Lb. buchneri, Lb. fermentum, Lb. reuteri* and *Lb. plantarum*. Newer species of LAB that have been isolated from sourdoughs are typically lactobacilli such as *Lb. mindensis, Lb. panis, Lb. pontis, Lb.rossiae* and *Lb. zymae* (De Vuyst and Vancanneyt 2007; De Vuyst et al. 2009; Liu 2014). The yeasts in sourdoughs are mainly from the genera *Candida* and *Saccharomyces,* although others such as *Issatchenkia, Hansenula* and *Pichia* are occasionally isolated. The common sourdough yeasts are *C. humilis, S. cerevisiae* and *S. exiguus* (De Vuyst and Neysens 2005; Liu 2014).

The sourdough fermentation may be performed as firm dough or as a liquid suspension of flour in water. This proportion between flour and water is called the Dough Yield (DY) and will influence the flavour profile of the sourdough. The DY is defined as:

$$\mathrm{DY} = \left(\text{amount of flour} + \text{amount of water}\right) \times 100 / \text{amount of flour}$$

Sourdough may be classified in 4 main types depending on the type of fermentation and the technological processes used:

- Type I sourdough is traditionally produced using a firm dough characterized by spontaneous fermentation. The fermentation is initiated by the microbial strains already present in the first dough and carried out at room temperature (20–30 °C) (Hammes and Gänzle 1998; Nionelli et al. 2014; Siepmann et al. 2018). The first dough may be prepared using only flour and water or by the addition of another raw material acting as the inoculum such as yogurt and fruits (Ripari et al. 2016a, b). The selection of sourdough microbiota happens spontaneously through daily refreshment or backslopping. Once obtained, the stable sourdough is used as a sponge or mother dough in the production of a traditional breads. The microbiota type I is composed chiefly of heterofermentative and facultative heterofermentative LAB: L. *brevis, L. sanfranciscensis, L. fermentum, Leuconostoc citreum, L. plantarum, and Pediococcus pentosaceus* (Corsetti 2013; Mariotti et al. 2014; Minervini et al. 2012); and yeasts of the species *S. cerevisiae* and *C. humillis (Iacumin et al.* 2009*; Minervini et al.* 2012*; Valmorri et al.* 2010*).*
- In type II, fermentation occurs after the inoculation of a starter culture at industrial scale. *Saccharomyces cerevisiae* is incorporated to leaven the dough. Heterofermentative LAB such as *Lb. pontis, Lb. panis, Lb. sanfranciscensis, Lb. brevis, Lb. fermentum, Lb. reuteri, Lb. frumenti* as well as obligate homo-fermentative such as *Lb. acidophilus, Lb. delbrueckii, Lb. farciminis, Lb. amylovorus* (rye), *Lb. johns*onii dominate the microflora (Arendt et al. 2007; Behera et al. 2015; Jay et al. 2008).
- Type III are dehydrated sourdoughs fermented with defined mixed cultures of *Lb .brevis, Lb. plantarum* and *Pc. pentosaceou*s without yeasts (Liu 2014).
- Type IV is a mixture of type I and type II sourdough, produced at laboratory scale (Siepmann et al. 2018).

Metabolic interactions arise between the yeasts and the LAB growing in the microbial ecosystem of sourdough. The yeasts release nutrients, such as amino acids and vitamins, that are beneficial for the growth of LAB (Gobbetti 1998), which in turn produce acids and reduce pH to the optimum value of about 5 for yeast growth during early stages of sourdough fermentation (Liu 2014). The classic metabolic association between *Lb. sanfranciscensis* and the maltose-negative sourdough yeasts such as *C. milleri* has been well established in the literature (Gobbetti 1998; Hansen 2004). Due to this synergistic growth of LAB and yeasts, the dough acquires greater

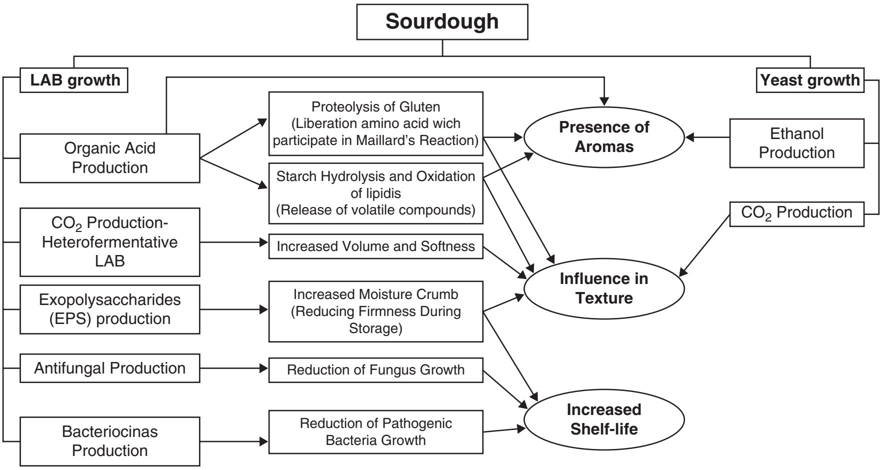

Fig. 1.4 Lactic acid bacteria (LAB) and yeast in sourdough and their effects in texture, aroma and shelf-life of bread. (Image taken from Siepmann et al. 2018 reproduced with permission of Springer Nature)

acidity, and the gluten is degraded. The products obtained from sourdough have improved texture, concentration of volatile compounds and species specific enzymes and longer shelf life than bread fermented only by yeast (Chavan and Chavan 2011). The effect of LAB and yeast on multiple parameters affecting the texture, aroma and shelf-life of bread are represented in Fig. 1.4.

It has been reported that in sourdough fermentation there is an increased in folate content of both wheat and rye breads (Kariluoto et al. 2004; Liukkonen et al. 2003). A reduction in tocopherol and tocotrienol (Wennermark and Jägerstad 1992) and decrease/increase in thiamine content were also reported depending on the fermentation process (Ternes and Freund 1988).

Sourdough fermentations have shown to have enhanced antioxidant activity, inhibited lipid oxidation, and decreased the content of anti-nutritional factors (De Angelis et al. 2006; Đorđević et al. 2010; Poutanen et al. 2009; Rizzello et al. 2007; Songré-Ouattara et al. 2008). Some of the EPS produced by LAB have prebiotic properties (Roberfroid et al. 1998). Moreover, LAB produces proteases that breakdown gluten that is responsible for causing celiac disease in gluten-intolerant people. This generates an opportunity to develop gluten free cereal product using sourdough fermentation (Gänzle et al. 2008; Marco Gobbetti et al. 2007; Moroni et al. 2009).

6 Nutritional Quality of Bread

Consumers are increasingly becoming more conscious about the mutual relationship between nutrition and health. Despite the fact that the nutritional composition of bread varies with the type of bread, and cereals used, in general, bread is an energy-dense product due to its high carbohydrate content in the form of starch. Currently, innovations in bread are mainly focused on nutritionally improving bread through enrichment or the use of different flours (Collar 2008). The gelatinisation of starch during baking is important in relation to the susceptibility of starch to enzymatic breakdown and subsequent spike in postprandial blood glucose level. White wheat or refined wheat bread induce high glycaemic responses, while the lowest glycemic index values have been reported when consuming pumpernickel type breads and coarse barley breads containing intact kernels (Jenkins et al. 1981, 1986; Liljeberg et al. 1992; Wolever et al. 1987). The intact kernel protects the encapsulated starch in it against the gastrointestinal amylolytic enzymes hydrolysis (Granfeldt et al. 1992). Bread is an important source of dietary fiber, although dietary fiber content decreases significantly during the refining process. Wholemeal or multigrain breads made with wheat combined with rye, barley, and oats (Dewettinck et al. 2008) are currently recommended for healthy diets as these multigrain products makes it possible increase the diversity in fermentable soluble fibres (notably arabinoxylans and β-glucans) (Lopez et al. 2001).

Although lipids comprise only about 1.5–7% of cereal grains, they include a range of components such as essential fatty acids, fat-soluble vitamins and phytosterols (Ruibal-Mendieta et al. 2004). Wheat, rye and barley generally have a similar fatty acid composition and are rich in palmitic and linoleic acids, although rye is somewhat higher in linolenic acid (Chung and Ohm 2000). The protein nutritional quality of wheat flour is inferior to that of other cereals and other protein sources (Chavan et al. 1993; Singh et al. 2001). Efforts are being made to fortify bakery products with high quality non-wheat proteins. Eggs, milk and milk products exhibit excellent protein quality and functional characteristics, but as these products are expensive and lack dietary fibre, other protein sources such as legumes, oilseeds and non-wheat cereals are used (Chavan et al. 1993).

Whole grains provide significant dietary amounts of many B vitamins, particularly thiamine, riboflavin, niacin and pyridoxine (Bock 2000). Wheat, barley and oats are also moderate sources of biotin (10–100 mg/100 g) and, together with rye, of folic acid (30–90 mg/100 g). Moreover, wheat, rye and oats are classified as rich sources of phosphorus (200–1200 mg P/100 g), while barley is considered as a moderate source (100–200 mg P/100 g) (Dewettinck et al. 2008).

Cereals can have a protective effect as a source of antioxidants and phytochemicals (Slavin et al. 2000). The major functional antioxidants are phenolic acids, namely ferulic, vanillic, caffeic and p-coumaric acid (Horvat et al. 2020). Furthermore, cereals are also good sources of phytoestrogens of the lignin family which may have a protective effect against hormone-related cancers in adults (Adlecreutz and Mazur 1997). One sector of the bread market which has developed significantly in recent years is of gluten free products catering to people suffering from celiac disease, a chronic intestinal malabsorption disease characterized by lifelong intolerance to materials, such as prolamins in wheat (gliadin) (Wang et al. 2017) commonly referred to as gluten intolerance.

There are several varieties of bread that have been increasingly produced due to their nutritional quality or health related attributes including:

1. *Rye bread.* Rye is the only cereal grain that approaches wheat in terms of bread-making properties. However, attainment of bread quality in rye breads usually requires the incorporation of a significant proportion of wheat flour to provide the baking quality that is lacking in the rye gluten. The essential amino-acid composition of rye is slightly better than that of wheat (Bekes and Wrigley 2004) Rye grain contains high level of pentosans which helps in reducing the rate of rise in the blood sugar level after ingestion. Baked products based on rye include crisp bread and varieties of bread, including pumpernickel (Wrigley 2016).
2. *Oat bread.* There is growing interest in the using oats along with wheat flour for bread making. Oat flours have appreciably higher levels of ß-glucans which are linked with the potential for lowering blood cholesterol levels. Oat flours are singly incapable of forming an efficient gluten network strong to hold large quantities of gas. Oat based bread products utilise high proportion of wheat flour in their formulation. Moreover, oats have high lipid contents and thus, these products are prone to rancidity (Cauvain 2015b).
3. *Multigrain bread.* Multigrain breads are formulated multiple grains, legumes and seeds. These breads are more nutritious, richer in flavour than normal wheat bread. Researchers studied the effect of replacement of wheat flour with 5, 10, 15 and 20% multigrain mix produced by combining soya bean, oats and seeds (fenugreek seeds, flaxseed and sesame). The protein, fat and dietary fiber contents of bread with 15% of the mix was 1.5, 5 and 2.5 times higher than the control 100% wheat bread (Indrani et al. 2010). Consumption of fibre and whole grains has been linked to reduction of the incidence of a wide range of disorders including coronary heart disease, few forms of cancer and type 2 diabetes (Jones 2005).
4. *Gluten free bread.* The development of the structure of gluten-free breads relies strongly on the gelatinization capacity of the mixture of starches used in the formulation. Generally, starch granules from the different sources remain intact at the start of the manufacturing process and their water absorption capabilities are restricted. Therefore, gluten-free formulations incorporate a gum or modified starch to aid in absorption of water until the gelatinization processes begins (Cauvain 2015b). In most gluten-free research studies, rice flour and starches (from maize and tubers) are used as the main starch sources. There are other studies using alternative flours, alone or in combination with these flours and starches (Masure et al. 2016). The usage of hydrocolloids is one of the most explored aspects in the literature (Anton and Artfield 2008; Mir et al. 2016). Hydroxypropyl methylcellulose (HPMC) was the most extensively used compound (39% of the cases), followed by xanthan gum (25%), psyllium (16%), and guar gum (13%). Other conventional cereals and their starches used include corn flour and starch, potato starch, cassava starch, sorghum, millets, pseudo-cereals (buckwheat, amaranth and quinoa), roots and tuber flours (cassava and yam) and legumes (chickpea, soy, carob, pea, lentil and beans).

7 Technological Modification in Bread Making

There are several technological advances also in the field of bread making aiming to improve the availability of bread in multiple geographical locations and reach consumers as well as to improve the working conditions at the bakeries. These technological modifications include:

1. ***Frozen dough***. Frozen dough is a regular dough piece which has undergone freezing to a core temperature of −7 °C and frozen storage at −17.8 to −23.3 °C, thawing, proofing and finally baking (Neyreneuf and Van Der Plaat 1991). It is a value-added product that improves fresh bread availability (Wang et al. 2017).
2. ***Retarded fermented doughs***. Most fermented goods can be produced using retarded dough, provided that retarding and proving conditions are selected to suit the definite type of product. If the dough temperature is dropped to a predetermined value, yeast fermentation will stop and the dough can be held in a state of suspension. Primary experiments refrigerating yeasted doughs eventually led to the development of this process known as 'dough retarding' (Cauvain 2007). The techniques that can be used to delay dough fermentation focus on delaying first fermentation with the mixed dough kept at −7 to −9 °C for 12–18 h, slow final proof, and retarding-proofing process. This method of baking has been developed to meet customer expectations of fresh bread throughout the day, and also to offer the baker a healthier quality of life by decreasing extent of night work (Suas 2012).
3. ***Par-baked bread***. Par-baked products give rise to ready-to-use bakery products in a convenient market form (Cauvain 2014). In par-baking the dough is first baked until the starch gets gelatinized and protein gets coagulated. At this stage, the structure of the product is solid, and its volume is nearly final. Par-baked breads are removed from the oven when the crust still exhibits a light beige color (Suas 2012). After the par-baked bread is cooled, it can be processed fresh or as frozen par-baked dough. Thereafter, this par-baked dough has to be thawed and re-heated to contribute the required product colour, crust characteristics, crumb softness and other final desired properties (Cauvain 2014). Par-baked breads can be ready to sell or to serve within 15–30 min after being removed from the freezer (Suas 2012).
4. ***Steamed bread***. Steamed bread is a staple item in China and many other Asian countries (Huang 2014). This bread is made of fermented wheat flour, and the steaming process which contributes to the development of a thin, white skin to the product with an upright profile. The internal crumb structure may vary from dense and firm to open and soft (Huang and Miskelly 2019). After proofing, dough pieces are cooked by steaming in bamboo baskets over boiling water or in a steaming chamber. This cooking process give rises to distinct characteristics to steamed bread different from that of baked bread. Steamed products mainly refer to mechanical processed products such as steamed buns, steamed rolls and steamed cake (Huang 2014).

5. ***Soda bread***. Soda bread is chemically leavened bread traditionally manufactured in Ireland. The bread is leavened chemically using sodium bicarbonate and not yeast. Traditionally, the source of acid used was buttermilk containing lactic acid. The use of cream of tartar has become increasingly common these days to avoid the bread from developing excessive alkalinity. Soda bread can be prepared with a weaker flour than those used for making yeast leavened bread and it should be baked at a lower temperature (Edwards 2007).

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Chapter 2
Traditional Breads from the Baltic Countries (Estonia, Latvia, Lithuania)

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1 History of Rye Bread in Estonia, Latvia, and Lithuania

Rye bread has a special place in the culture of Baltic states. It is produced in large factories, artisan bakeries and at home using various recipes based on rye sourdough. The whole process of rye bread preparation includes rye sourdough fermentation, leavening, and baking. Frequently, scalding is also applied. Although the

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Baltic states, Estonia, Latvia and Lithuania, are neighbor countries there are some differences in the making of rye bread making.

1.1 Estonia

Estonia is the northernmost and the smallest country among the Baltic States. Due to its location and history, the Estonian cultural traditions, including bread baking, were strongly influenced by neighbor countries and conquerors. Starting from 1219 and until receiving independency in 1918, Estonia was part of German, Denmark, Kingdom of Sweden, Poland, or Russia Empire. Barley, oats, legumes, turnips, flax, hemp were grown as first cultures on native fields.

Rye became spread from the eleventh century, first as summer and then as a winter grain. A cool climate and poor soil were very suitable for rye and, thus, rye became the most widespread grain cultivated on the territory of the modern Estonia (Moora 1991). Therefore, barley bread was replaced by rye bread, which became the most important food of our ancestors. Somewhat later, they learned to bake sourdough rye bread (*rukkileib*).

Already in the fifteenth to sixteenth century, Estonia became famous for its rye quality, and it was exported to Europe (Mere 2009). The grain quality depends on harvest timing and processing. The harvested rye sheaves had been dried in the barns which were warned by the big barn kilns. Dried sheaves were threshed by beating, first against a threshing bench or wall and then by clubs or flails. The fallen grains were purified by winnowing letting draught to waft away husks and other light residuals. To get flour the grains were milled. Hand mills with grindstones were in use until the end of nineteenth century although water mills and windmills were built staring from the 12–13th Century.

Farm ovens were initially round- or oval-based barn kilns, in which large round or oval breads were baked. The loaves weighed 5–12 kg and were baked 6–15 pieces at the time. At the end of nineteenth century, ovens became smaller and quadrangular which influenced size and shape of bread. The loaves became oblong or oval and weighed 3–6 kg reaching 2–4 kg at the beginning of twentieth century (Moora 1991).

To bake bread, oven had to reach at least 250–300 °C and maintain the temperature for the whole duration of baking of 2–3 h. The extinguished charcoals and ashes were removed from the heated oven, the oven floor wiped, and the bread loaves were placed into the oven by special wooden peel.

Chaffy bread was the daily food of Estonian peasants in the sixteenth to seventeenth century and even in the middle of the nineteenth century. Bread included dried ferns, young thistles, berries, birch catkins, moss and other plants. The worse the harvest year, the more chaff was added to dough. Bread was baked from pure rye flour only for weddings and great holidays (Moora 1991; Pärn 2006). Pure rye flour began to be used for bread by peasants from the second half of nineteenth century when rye harvest increased. Wholemeal and unscreened flour was used routinely whereas breads from fine flour were baked on holidays and fests (Moora 1991; Mere 2009).

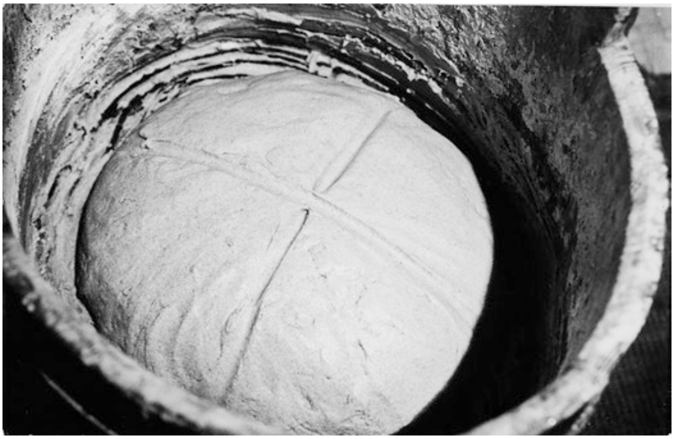

Fig. 2.1 Rye dough before proofing. (Photo: Estonian National Museum collection)

Fig. 2.2 Rye bread making. (Photo: Estonian Rural Museums Foundation, Estonian Agricultural Museum collection)

Everyday bread was started by mixing lukewarm water and half of the rye flour in bread trough. As a starter culture, the leftovers of previous dough were scraped off from the walls of bread trough and dissolved in water. Thereafter, rye flour was sprinkled. In the next day, the rest of the flour was added, and the soured dough was kneaded until it did not stick to the hands. The final water-flour ratio was around 1–1.5. Salt and caraway seeds were also added as a rule before kneading. The dough was left in a warm place to prove again (Fig. 2.1), and the loaves were formed by hands (Fig. 2.2). Usually, breads were baked for 2–3 h (Mere 2009).

In a middle of nineteenth century in addition to the traditional one-day fermented bread, the so-called three-day rye bread made from fine rye flour became popular in some areas of Estonia. For that rye flour was scalded by boiled water, allowed to convert gelatinized starch into sugars (saccharification process) during 5–6 h. The next day the rye flour was added in several parts, mixed, and fermented in a warm place. On the third day, the rest of the flour, salt and caraway seeds were added, the dough kneaded, rye bread moulded, proofed, and baked. It took 3 days to prepare these sweet-sour rye breads and they were baked usually for weddings, holidays, and festivals (Moora 1991; Mere 2009).

Surface of loafs were decorated with different marks pressed by fingers, palm, wooden peel or horseshoe (Fig. 2.3). Although these marks prevented crust separation during baking, some of the symbols were having protective meaning (*e.g.*, cross, five-pointed star, horseshoe) (Kreem 2020). Different cultural beliefs and practices are also connected with bread and its baking in Estonia. They supported hygienic and technological requirements such as clean hands and cover apron, covered head, non-drinking and eating during dough mixing, proper bread moulding (Mere 2009; Kreem 2020). It was believed that kneading with unwashed hands will ensure shortage of bread in the life after death while not washing hands after kneading will transfer you into wolf. Thick layer of sprinkled rye flour on sourdough will ensure birth of children with white hair and smooth surface of moulded bread will guarantee birth of beautiful daughters.

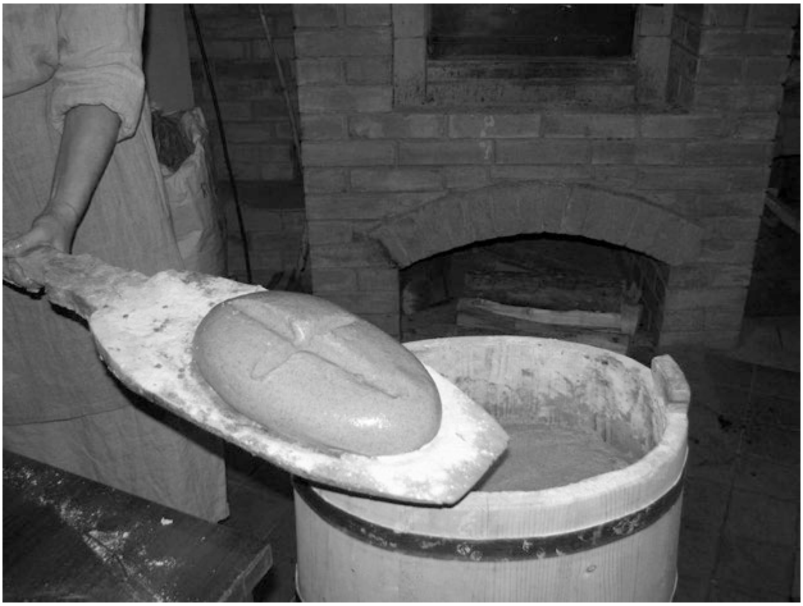

Fig. 2.3 Molded and decorated rye bread. (Photo: Estonian Rural Museums Foundation, Estonian Agricultural Museum collection)

1.2 Latvia

Bread has a special place in the Latvian culture. Rye sourdough bread is known and appreciated in each Latvian family. Latvians consider it as a national treasure – their historical and cultural heritage, the national symbol and pride. Bread was baked at home until the twentieth century. In the 1940s, the baking of traditional sourdough rye bread and the development of technology were completely stopped. Around the years 1987–1989, small bakeries resumed the production of traditional sourdough rye bread baking technology. In the twenty-first century, home-baked bread became a new trend, which was being addressed by more and more housewives, using both recipes from grandmothers' heritage and new hitherto little-used, but being nutritionally very valuable recipes. In the sourdough rye bread (*rupjmaize*), known as "*salinātā*", part of the rye flour is scalded with hot water. In many Latvian bakeries, traditionally, as in ancient times, the scalds and the dough are made in wooden dough tubs (Fig. 2.4). Additionally, a piece of dough from a previous batch of bread is dissolved in warm water and added as a sourdough. The runny dough is mixed and beaten with long wooden spatula in the wooden pail and left overnight to ferment. In the morning, long kneading process starts. Caraway seeds (*Carum carvi*) and more rye flour is added during kneading.

When the dough no longer sticks to the hands, means that it is ready. The tub with the fermenting dough is placed next to the oven and long small loaves are shaped on the peel, which is covered with a dusting of rye flour or maple leaves, decorated (Fig. 2.5) and quickly placed in the oven (Cekstere 2004).

Fig. 2.4 The scald preparation process. (**a**) scald is mixed with a wooden spatula, (**b**) ready scald. (Photo: Ruta Murniece)

Fig. 2.5 Rye breads with marks. (Photo: Ruta Murniece)

1.3 Lithuania

Lithuanians are a people of farmers, whose well-being for many centuries depended on natural phenomena such as the fertility of the land, the climatic conditions that led to better or worse grain harvest and yields. Two-thirds of Lithuanian landscape belongs to the regions of infertile lands suitable for growing rye and it is one of the factors that determined Lithuanian eating habits. This has conditioned a deep tradition of rye cultivation and rye bread production, which have been passed down from generation to generation for many years.

The respect for rye bread is one of the most essential features of Lithuanian culture and with the introduction of Christianity in Lithuania (the fourteenth century) "Bread" becomes one of the magic symbols in the religion. Bread is considered sacred in the Lithuanian population, and this influenced the education of the young generation and traditions. From an early age, children have been used to respect bread, not to scatter, rub or throw it. In ancient times, when making bread at home and before cutting it, the first loaf of bread was consecrated by making the sign of the cross above the loaf, and by making a mark of the holy cross onto the crust of the loaf. Special importance was given to the first and last bread loaves. The first loaf, marked with a cross, was eaten in the last turn since it was believed that this would guarantee no shortage of bread in the house. When the young children fell ill, they were laid down on the first freshly baked still warm bread loaf, which was covered with a linen cloth. Sick and anxious people used to be given a slice of bread that had not had any contours of the mark of the cross. The last loaf of bread usually smaller in size, formed from the remains of the dough, has had many names referring to the "crumbled, grabbed, scraped, scratched" (*pagrandukas*, *sugraibytinė*, *papentėlis*), "small bread loaf" (*mažkepalis*), "bunny pie" (*zuikio pyragas*, *etc*., and it was mostly given to children. For Pentecost, there was followed a ritual of adding the whole egg into that small loaf of bread. This bread bun was given to the shepherds or shared with the whole family so that everyone would get a piece of an egg baked in bread. The custom of consecrated bread or breadcrumbs has survived until these days and is celebrated in the church on February 5th, also known as Saint Agota Day. The consecrated bread is believed to protect from fire, lightning, disease, and snake bites.

Although, yet in the sixteenth century, the inventory books of Vilnius dukes mentioned various types of cereal grain flour, wheat was long considered as exceptional grain for the rich though, and wheat cakes were baked only for the big holidays. Due to more difficult times in the history of Lithuania and only in the years of the bad poor grain harvest – for example, in the second half of the nineteenth century – the poor peasants used to mix in other cereal grain flour, seeds of wild plants, catkins, or beets into the dough of bread. For dough softness, potatoes were added to it.

2 Present Rye Sourdough Bread Technology in Baltic States

The rye sourdough bread is still very popular in the Baltic states due to its traditional taste and health promoting benefits like high fibre and B-group vitamins (Mihhalevski et al. 2013) content and moderate glycaemic index. Rye breads are produced in large factories, artisan bakeries, and at home using various starters, rye flour with different extraction rates, other cereals, and supplements. More than 25 different names of rye breads could be found in supermarkets (Fig. 2.6).

Fig. 2.6 Rye breads in the supermarket. (Photo: Jürg Samel)

Fig. 2.7 Rye breads prepared by different recipes. (Photo: Inga Sarand, Gunta Duka)

To expand the range of the baking products, producers are making rye breads with various additives and seeds (caraway, sunflower, flax, pumpkin, hemp and others), grated carrot, sprouted grains and rye malt (Fig. 2.7).

Nowadays about 60–70 thousand tonnes of bread products are produced per year in each of Baltic country, where two thirds are wheat bread and one third are rye bread (Statistics Estonia, Official Statistics of Latvia, Statistics Lithuania).

The technological properties of rye breads differ from wheat bread due to the lack of gluten and the importance of the pentosans in dough structure formation. Sourdough addition increases the acidity of the baking dough that is necessary for optimal swelling of pentosans – polysaccharides composed of five carbon sugars. Increased acidity of the rye dough also promotes inactivation of amylases controlling the degree of starch hydrolysis, thus forming optimal rheological properties of rye dough and bread texture. Sourdough also improves aroma and taste properties of rye bread; increases the nutritional value of products; prolongs shelf life of the products as organic acids and other antimicrobial compounds synthesized during sourdough fermentation which, in turn, inhibit the growth of spoilage microorganisms during storage of rye bread.

Most of the bread factories, including large scale ones, use in their daily production sourdough, which is obtained by back-slopping processes. Part of mature sourdough is mixed with water and flour and fermented. Usually 10–30% (w/w) of the rye flour used for dough preparation is fermented, while some home bakers ferment all the rye flour used on the recipes. The time of fermentation depends on the fermentation temperature and the desired acidity and can vary from 4–24 h.

The rye bread dough is prepared by mixing mature sourdough and the rest of ingredients including the rest of flour and water. Baker's yeast is not always added in the doughs with high proportion of sourdough (30% or more from total amount of dough). The final concentration of added salt varies up to 1% (w/w).

There are three basic technological schemes used for traditional rye bread making in the Baltic states (Figs. 2.8, 2.9 and 2.10). In Fig. 2.8, the technological scheme without scalding is presented. Fermented sourdough is mixed with a major portion of rye flour, water, and other additives to obtain dough that is further moulded, proofed, and baked.

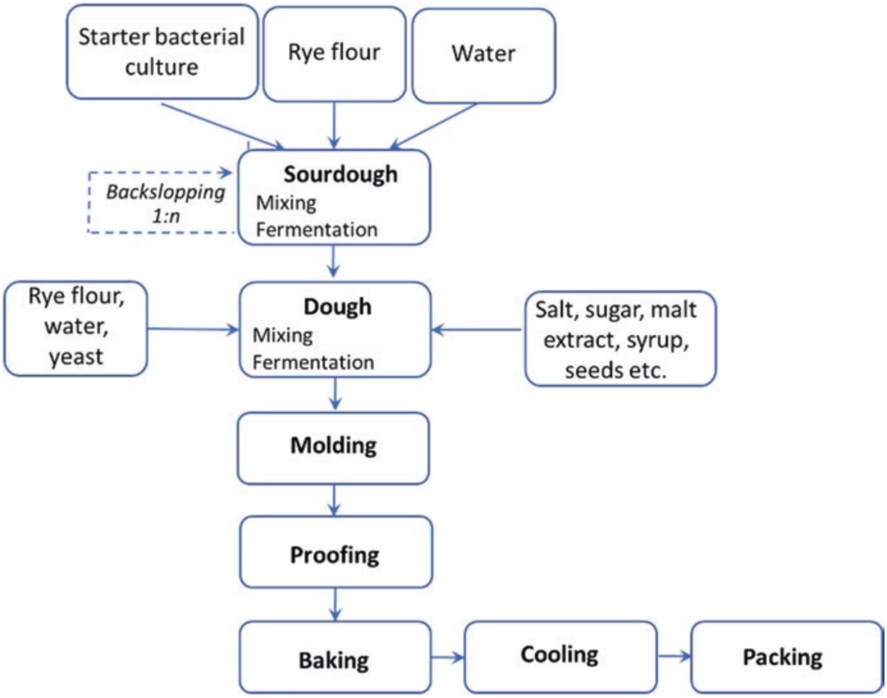

Fig. 2.8 Rye sourdough bread typical technological scheme

Quite often, the bakeries scald 10–15% (w/w) of the rye flour used for rye bread making (Figs. 2.9 and 2.10). Scalding is one of the oldest processes used in rye dough making, where part of rye flour is mixed with hot water as a rule in ratio 1:2 or 1:3, by weight, to induce the process of starch gelatinization (Petrova and Petrov 2020; Ask and Nair 1989).

Enzymatic activity of rye flour used for the scalding process is very important. According to Straumite (2006), it is important to have rye flour with good baking properties – chiefly, a falling number of 160–190 s and a maximum starch gelatinization of 350–650 AU. The temperature of the water used for scalding should be in a range of 70–100 °C. Most often, the water at 90–95 °C is used.

At the end of this process, rye or barley malt flour obtained from germinated grains is added to perform the process of saccharification (about 45–120 min). Enzymes from active malt increase the extent of starch and protein hydrolysis and enhance the formation of aroma and flavour during leavening and baking (Mihhalevski 2012; Kunkulberga et al. 2001). Sugars formed during scalding are further used as substrate by sourdough microorganisms. Also scalded flour acts as anti-staling agent by delaying the retrogradation (re-crystallization) of hydrolysed starch (Ask et al. 1991; Siljestrom 1988). Breads made with addition of scalded flour stale slower and are softer.

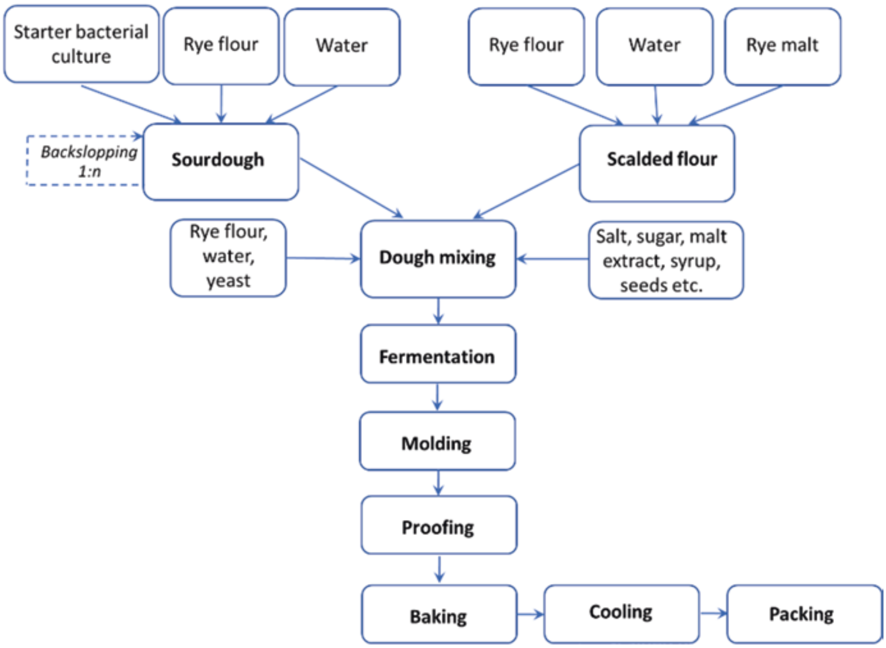

Fig. 2.9 Rye sourdough bread technological scheme with scalding

For rye bread, the scald is made from 1740, 1370, and 700 type rye flour. Flours of type 1370 (not more than 1.45% ash) and 700 (not more than 0.73% ash) are used more often, which contain less ash and fiber but more carbohydrates.

In Fig. 2.9 is shown rye sourdough bread technological scheme with unfermented scalded flour. Mixed dough is fermented around 1.5 h, molded, proofed and, finally, baked. This technological scheme is more typical in Estonian bakeries.

Sometimes, the so-called red malt or inactive malt is also used. Germinated rye or barley grains are dried at higher temperatures (80–90 °C) comparing with the drying process of active malt (50–70 °C), and browned due to the Maillard's reaction before grinding. The obtained flour is added to scalded flour or directly into the dough to improve rye bread colour and flavour. For the same purposes malt syrup is used in some recipes.

During scalding caraway seeds are also added into dough. However, it is more often done in Latvia than in Estonia and Lithuania. Caraway seeds come from the herbaceous plant *Carum carvi* L. and contain 1–6% (w/w) of essential oils. Up to 95% (w/w) of essential oil is composed by carvone and limonene – known to possess antibacterial properties (Sedlakova et al. 2003). By mixing flour, malt, and caraway seeds with hot water (scalding), essential oils are released from caraway seeds and a special taste and aroma is developed.

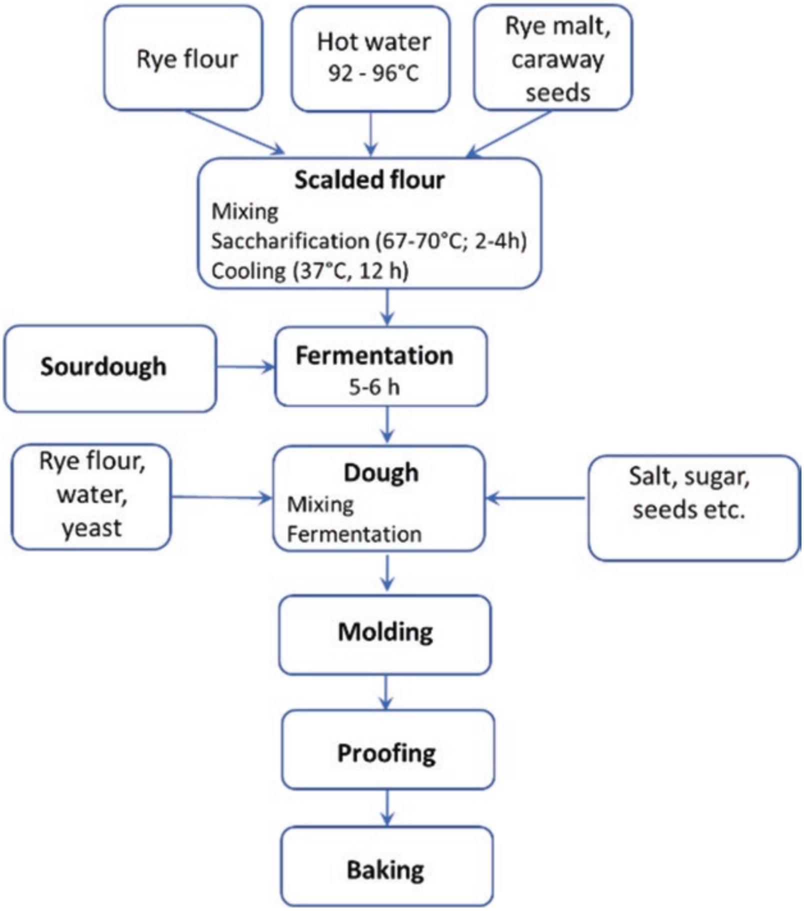

Fig. 2.10 Rye sourdough bread processing scheme with fermentation of scald

Some recipes, most popular in Latvia and Lithuania, include fermentation of scalded flour by adding of starter cultures for better leavening of dough and improved flavour formation (Fig. 2.10).

Mixed dough is left for leavening in a warm place or in a chamber with controlled conditions up to 2 h. Afterwards, bread loaves are molded into portions and proofed at 35–38 °C for additional 40–60 min. Baking of proofed breads is carried out in an oven at 200–230 °C. However, in large-scale production, the baking at gradually decreasing temperatures starting from 300–350 °C and final temperature 180–200 °C may be used. The baked bread is taken out from the oven and cooled down to room temperature, sliced and packed.

3 Diversity, Properties, and Novel Applications of Microorganisms from Rye Sourdough

Sourdough quality is one of the most important part of rye bread making. It is obtained during rye flour fermentation due to the activity of lactic acid bacteria (LAB) and yeasts. Homemade sourdough preparation process resembles traditional ones, where mature sourdough from the previous baking is kept at cool temperature (in the fridge) and is mixed with new rye flour and water before the rye bread making process and it is fermented at room temperature from a few hours to overnight. Similar approach is used at industrial scale although more stable propagation conditions are used. While homemade sourdough originates from spontaneous fermentations or supermarket sold lyophilized microbial starters, the middle- and large-scale bakeries use commercial starters or bakery own developed starters, which can be further propagated by back-slopping for daily use. However, regular renewing of sourdough (once per year) with original sourdough starter is common practiced in the middle- and large-scale bakeries.

3.1 Microbial Diversity of Rye Sourdoughs

In general, type I and type II sourdoughs can be distinguished based on the dough yield (the ratio between dough weight and flour weight multiplied by 100), the time of fermentation and the inoculation rate with mature sourdough (Gänzle 2019; Novotni et al. 2020).

Type I (so called the traditional sourdough) is characterized by low dough yield and short fermentation cycle at ambient temperature. Type II sourdough are semi-liquid or liquid sourdoughs with high dough yield and which are fermented at relatively high temperatures (≥30 °C) for prolonged time, reaching pH values around 3.5.

Homemade bread bakers often use sourdough originated from spontaneous fermentations. Their composition depends on the type and origin of flour, environmental microbiota, regularity, and temperature of propagation. In spontaneously started sourdoughs the establishment of a stable consortium occurs through a three-stage evolution, during which the sourdough-atypical LAB are replaced by sourdough-typical LAB, and then highly adapted sourdough-typical LAB (Vuyst et al. 2014).

For example, after 24 h of spontaneous flour fermentation at 20 °C or 30 °C the majority of the microbiota was formed by representatives of the genera *Enterobacter, Pantoea, and Lactococcus* and genera from the family *Lactobacillaceae* in ratios depending on the fermentation temperatures used (Bessmeltseva et al. 2014). In the work of Juodeikiene (2016) the pH of water-flour mixture decreased during the first days (48–72 h) of fermentation mainly due to the growth and activity of *Pediococcus acidilactici* and *Pediococcus pentosaceus*, irrespectively of temperature used (25–35 °C).

Additional feeding of spontaneously fermenting flour-water mixture with fresh rye flour after 24 h and 32 h from the start of fermentation helps to enrich sourdough-typical LAB, such *as Lactiplantibacillus plantarum*, *Companilactobacillus alimentarius*, *Latilactobacillus curvatus* and *Lactobacilus delbrueckii* in the 48 h sourdoughs (Kozlinskis 2011). Acidification of fresh flour-water mixture with acetic acid in the beginning of the spontaneous fermentation at 30 °C and addition of fresh flour and water after 48 h of fermentation resulted in the dominance of species from the family Lactobacillaceae (*L. plantarum*, *Lacticaseibacillus casei*, *L. curvatus*, *Lentilactobacillus farraginis*, *Pediococcus pentosaceus*, *P. acidilactici*, *Lacticaseibacillus paracasei*, *Loigolactobacillus corineformis*, *Levilactobacillus brevis*, *Liquorilactobacillus uvarum*) in 72 h sourdough (Bartkiene et al. 2020). Metabolic activity of spontaneous rye sourdough can be enhanced by substituting part of the flour with flour from germinated rye grains (Kozlinskis 2011). However, only prolonged renewal (back-slopping) of sourdough – *i.e.* when part of mature sourdough from previous fermentation is mixed with fresh components – can guarantees its metabolic and microbiological stability at the selected propagation conditions. In the work of Bessmeltseva et al. (2014), it was shown that even at controlled conditions the microbiota of mature sourdough can continue to evolve even after 2 months of daily sourdough propagation. Four species, *L. brevis*, *L. plantarum*, *Companilactobacillus crustorum* and *Companilactobacillus paralimentarius* were detected in different combinations and ratios in all sourdoughs after 56 propagation cycles at 30 (three parallel sourdoughs) or 20 °C (three parallel sourdoughs). Facultative heterofermentative lactic acid bacteria dominated in sourdoughs fermented at 30 °C, while both obligate and facultative heterofermentative lactic acid bacteria were found in sourdoughs fermented at 20 °C (Bessmeltseva et al. 2014).

Information about the microbial composition of industrial sourdoughs is not numerous. The study of Viiard et al. (2016) on the microbial diversity and stability of sourdoughs in Estonian middle and large-scale bakeries showed their dependence on technological parameters. *Lactobacillus helveticus*, *Limosilactobacillus panis* and *Limosilactobacillus pontis* were dominating species in semi-liquid sourdough fermented at 32 °C (Viiard et al. 2013), while the thermophilic *Lactobacillus amylovorus* and *Limosilactobacillus frumenti* were found in the liquid sourdough fermented at 44 °C. *L. helveticus* is not a very common species in sourdoughs however these results showed its high stability in the studied sourdough. Analysis of its metabolic profile and genome confirmed adaptation to cereal environment (Sarand, not published; Schuster et al. 2020). Stability of the thermophilic *L. amylovorus* in industrial sourdoughs can be attributed to its high amylolytic activity and common ability of representatives of this species to synthesize bacteriocins. *Companilactobacillus farciminis* was found to dominate industrial sourdoughs in Lithuania either alone or in combination with *L. curvatus* (Juodeikiene 2016). Also, *Latilactobacillus sakei* KTU05–06, *P. acidilactici* KTU05–7, and *Pediococcus pentosaceus* KTU05-8, KTU05-9 and KTU05-10 strains were isolated from different Lithuanian rye sourdoughs (Digaitiene et al. 2005).

Microbial composition of sourdoughs from small and middle-scale bakeries are generally less stable, and their microbial composition frequently oscillates depending on ambient temperatures at different seasons. The dominating populations can be composed from: (i) *Fructilactobacillus sanfranciscensis*, *L. pontis* and *Levilactobacillus zymae* (Viiard et al. 2016), (ii); *L. helveticus*, *L. pontis* and *L. zymae* (Viiard et al., 2016); (iii) *F. sanfranciscensis, Companilactobacillus paralimentarius* and *Levilactobacillus hammesii*; (iv) *C. paralimentarius* and *Lentilactobacillus diolivorans* (Sarand, personal communication). *F. sanfranciscensis*, *L. pontis* and *C. paralimentarius* are common representatives of Type I sourdough. The increase of *L. zymae* is associated with the lower ambient temperature at autumn and winter period (Viiard et al. 2016).

3.2 Technological Properties of Bacteria Isolated from Rye Sourdoughs

Lactic acid bacteria strains obtained during prolonged adaptation to the sourdough environment can carry different useful technological properties such as resistance to low pH values, antimicrobial characteristics, proteolytic activities, *etc*. Studies of the bacteria isolated from Lithuania sourdough have shown that several strains of *L. sakei*, *P. acidilacftici* and *P. pentosaceus* species have broad antimicrobial activity, both *in vitro* and *in vivo*, due to the production of the antimicrobial compounds sakacin and pediocins active against other LAB, rope-producing *Bacillus subtilis* cells and main fungi causing bread spoilage such as *Aspergillus*, *Fusarium*, *Mucor* and *Penicillium* (Digaitiene et al. 2012; Cizeikiene et al. 2013). The majority of antimicrobial activities associated with these LAB strains were not significantly impaired by baking enzymes hemicellulase, lipase, amyloglucosidase or amylase (Narbutaite et al. 2008). On the other hand, antifungal activities of selected strains both *in vivo* and *in vitro* could be attributed solely to production of organic acids (Surženko 2017; Mihhalevski et al. 2011).

It has been shown that LAB strains with antimicrobial properties could be also obtained from 72 h fermented spontaneous rye sourdough which was started from acidified flour-water mixture (Bartkiene et al. 2020). From 13 isolated strains, five (*L. plantarum* 122, *L. casei* 210, *L. curvatus* 51, *L. paracasei* 244 and *Loigolactobacillus coryniformins* 71) showed antimicrobial activity not only against fungi but also different pathogenic and opportunistic bacteria strains. Some of these LAB also retained their viability after exposure to low pH of 2.5 for 2 h – thus showing their potential to become part of sourdough starter cultures.

Sourdough microorganisms produce during fermentation different metabolites that can affect sensory properties of dough and bread. These include not only lactic and acetic acids – the main metabolites of LAB fermentation – but also different volatile compounds (Kaseleht et al. 2011; Surženko 2017). *L. helveticus* isolated from industrial rye sourdough produced 2-methylbutanal with malty and fermented aroma. This strain is also unique in producing of benzaldehyde that gives sweet and fruity aroma. *L. casei* isolated from the same industrial rye sourdough demonstrated more intensive synthesis of 2,3-butanedione (butter aroma) (Kaseleht et al. 2011).

L. brevis M30I–2, isolated from spontaneous rye sourdough after 2-months daily propagation (Bessmeltseva et al. 2014), was showed to be sucrose-negative and unique in producing butyrolactone, (Z)–2–decenal, and (E, E)–2,4–decadienal (Surženko 2017). The latter is reported as a contributor to the overall flavor of the crumb in rye breads (Burdock 2009; Kirchhoff and Schieberle 2002).

3.3 Novel Applications of Bacteria Isolated from Rye Sourdoughs

Microorganisms isolated from rye sourdough showed good performance in fermentation of sourdoughs made from other flours (*e.g*. wheat flour and lupin wholemeal flour), as well as in production of non-cereal goods.

The combinations of isolated LAB strains (*Pediococcus pentosaceus* and *Leuconostoc mesenteroides*, *P. pentosaceus* and *L. brevis*, *P. pentosaceus* and *Enterococcus pseudoavium*, *P. pentosaceus* and *L. curvatus*, *L. plantarum* and *L. curvatus*, *L. plantarum* and *P. pentosaceus*) were used for wheat sourdough fermentation, and the influence of selected LAB combinations on wheat bread quality characteristics, including acrylamide formation, was analyzed (Bartkiene et al. 2017a). Most of the used LAB strains (except *E. pseudoavium*) were able to ferment L-arabinose, D-ribose, D-galactose, D-fructose, and D-maltose and showed high tolerance to acidic conditions. The highest overall acceptability was found in bread prepared with *L. plantarum* and *P. pentosaceus* sourdough. This group of bread also showed the highest specific volume, porosity, and moisture content. Selected sourdoughs (prepared with *P. pentosaceus* and *L. mesenteroides* or with *P. pentosaceus* and *L. curvatus*) reduced acrylamide concentration in bread samples to 30 and to 67%, respectively, in comparison with bread prepared without sourdough. According to the obtained results, it could be stated that selected sourdough LAB combinations can be used to improve bread quality, as well as to reduce acrylamide concentration in breads.

Results regarding the influence of different sourdough LAB strains and dough improver containing *Aspergillus niger* glucoamylase used for scald saccharification on acrylamide concentration in rye-wheat bread were published (Bartkiene et al. 2013a). Rye sourdough was fermented with *Lactobacillus delbruecki*, *L. sakei, Pediococcus acidilactici* and *Pediococcus pentosaceus* strains. It was shown that lower acrylamide formation was related to reduced dough pH values, as well as to increased activity of LAB amylolytic and proteolytic enzymes activity in dough. The fermentation of sourdough with selected LAB strains processing proteolytic enzyme activity led to significantly lower (up to 64%) acrylamide concentration in bread samples. Strong negative correlation between the reducing sugars concentration and sourdough amylase activity was found. The addition of *Aspergillus niger* glucoamylase for scald saccharification, lowered acrylamide concentration up to 48.9%. This study results confirmed that appropriate sourdough LAB starter in combination with glucoamylase enzyme can be an effective solution for the reduction of acrylamide formation in bread.

L. plantarum strain isolated from spontaneous rye sourdough was used for the production of rye, wheat, barley and oat sourdoughs. Their influence on 60%/40% (w/w) mixed rye-wheat bread quality characteristics and acrylamide concentration were evaluated (Bartkiene et al. 2017b). *L. plantarum* showed a good growth and acidification rates, as well as the ability to induce high activity of amylolytic and proteolytic enzymes in different tested cereal sourdoughs. However, reduction of acrylamide concentration depended on sourdough cereal type and its amount in dough.

The effect of *Lupinus angustifolius* L. wholemeal flour (15%, w/w of wheat flour) either non-fermented or fermented with different sourdough LAB on acrylamide content in bread crumb, as well as on bread quality parameters was studied (Bartkiene et al. 2013b). It was concluded that the fermentation with sourdough LAB strains could increase the potential use of lupine seeds as a proteinaceous food ingredient, while reducing acrylamide concentration and enriching bread with high quality proteins. Finally, it was stated that the selected LAB could be recommended for improving the quality and safety of bread, including the reduction of acrylamide formation (Bartkiene et al. 2017c, 2017d).

Addition of apple by-products in barley sourdough fermented by *P. acidilactici* (Bartkiene et al. 2017b) and *Cannabis sativa* L. seeds fermented by *P. acidilactici* and *P. pentosaceus* (Bartkiene et al. 2016) showed positive effects on wheat bread quality made with thesesourdoughs.

Sourdough microorganisms can also be used to improve ready-to-cook minced meat products (RCMP) quality. Results of a study demonstrated positive effect of fermentation of tomato powder by rye sourdough strains *P. pentosaceus and L. sakei* on the color and lycopene content and total carotenoids content of tomato powder (Bartkiene et al. 2015a).

RCMP functional value and safety parameters can be improved by using fermentation with sourdough LAB *P. acidilactici* of savory plants (*Satureja montana* L.) (Bartkiene et al. 2015b). The addition of *Satureja montana* L. bioproducts (fermented savory plants) increased tenderness and water holding capacity and enriched the RCMP with biologically active compounds such as ρ-cimene, γ-terpinene and carvacrol. Fermentation of *Satureja montana* bioproducts can be a good alternative for RCMP processing to prevent meat decolouration and microbial spoilage, thus increasing overall acceptability and prolonging shelf-life of RCMP.

The influence of natural marinade-based on potato tubers juice fermented by the sourdough LAB *P. acidilactici, P. pentosaceus* and *L. sakei* on pork meat quality parameters and biogenic amines content was reported (Mozuriene et al. 2016a). Marination (24 h) with potato tuber juice fermented using abovementioned LAB increased the tenderness and improved the color and sensory properties of pork meat.

Some milk products can also be made using sourdough strains. *L. sakei*, *Pediococcus acidilactici* and *Pediococcus pentosaceus* sourdough strains and

Satureja montana and *Rhaponticum carthamoides* savory plants bioproducts were used for unripened cow milk curd cheese production (Mozuriene et al. 2016b). LAB and savory plants bioproducts reduce pH values and increases total titratable acidity and volatile compounds (thymol, carvacrol, p-cymene) content, as well as the overall acceptability of the unripened cow milk curd cheese. D(−)lactic acid and biogenic amines content in all analyzed cow milk curd cheese samples were far below those levels causing a health risk. Finally, it was concluded that LAB – savory plants bioproducts could be recommended for higher quality unripened cow milk curd cheese preparation. *L. plantarum, L. paracasei* and *L. brevis* strains isolated from spontaneous rye sourdough can be also used for unripened goat cheese making (Bartkiene et al. 2018).

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Chapter 3
Traditional Breads in Bulgaria

Angel Angelov, Elitsa Stoilova, Tsvetan Dimitrov, and Velitchka Gotcheva

1 Introduction

Traditional foods are part of each country's cultural, historical and geographical inheritance, which has a significant influence on the contemporary dietary patterns (Costa et al. 2010). However, the increasing urbanization and globalization of the European food market that started during the second half of the twentieth century put a number of traditional foods at risk of being lost from the knowledge and culture in multiple regions (Weichselbaum et al. 2009). The importance of preserving traditional foods is not only related to ensuring a diverse, healthy and tasty diet for the European citizens, but it also means preservation of the cultural and historical heritage and identity of the EU countries.

During the past 10–15 years, as opposed to food markets of large volumes of uniform food products, the European consumers are developing an increased interest towards traditional foods, which are perceived as "good quality" and "healthy" products. The trend of going "back to traditional foods" is also observed in Bulgaria. However, approximately 50 years of centralized food production during the socialist political system has posed a huge challenge for the survival of traditional foods. Therefore, there is an urgent need to seek out the still preserved traditional foods in Bulgaria and to revive them for the contemporary food market in order to enrich and improve consumer's choice and dietary habits.

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The modern style of life and the increased dietary knowledge of consumers also set the demand for more nutritious, functional, and more convenient traditional foods, available at a larger scale. This need requires research on the possibilities to combine tradition with modern knowledge on food processing and technologies, food microbiota, functional properties and health effects, in order to provide consumers with foods which are traditional, yet with improved production technology and quality characteristics.

In this context, it is necessary to first discuss the term “traditional foods”. The first official European Union (EU) measure to protect the heritage of traditional foods was the establishment of the quality product designation schemes in 1992, including Protected Designation of Origin (PDO), Protected Geographical Indication (PGI) and Traditional Speciality Guaranteed (TSG). These schemes aimed to protect registered traditional foods with specific characteristics and distinguish them from conventional foodstuffs of the same categories. Furthermore, these product designation categories were protected by EC Regulations 509 and 510 from 2006, with the first regulatory definition of “traditional” set in Regulation (EC) 509/2006 as “proven usage on the Community market for a time period showing transmission between generations; this time period should be the one generally ascribed to one human generation, at least 25 years”. In 2008, this definition was acknowledged by the Food and Agriculture Organization (FAO). A definition of the European Food Information Resource Network (EuroFIR) project states “practices or specifications established prior to the Second World War”, with time limit selected to note the era before the large-scale introduction of technological innovations which significantly altered food production processes (Trichopoulou et al. 2007).

The EU-funded TRAFOON project (Traditional food network to improve the transfer of knowledge for innovation) defined “traditional food” as “a food which is produced according to the gastronomic heritage of at least three generations, which shows specific feature(s) that distinguish it clearly from other similar products of the same category in terms of the use of “traditional ingredients” (raw materials of primary products) or “traditional composition” or “traditional type of production and/or processing method”, and also associated with a certain local area, region or country” (Braun 2016).

Reinders et al. (2019) defined traditional foods as products of which (1) the key production steps are performed in a certain area at national, regional or local level, (2) are authentic in their recipe (mix of ingredients), origin of raw material, and/or production process, (3) are commercially available for about 50 years, and (4) are part of the gastronomic heritage.

The current Regulation (EU) 1152/2012 on the quality schemes for agricultural products and foodstuffs, which replaced EC Regulations 509 and 510 from 2006, revised the official definition in its Article 3: “traditional” means proven usage on the domestic market for a period that allows transmission between generations; this period is to be at least 30 years.

In the light of the above definitions, tradition of bread making existed in the territory of Bulgaria for thousands of years, long before the country was established in

681. This tradition was preserved until modern days, with bread always being the staple food of Bulgarians as an inseparable part of daily life, all holidays and religious rituals. It is a key connection between traditional and modern life and diet, but most old recipes and preparation methods are at risk of being lost. Therefore, the aim of this chapter is to bring traditional Bulgarian breads "out of the chest", to preserve and share cultural heritage, and attract scientific interest in order to employ traditional practices into diversifying the modern bread market.

2 Cultural Aspects of Bread making in Bulgaria

Bulgaria's historical, economic, and political development is related to its position on the crossroad to Western Europe, the near- and middle East, and the Mediterranean. At the end of the fourteenth century, Bulgaria came under the rule of the Ottoman Empire, a dependence that lasted nearly five centuries. The co-existence of ethnic groups with diverse cultural, linguistic, religious, and dietary habits influenced significantly Bulgarian traditional cuisine, which has evolved in the common Balkan-style as a mixture of Bulgarian, Greek, Romanian, Serbian, and Turkish culinary traditions characterized by balanced consumption of meat, vegetables and bread (Stareva 2005). Bread making and consumption in Bulgarian culture is related with particular behaviour patterns, cultural technological knowledge and with religious, folklore and cosmological beliefs. For Bulgarian society, bread is not just a staple food, but it has special meaning, it is a symbol, even at the time of consumption. It has an important role not only in everyday life, but also in our culture of traditional holidays and rituals. That is why in Bulgaria the term "culture of bread" is used by some ethnologists (Momchilova 2018). For Bulgarians, bread is a synonym of life. People's attitude to bread is expressed by the saying "No one is bigger than bread", which lives through the centuries and expresses not only the profound respect of Bulgarians to bread, but it also provides an understanding of the cultural and symbolic connotation related to sacred foods (Ninova 2012).

Bread is the key element of Bulgarian dietary habits. A meal without bread is considered incomplete. The pre-modern Bulgarians were in a constant interaction with bread, not only as a means of preserving biological life, but also as a synonym of live itself (Tauchanova 2013). In traditional Bulgarian culture, bread was also a symbol that united and brought equilibrium between everyday live and what was believed to be the sacral time and space dedicated to God, spirits and mythical creatures. According to Georgieva, 1992 bread was considered the connection between the material and immaterial words. The pre-modern Bulgarians believed that bread is a sacred food for sharing, and as such it took part in every practice related to the Orthodox Christian holiday calendar, natural and personal life cycles (Fig. 3.1). The interconnection between social, religious and nature is typical of a traditional and pre-industrial society. The ritual sharing of bread among the local community is a social unifying act which marked important events of the human life cycle such as birth, baptism, marriage, and death. Through bread, all participants in a ritual communicate with each other and share an event, a home and values (Cherkezova et al. 1996).

Fig. 3.1 Sourdough bread for Christian Orthodox rituals in Bulgaria. (Photo by Marushka Marinska, Momchilovtsi, Bulgaria)

Georgieva (1993) and Yaneva (1989) provide information on the specific rules and rituals followed in traditional bread making. Bread was prepared by women, and training in bread making technology started since early childhood. Every woman was required to achieve not only this technological expertise, but to also learn the rituals of which bread was an integral part. People believed that the first (Monday) and the fourth (Thursday) day of the week are charged with positive connotations, therefore these were considered good days for bread making. Pre-industrial Bulgarians characterised Saturday as "the day of death", and bread for the everyday use was not prepared on this day. However, on Saturdays women made bread used in the rituals of memorial services. Sunday was considered the day of the God and bread making was avoided. In some regions, there were also other days of the calendar when making bread was believed to bring a risk of harm or to compromise the prosperity of the entire community.

Ritual breads were prepared by following very specific rules regarding the specific day according to its purpose, origin and condition of the ingredients, place and time of the stages of preparation, technology, age, character and status of the woman preparing the bread, as well as the other participants in the ritual (Fig. 3.2). Depending on the purpose of the bread, the one who is making it was a maiden or an elderly woman. A ritual purity of the person engaged in the ritual bread kneading was required. Part of this purity was represented by wearing a festive dress and a

Fig. 3.2 Traditional bread making in Bulgaria. (Photo by Angel Angelov, Museum of Bread and Traditional Foods, Bulgaria)

head decoration with basil or geranium which are plants with the specific symbolic meaning of protectors. Specific conditions such as pregnancy, recent childbirth (until the 40th day after birth) or a monthly period were considered conditions of impurity and those women were not allowed to participate in ritual bread making. It was very important to follow all rules in order to facilitate the required transition or to achieve the required positive denouement.

The symbolism of bread making in Bulgaria related to human life starts at birth with the preparation of ritual bread "*Bogorodichna pita*" named after the Virgin Mary. In traditional Bulgarian culture, Virgin Mary is recognised as protector of the parents. The ritual consumption of the bread is believed to give strength to the Virgin Mary in order that she is able to assist women in labour. Another meaning of this bread is to protect the new born and to introduce the new soul into the human world. When the child is born, a round loaf of the bread is broken over the mother holding the child and good wishes are made for their health and happy life. The ritual bread is eaten right after its preparation as a symbolical act of gratitude to the saint. This bread is also a gift that should provide the new born with the saint's protection, and when the child is a grown-up to guarantee that he or she would be able to have children on their own. An additional meaning is that with this bread the new person is welcomed and symbolically accepted in human society (Georgieva 1993). Ritual bread is prepared for every important further event of a child's life – first entry in the church on the 40th day after birth, baptism. When an infant makes its first steps, a round loaf of bread is rolled before it so that the child follows and catches it.

Bread is also the food which guides a person on his last journey. It plays an important role in the funeral custom as it is perceived as a food that represents the soul. Right after a person's death, special bread named "*patnina*" (a bread for the trip) is made. The role of that bread is to facilitate the transition of the soul to the other world. Its name *patnina* shows that this bread is a guiding light though that journey. Bulgarians believe that when the hot bread is broken into pieces and eaten by the participants in the funeral, the soul leaves both the body and the human world.

It is believed that the rising steam of hot bread represents the soul. That is why warm bread is also named "*dushitsa*" (soul). Based on this belief, both in everyday life and in rituals bread should be broken into pieces instead of being cut as the soul might be hurt by the knife (Georgieva 1993). There is also a belief that warm bread is dangerous because of its spirituality; therefore, it is recommended that "hot bread must first go around the field" before being eaten.

Bread plays a key role in another life cycle ritual as well: the wedding. This is a central transition event in one's life, related to the separation with the old social role of young people and their families and the assumption of the new position. Through the wedding, two different families connect and two persons (the groom and the bride) become husband and wife. In order to facilitate those social transitions, the customs of a Bulgarian wedding are accompanied by the ritual preparation and consumption of several different breads dedicated not only to particular moments of the wedding but also to particular participants in the ceremony (the bride, groom, bridesmaid and best man) (Fig. 3.3). The newlyweds are given bread prepared by

Fig. 3.3 Traditional wedding bread for the best man. (Photo by Velitchka Gotcheva, co-author)

the groom's mother as a symbol of passing on the knowledge of bread making through the generations.

Christmas Eve is one of the most important holidays in the Bulgarian calendar, in which bread plays a central role. Christmas Eve is dedicated to the home, the hearth, but also to the deceased relatives, who are also considered part of the family. Several breads with different dedications are prepared for this holiday. The most important is called "*bogovitsa*" or "*badnik*" and a silver coin is placed in it. This bread represents a sacrifice dedicated to God and the house. It is decorated with dough figures with shapes of a cross, farming land and farm animals (Fig. 3.4). The coin in the Christmas Eve bread is the human symbol that connects the spiritual with the material. After the main prayer, the eldest person at the house breaks the bread into pieces, of which the first one is left before the icon of Jesus Christ, the second is for the house, and the rest pieces are distributed to each member of the family. It is believed that the house member who finds the coin in his piece of bread will be gifted with luck and prosperity throughout the whole year. This person must afterwards go to a God's temple and light a candle in recognition of God, the cosmos and human energy, with gratefulness for all gifts in his life.

Bagel-shaped bread is prepared to give to the Christmas carol singers (men only). Christmas bread dedicated to the farm is also made.

Fig. 3.4 Traditional Bulgarian Christmas Eve bread (*bogovitsa*/*badnik*). (Photo by Angel Angelov, Museum of Bread and Traditional Foods, Bulgaria)

Traditionally, ritual breads were prepared for every significant activity related to a house life – the first day of ploughing the fields, pruning the vines, the end of harvest, etc. Bread was prepared for rituals related to the stock. As an example, on the 11th of February (*Vlasovden*) bread is prepared for a ritual that should protect the health of the cows and water buffalos' of the family. Ritual breads "*vlasovina*" are made and the animal owners are giving them away to relatives and neighbours while imitating animal sounds (Marinov 1981).

The ultimate purpose of ritual bread is to ensure fertility and abundance for the family. It represents a prayer for prosperity of both the single individual and the community. In order to "direct" the prayer, decorations with symbolic representation are crafted on the bread to illustrate its specific meaning and function in the particular ritual.

Breads are also part of the ethno-medical practices of the pre-industrial Bulgarian society. Unleavened bread was made for health and to appease mythical creatures. Fresh bread spread with honey was made against diseases such as plague and measles. In times of epidemics, warm unleavened bread was put into a bag and left in a place far away from the village to lure away the disease. The basis for that rite is the belief that unleavened bread can appease mythical creatures, while due to its ability to increase its volume yeast would bring multiplication of pests and diseases (Georgieva 1993).

Fresh sourdough bread was used even to foretell future harvest, life expectancy, how to treat a disease or how to stop bad luck. Even today, in many parts of Bulgaria bread is distributed as a token when someone is sick so that the person recovers faster.

Ninova (2012) informs of two practices of using bread for healing injuries. Compress bread soaked in milk was used to stop bleeding and to heal a wound. Bread was also used to treat someone with a strong cold by placing very warm bread on the back of the person back until it cools down.

Nowadays, preparation and consumption of bread in the life of Bulgarians is a characteristic feature of national identity, preserved and passed down as a heritage through the generations. Despite the technological progress and changes in the way of life, bread continues to be part of each meal of the Bulgarians, and traditional breads are made according to the old rituals for every holiday and every important event in a person's life. According to tradition, Bulgarians continue to welcome important guests with bread and salt or honey and to give bread with honey as a symbol of gratitude.

3 Traditional breads in Bulgaria

Bread has been the staple food in Bulgaria for thousands of years. The first information about bread preparation in the lands of Bulgaria dates back to 3–4 centuries BC. In the tombs of the Thracians remainings of grain, bread and other foods were found. The most popular ancient source of information regarding bread making by the Thracians are the frescoes at the Thracian tomb in Kazanlak, Bulgaria. The ancient breads were made from einkorn, rye, barley and millet. They were also used for the preparation of fermented beverages. In Greek historical records from fourth BC about the current lands of Bulgaria, various breads made from einkorn, water nut or water chestnut are described (Ninova 2012).

In their daily diet, the Thracians used flour from whole grain cereals ground in stone mills, to which they added warm water and rock or sea salt. The resulting dough was placed in a wooden pan and kneaded to obtain a semi-solid consistency. The dough was baked immediately or allowed to ferment at room temperature for 7–8 h before baking. This bread was called "*prosenik*" and it passed through various transformations over time. The bread itself is firm and crumbly but can be stored for a long time without spoiling (Ninova 2012).

Later, in the tenth–twelfth century, preparation of sourdough began and the bread obtained from it was used for family and at religious holidays. Various methods for sourdough preparation, in some of which various plants, fruit or wine were used. An example found in historical records is einkorn sourdough bread: ground einkorn and wine sludge were placed in a clay vessel with lukewarm water to obtain thin slurry. For a period of 10–14 days the mixture was slightly aerated and flour was added until a thick mixture was obtained. When bubbles began to form from the separated gases, it was considered that the sourdough was ready for use as a starter for making bread. The sourdough was added to the einkorn flour and the dough was fermented for 5–8 h. A small amount was separated from the dough, and more flour was added to it to obtain firm dough which was dried for long-term preservation. The preparation of dried sourdough was done once a year and it could be renewed if necessary (Georgieva 1993).

In the past, the heterogeneous nature of geographic and climatic conditions in Bulgaria set the primary use of rye flour in the mountain areas, while wheat and corn were mostly used in the plains and valleys. When the harvest was poor or in state of penury, the daily bread was made from millet or barley.

Bread was prepared without (unleavened) or with the addition of a raising agent – sourdough usually prepared from a mix of cereals, from chickpea or from cereals combined with wild hop (most often) or other plants, herbs, or fruit. There were significant differences in the preparation technology and the cooking time. Due to the labor-intensive process and its duration, sourdough bread was made less frequently – once a week or on special occasions (guests, religious holidays, rituals). Unleavened bread was faster to make and the process required no special skills, but the bread had shorter shelf life. Unleavened bread was usually made for immediate consumption or to sell at the city streets to visitors (Georgieva 1993).

Sourdoughs in Bulgaria were prepared as type II (semi-liquid, with fermentation time of 2 to 5 days) or type III (sourdough is dried and preserved for a long period to be used as a starter) (Ganchev et al. 2014). Traditionally, sourdough was prepared by women, and a small amount of a previous batch was used as a starter. Sourdough bread was made in each household once a week or 2–3 times depending on the number of people. It had better structure and flavor and had a much longer shelf life than the unleavened bread. In some specific occasions related to traditions, it was important to use sourdough prepared at another household. When bread turned stale after long preservation, it was broken to pieces and consumed soaked in various liquid foods, such as milk, yogurt, herbal tea, or wine.

Over the years, sourdough technology evolved to achieve different quality characteristics of the product – crispy crust with characteristic color, size of the pores, elasticity, taste, nutrition value.

Based on records from the second half of the nineteenth century to the present (research of Dimitrov, co-author) in the regions of Lovech, Montana, Stara Zagora, Varna, Shumen and Yambol in 2018–2019, methods for sourdough preparation in Bulgaria may be classified as follows:

- Sourdough prepared from cereal flour – wheat, einkorn, millet and barley: Part of the flour is boiled to form thin slurry and after cooling more flour is added to it. The mixture is stirred for 7–14 days and a small amount of flour is added to feed the microflora (mainly lactic acid bacteria) until a thick slurry is obtained. It is then used to prepare soft dough which is left to ferment for 4–5 h.
- Sourdough made from flour and dried fruits: Dried apples, plums or pears are soaked in lukewarm water for 24 h, then removed and einkorn flour is added to the water to form a thick paste. The resulting bread has a sour taste and a pleasant malt flavor.
- Sourdough prepared with wine sludge (described above).
- Sourdough prepared with fresh vegetables and spices: ground or finely chopped vegetables are put into salted lukewarm water and wheat flour is then added to obtain a thin paste. The mixture ferments for 10–15 days, with periodic addition of more flour. Bread prepared with this sourdough has a stronger flavor than other types.

At the beginning of the twentieth century, Bulgarians began growing corn and corn flour replaced millet in the preparation of the traditional daily sourdough bread known as *prosenik*. Prosenik was prepared until the 60 s of the twentieth century as bread for breakfast, dinner and a snack. The purpose of this type of bread is to be filling and to be of high durability (Popov et al. 1984).

In Bulgaria, sourdough bread was also used to treat various illnesses – stomach problems, headaches and fatigue. It was also applied as a compress to reduce joint pain, to treat superficial hematomas and skin problems (Taushanova 2013).

Based on the information collected by personal meetings and interviews of Tsvetan Dimitrov (co-author), there are several ways to prepare prosenik, as further described:

– Prosenik with yogurt or buttermilk (based on interviews in Lovech and Yambol): Corn and wheat flour are added into lukewarm yogurt or buttermilk in a ratio of 3:1, with a little salt. The mixture is left to ferment for 2–3 h, then it is placed in a greased pan and baked. The peculiarity of these breads is that they are flat and 1–2 cm thick.

It is possible to add more flour to the mixture and to also add baking soda (sodium bicarbonate) to obtain soft dough. The baked bread is up to 4 cm thick, with a pleasant soft middle part, which is characterized by uniform bubbles. This bread retains its freshness and texture for a long period of time.

– Prosenik with sauerkraut juice (an interview in the village of Brusen, region of Etropole): This type of sourdough bread is prepared in North Bulgaria. Sauerkraut juice is diluted with water in a ratio of 3:1, then corn and wheat flour are added in a ratio of 3:1 (flour:water) to obtain a thick paste. The mixture is left for 2–3 h and then baked in a shallow pan sprinkled with flour or fat. Very often curd, white brined cheese or fried pork are added to the dough. The thickness of the bread is 1–2 cm.

Bread has a special part in all important events in the life of the Bulgarians from birth to death. It was very important that ritual bread is prepared from top quality ingredients. Since wheat flour was considered the best raw material for bread, wheat sourdough bread was prepared for family and religious holidays. For a child baptizing, sourdough bread was prepared from wheat flour, milk, butter and eggs to be soft, rich and nutritious and to symbolize a prosperous life for the child (Stareva 2005).

Festive bread from the region of Shumen (interview of Dimitrov, co-author): Lukewarm water and salt are added to warm milk, followed by wheat flour, sourdough and a small amount of sugar. Soft dough is kneaded and left to ferment for 4 h. Then it is kneaded again with gradual addition of oil or fat. The resulting dough is tough and sticky. It is allowed to ferment for further 4 h. It may be shaped into balls or wound as a rope, placed in a tray and left to rest for another hour. The resulting bread is 6–8 cm thick, with a thin crust, soft middle which is dividing into threads and has a pleasant aroma.

An interesting recipe for bread with apples from Southern Bulgaria was described in the first Bulgarian cooking book by the famous Bulgarian classic writer Slaveikov (2015). Apples are cleaned and cooked until soft. After cooling apples are crushed, sourdough is added to the resulting mash and a soft dough is kneaded from the mixture. It is allowed to ferment for 5–6 h and then form into the desired shape. The shaped dough is placed in a pan, then left to rest for 1–2 h and baked. The resulting bread has a soft middle, pleasant aroma and a crispy crust.

At the beginning of the twentieth century, potatoes were introduced in Bulgaria as a cheap food and they began to be used for bread making in the northern parts of the country. An authentic recipe for sourdough bread with potatoes was recorded in the village of Daben, region of Lukovit (interview of Dimitrov, co-author): Whole potatoes are boiled, peeled and mashed through a press. Lukewarm water, salt, sourdough and wheat flour are then added to obtain soft dough. It is allowed to ferment until its volume doubles. Then it is formed into the desired shape and left on a tray for another 2 h. The resulting bread has a thin crust, soft middle and retains its freshness for up to 10 days.

The other most typical traditional type of bread in Bulgaria is the Bulgarian pie, called "*banitsa*". This bread is regularly prepared in every home both as part of the daily diet and for special occasions – life events and traditional holidays (Fig. 3.5). Essentially, it is made by layers of rolled out dough (filo or phyllo dough) with

Fig. 3.5 Bulgarian *banitsa.* (Photo by Angel Angelov, Museum of Bread and Traditional Foods, Bulgaria)

different filling between the layers. There are many types of banitsa, which differ in their filling and the way the filo dough is prepared.

Banitsa with pre-baked filo dough is typical for Northern Bulgaria (recipe from the region of Montana). It is prepared for the New Year's dinner, at the birth of a child and at baptizing. Soft dough is prepared from white wheat flour, sourdough and salt. After fermentation, 12 balls are formed from the dough, symbolizing the months of the year. The shaped dough is left to ferment for another 1–2 h. From each ball a thin filo is rolled out and baked on a plate over low heat. The obtained baked filoes with large bubbles are briefly immersed in hot water with fat and arranged in a pan, with crushed white cheese, and a mixture of yogurt and eggs, and melted animal fat being sprinkled over each crust. After placing the last filo, banitsa is perforated with a knife and poured with hot fat. It is then baked at low heat and after baking sugar syrup is poured over it.

In the mountainous areas, specific banitsa types are made with leaves of various wild plants such as sorrel, dock and nettle.

A recipe for luchnik (banitsa with onion) was obtained from the town of Apriltsi in Central North Bulgaria (interview of Dimitrov, co-author): Soft dough is prepared from white wheat flour, sourdough and salt and is allowed to ferment for 4 h. During this time, green onions, yellow onions and sorrel are stewed in fat. When the filling has cooled, eggs and cheese are added. The dough is divided into three parts, which are rolled out into thin filoes, sprinkled with the resulting filling, shaped into one roll and twisted. The resulting "rope" is wound in a greased pan and baked.

Pumpkin banitsa is an integral part of the completion of the annual cycle in the holiday calendar. The specificity is mostly related to the preparation of the filling. Pumpkin can be boiled, raw or fried. Crushed walnuts, sugar, dried fruit and cinnamon are added to the pumpkin. The filling is distributed over fine filoes, which are then rolled up and placed in an oiled pan. Banitsa is baked at a moderate temperature and then sprinkled with vanilla sugar (Ivanova and Vukov 2010).

Another traditional type of bread is prepared on the mourning day. The relatives of the diseased person prepare 3 loaves of unleavened bread which are distributed to the bereaved. The mourning continues for 50 days, and in the end of it some Bulgarian communities prepare a specific type of banitsa, called "*stareshko tochene*". A recipe from the village of Glogovo, region of Teteven is hereby presented (interview of Dimitrov, co-author): Dough is prepared from wheat flour, sourdough and salt and it is left to ferment for 3–4 h. The dough is divided into 3 parts and is left for another hour. Corn flour is added to melted butter and fried, then eggs are added and crumbs are formed. The dough is rolled out and the filling together with some white cheese is distributed over the 3 thin filoes. They are rolled up and placed in a pan. The banitsa is baked at a low temperature until the fat comes to its surface. The cooled banitsa can be stored for up to 20 days in a dry place. Before consumption, cold saline solution is poured over it. This is one of the few types of banitsa where the cold pie is poured with a cold solution.

4 Recent Developments and Trends in Bread Consumption

Bulgarians eat bread with each meal of the day – at breakfast, lunch and dinner. In the last 3 years, a trend for decreased bread consumption is observed: in 2017–87,1 kg of bread per person yearly, in 2018–85,3 kg, and in 2019–82,4 kg of bread per person (https://www.nsi.bg/). However, these levels are still much higher than the consumption of bread by other European countries. As an example, nowadays Dutch people consume an average of 50 kg of bread per year. In terms of market distribution, Bulgarians buy most of our bread at the supermarket (about 85%) or at small bakeries (about 10%), and only a small part is prepared at home (Kuiper 2016).

In the past, white wheat bread was considered of the highest quality. During the 45 years of communism, availability of bread varieties of the centralized bread delivery system was very limited (4–5 varieties), with white bread being predominant. This has cultivated nationwide predominant white bread consumption and this habit is still predominantly preferred in the rural areas of Bulgaria. However, after 1989 consumers in the cities gradually changed their preference towards an increased consumption of wholegrain bread, breads made from different grains and with various additional ingredients such as flax seed, oats, etc., which offer richer taste and flavor and are perceived as more healthy.

Bulgarian daily diet has undergone significant changes throughout the past 50 years. On one hand, there is a trend for keeping the traditional and unique recipes, including the use of microorganisms in the production of fermented foods. In this connection, during the past 10 years a keen interest in finding and preserving such endemic recipes and products has risen among the population. On the other hand, the ongoing processes of globalization and urbanization, aided by the enormous role of advertizing in social networks and media lead to changes in the food habits of modern Bulgarians and increased consumption of innovative healthy fermented products. Most of the changes are observed among the younger population, the citizens of the capital and the biggest cities, as well as the middle and higher social class in the country (Petrova 2017).

Throughout the past 10 years, interest towards traditional sourdough bread is rapidly rising. Bulgarians are renewing the tradition of preserving sourdough and making sourdough bread at home and numerous recipes are shared over the social networks. Sourdough bread is offered both by local bakeries and the big bread making companies and its market share is rising significantly. This trend has sparked the need for sourdough starter cultures with defined composition and specific characteristics for application in innovative healthy bakery products. Scientific research on Bulgarian sourdoughs is still very limited, but several teams are working on revealing the composition of traditional Bulgarian sourdoughs and the impact of geographical specificity, on strain selection and starter culture development for industrial applications (Dobreva-Yosifova et al. 2014; Ganchev et al. 2014; Gotcheva et al. 2018; Ignatova-Ivanova et al. 2014; Petkova et al. 2020).

5 Nutritional Benefits of Sourdough Bread

At the beginning of the twentieth century, Metchnikoff studied the connection between the good health and longevity of Bulgarians and their diet. The highest health credit was given to Bulgarian yogurt and the beneficial effect of the bacteria involved in its fermentation (Cavaillon and Legout 2016). However, other fermented foods also contributed to the positive health effect, especially traditional sourdough breads which were the staple food of the country.

Modern research has revealed a number of nutrition and health benefits of sourdough breads, which are specifically attributed to the effect of the fermentation (Gobbetti et al. 2019; Poutanen et al. 2009). One positive effect is related to phytates in the flours, which are considered antinutrients because they chelate minerals, thus reducing body's ability to absorb them. Lactic acid bacteria in sourdough produce organic acids which lower pH and that helps degrade phytic acid by 24–50% more than conventional yeast fermentation (Lopez et al. 2001). In addition, some lactic acid bacteria and yeasts have the ability to produce extracellular phytases, which cleave the phosphate groups from phytic acid-mineral complexes, liberating minerals in solubilized form (Sharma et al. 2020). Both effects result in breads with much lower phytate content than conventional yeast-leavened bread and, respectively, have higher bioavailability of essential minerals including iron, selenium, potassium, phosphorus, magnesium and zinc (Gobbetti et al. 2014; Katina et al. 2005).

Sourdough also contains high levels of folate which is synthesized by yeast and some bacteria from the fermenting microbiota (Kariluoto et al. 2004, 2006).

A number of studies show that lactic acid bacteria are able to release antioxidant peptides through the proteolysis of native cereal proteins during sourdough fermentation (Coda et al. 2012; Sarmadi and Ismail 2010). Antioxidant peptides are characterized by high activity, easy absorption, higher stability and non-hazardous immune reactions compared to synthetic antioxidants (Sarmadi and Ismail 2010). Some studies show that specific flours, such as rye flour, used in some sourdoughs also contribute to the higher antioxidant content of sourdough products (Michalska et al. 2007). Thus, the natural antioxidants in sourdoughs help to produce high quality bread with prolonged shelf life without antioxidant additives while contributing with their functional benefits to improve the health of the consumer.

Other important benefits of sourdough fermentation are related to the improved flavor and texture, moisture content and mechanical properties of sourdough bread during storage. Antioxidants, organic acids, exo-polysaccharides, enzymes and other compounds produced by the sourdough microbiota contribute to an extended freshness and shelf life of the products, which eliminates the need of using additives (Katina et al. 2005; Papadimitriou et al. 2019; Torrieri et al. 2014).

Sourdough fermentation may also produce various functional compounds, such as prebiotic oligosaccharides and exo-polysaccharides, as well as peptides and amino acid derivatives (e.g., γ-amino butyric acid) (Gobbetti et al. 2014). On the other hand, it may also decrease anti-nutrient factors in breads such as gluten proteins and fructans. Both groups are known to cause intolerances and allergies. Some studies showed that sourdough fermentation resulted in solubilization and depolymerization of the gluten macropolymer, as well as glutenin hydrolysis which were mainly caused by pH-dependent activation of cereal enzymes (Nionelli and Rizzello 2016; Thiele et al. 2004). These results in improved digestion of gluten proteins present in most cereals used for bread making. Also, it was demonstrated that bacterial proteolytic activity is promising for eliminating traces of contaminant gluten in non-gluten matrices and for the manufacture of baked goods with lower gluten content which are easier tolerated by consumers sensitive to gluten (Gobbetti et al. 2007). A study of Rizello et al. (2006) demonstrates that proteolytic activity of selected sourdough lactic acid bacteria during sourdough fermentation results in pre-digested wheat and rye dough which contains IgE-binding proteins degradable by digestive enzymes.

Most sourdoughs are prepared by mixing various flours, which results in breads with naturally higher content of fibre and other macronutrients compared to conventional white wheat bread. Foods with higher fibre content and a lower glycemic index (GI) are very important for type 2 diabetes consumers, since they are less likely to produce a spike in blood sugar levels. Sourdough is recognized as a low GI food, as the index of sourdough wheat bread is approximately 54, compared to an average GI of whole wheat bread of ca. 71 (D'Alessandro and De Pergola 2014). Various studies revealed the different mechanisms explaining this effect. One may be that fermentation alters the structure of carbohydrates in sourdough and slows down the speed at which sugars enter the bloodstream, resulting in improved blood sugar control (Mofidi et al. 2012). A study of Östman et al. (2002), suggests that lactic acid present in sourdough promotes interactions between the starch and gluten during baking, hence reducing starch bioavailability and resulting in lower GIs of sourdough breads. Also, production of organic acids by lactic acid bacteria during sourdough fermentation the lactic acid bacteria may have a positive effect of delayed stomach emptying, thus preventing a spike in blood sugar (Lappi et al. 2010; Östman et al. 2002).

However, the high dietary fibre content and the low-molecular weight fructans of wholegrain sourdoughs places them in the group of foods containing FODMAPs (fermentable oligosaccharides, disaccharides, monosaccharides, and polyols), which may have beneficial or negative health effects depending on the specific health state of the consumer. On one side, oligosaccharides are fermented by colonic bacteria to short chain fatty acids which have a number of health benefits and oligomeric fructans act as prebiotics for the beneficial intestinal microflora (Singh et al. 2017). On the other side, consumers with irritable bowel syndrome (IBS) have to maintain a low FODMAP diet in order to prevent gastrointestinal symptoms. Sourdough fermentation breaks down fructans, making them easier on the digestive system, therefore sourdough products are a good alternative for IBS patients to increase their dietary fibre intake without suffering the negative consequences of their health condition (Albiac et al. 2020). Some studies demonstrate that sourdoughs with specific FODMAP-targeting metabolic properties could be used to significantly reduce the content of FODMAPs in wholegrain bread without affecting the content of the slowly fermented and well-tolerated dietary fiber, thus preserving the health benefits of fiver-rich bakery products for IBS consumers (Bo et al. 2017; Loponen and Gänzle 2018; Menezes et al. 2018).

Current research findings suggest that sourdough fermentation can also degrade α-amylase/trypsin inhibitors (ATI), which have recently been identified as inducers of an innate non-celiac immune response in consumers (Caminero et al. 2019; Geisslitz et al. 2018). Sourdough fermentation was found to degrade ATI structure and bioactivity, which may be applied as a successful strategy to reduce the severity of inflammatory non-celiac wheat sensitivity (Huang et al., 2020).

6 Conclusions

The systematic investigation and documentation of traditional bread making is essential to preserve Bulgarian cultural heritage. On one hand, this enables new generations to establish a sense of "roots" and "belonging" and to experience and enjoy unique specialty products. On the other, the new nutritional data on the health benefits of traditional sourdough bread offers a modern strategy for the development of functional sourdough products to meet the current cultural trends and the specific dietary needs of consumers. Contemporary scientific knowledge combined with geographical specificity is employed in the current research on strain selection and sourdough starter culture development for applications in modern bread production.

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Chapter 4
Traditional Croatian Breads, the "Peka"

Nada Knežević, Karlo Vulin, and Dubravka Novotni

1 Introduction

Peka is the name given to traditional open fire hearth baking. The name "*peka*" specifically refers to a bell-shaped dome lid made of either clay or cast iron. In Croatia, quite often other names are also in use: čripnja, crijepnja, pokljuka, vršnik, pokrivača, or sač (Gavazzi 1978). The *peka* resembles the testo, tegamo or tigello in modern Italy, the tian in southern France, and the klibanos, gastra or gastrion in the Byzantine world (Cubberley et al. 1988; Tivadar 2016). The *peka* has been used since prehistoric days in the territory of Croatia, particularly in Dalmatia, Dalmatian Zagora, and Lika. Around 700 B.C., its use spread throughout Croatia and other Balkan countries (Gavazzi 1978). Its usage has been preserved culturally, to the present day virtually unchanged, in the areas of Lika, Dalmatia and Dalmatian Zagora. The tradition of making *peka* bread is passed down verbally from generation to generation without written words by means of oral tradition. Nowadays, *peka* is used to prepare bread and other dishes in front of guests themselves as a gastro touristic attraction (Kocković Zaborski 2018).

Everywhere in the world, bread is made of similar basic ingredients. Nonetheless, every step in the making of bread, from the selection of raw materials to processing of the dough, determines the characteristics of the final product. By combining

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common wheat flour with water and a small amount of other ingredients, and after rising and baking under the *peka*, the bread has a unique appearance and flavor not comparable to bread baked conventionally in regular ovens. The bread is distinguished by its thick crust with bubbles on the upper surface, soft crumb with large and irregular holes, rich flavor, and extended freshness. Baking under a *peka* covered with wood embers, contributes to its subtle smoky woody flavor notes.

Peka bread is one of the oldest best known traditional Croatian breads. While some Croatian traditional bakery products such as Poljički soparnik and Zagorski mlinci received the international granted labels of protected geographical indications (European Commission 2016, 2019), the name of *peka* bread as a traditional specialty is still unregistered and unprotected. Since consumers increasingly want to become acquainted with the origin of the food product, such label could provide them the guarantee of quality. Though the traditional *peka* is still used for baking in some specialized bakeries and restaurants, the entire process of bread-making is experiencing modernization and industrialization which might uniform its quality but bland its unique sensory features.

The consumers' demand for local food is increasing, and traditional bakery products are becoming more attractive (Knežević et al. 2018). In Croatia and its regions, gastronomy, as an indispensable part of culture and tradition, represents an important factor in its authenticity and identity (Fox 2007). However, Croatia is not recognized through its traditional food due to its historically long foreign influence of Venice and Austria-Hungary (Renko and Bucar 2014). Croatian tourist destinations rarely found their gastronomic offer on local cuisine (Fox 2007), even though the coastal zone (Istria and Dalmatia), located in the Mediterranean, is rich in authentic and original meals prepared according to old recipes in that region.

2 Tradition of Baking Under a *Peka*

The history of baking bread and savory meals under the *peka* is thought to be more than three thousand years old (Žaper 2004). In prehistoric and ancient times, the *peka* was a principal culinary device and means for preparing food on an open hearth (Djordjević and Nikolov 2013; Tivadar 2016). In the mid-eighth century B.C., during great ethnic migrations, the baking cover was adopted from its Pannonian progenitors by the Illyrians, who introduced it as a novelty to the Balkans (Tivadar 2016). From there its use spread along the western Balkans and into central Italy (Tivadar 2016). While the traditional use of the baking cover in the Italian peninsula in the early medieval period continuesd through to late antiquity e, it was later replaced by bread ovens (the *furnus*) (Cubberley et al. 1988). It is believed that *peka* remained a tradition within the Croatia coastal area, because the inhabitants of the Dinaric area never accepted the Roman bread oven but kept their own tradition of baking under a *peka*. It was inexpensive and simple to use, making it readily accessible to many people (Nadvornik 2013). Its use was revived during the Ottoman conquests of the Balkan region (Tivadar 2016). In this period, the iron baking cover,

Fig. 4.1 Hearth and iron *peka* from Dalmatia (Croatia)

known by the Arabic-derived name sač, gained broader use in the area (Fig. 4.1). The adoption of baking bells by the Barbarian peoples (such as the Avars and the ancient Hungarians) who settled on the borders of the Mediterranean countries is considered as a cultural advance and the adoption of local traditions (Tivadar 2016).

Peka covers were made in two major types: in the form of bell or the calotte with flattened dome, often with a single top handle or two side handles (Gavazzi 1978). Early *peka* baking covers were kilned from clay, and tempered with sand, crushed rocks or shells, or sometimes even with chaff and goat hair to endure the high heat stress (Nadvornik 2013). Originally, they were hand crafted. In later times in antiquity, covers were thrown on a potter's wheel (Gavazzi 1978). First, the clay had to be excavated and mixed with other materials (e.g. sand). After the clay was formed on a potter's wheel, the *peka* dish was left to dry for about 15 days (Milićević 1976). In summer, it had to be covered to avoid drying too fast, to prevent clay cracking. Then, the dishes were baked in stone furnaces heated with wood for about 4 h until red-hot (Milićević 1976). They were left to cool in the furnace for 1–2 days. The dishes were not glazed or painted, but decorations were often present (Cubberley et al. 1988). In the late medieval period, the ceramic baking covers were increasingly replaced by its metal (iron) versions, primarily due to the greater ease of heating and maintaining heat (Tivadar 2016). A *peka*'s diameters is ranging from twenty to sixty centimeters and a height ranging from ten to forty centimeters (Nadvornik 2013). There were numerous local variations featuring a flange to hold hot ash and perforations to release steam and regulate the baking temperature. Late period Roman and early Byzantine artifacts found in Istria, from the Betiga site near

Barbariga or the Brijuni Castrum sites were found to be similar to their North Italian counterparts, whereas baking covers from the broader Balkan area exhibit great typological diversity and the similarity to numerous forms from earlier periods (Juroš-Monfardin 1987).

The method of baking under *peka* constituted a significant step forward from roasting directly over an open flame. It may have developed from the earlier practice of rolling food into a leaf or a thin layer of clay and then laying it on embers (Cubberley et al. 1988). Baking under a *peka* is performed by either placing the dough directly on the heated hearth surface or on a shallow baking tray, followed by placing the pre-heated *peka* cover on top (Fig. 4.1). The baking cover is then in turn covered with embers and hot ash and left to sit for a few hours (Gamulin and Vidović 1967). The practicality of the method and the ease of fabrication made the baking cover a popular cooking aid found across the Mediterranean world. In Balkans, until mid-1900s, *peka* was a mandatory piece of kitchenware (Djordjević and Nikolov 2013). It can be found in some areas of the Balkans even today (Tivadar 2016).

A hearth ("*komin*" in Croatian) was the central place for cooking in a wooden (of beech wood) or stone house. As early as the beginning of this century, and in some places even after World War II, it would be protected from the elements by a thatch roof overhang or one made of meter long twigs (Gavazzi 1978). The hearth would have a square shape, and the base was built of stone or wood (Gamulin and Vidović 1967). Smoke could escape from an opening in the roof or chimney (Randić 2001). Besides a clay or metal *peka*, a wooden peel (shovel) was kept nearby to be used to place the dough on the hearth (Nadvornik 2013). The hearth was located mainly along the outer home walls, it was elevated 20 cm and it was surrounded by stone (Gavazzi 1978). Urban hearths were higher than the countryside versions. In some rural houses hearth was made from mounds of piled soil, which were then covered by stone slabs along the edge (Kocković Zaborski 2018). A family would gather around a hearth that served as a place to warm up and socialize (Gavazzi 1978). Over the course of time, the *peka* cooking technique was used for various purposes, beyond baking of bread, to include pastries and cakes, as well as roasted roasting meat and fish. Today it is used as a means of 'slow cooking'.

3 Traditional Method of Making Bread Under a *Peka*

Bread has been one of the most important and indispensable part of the human diet since ancient times. In Croatia, bread has been made of several types of cereal flour. In the Dalmatian hinterland, flour was produced mainly from barley, corn, rye, millet, sorghum, and wheat (Gamulin and Vidović 1967). Crops were hand harvested with a crescent, and later with the use of a scythe. The grain was threshed in a way that domestic animals such as horses, oxes or even donkeys would tread the grain. The cleaning process was simple winnowing in order that wind blows the chaff. Grains were ground in a quern which almost every family owned (Randić 2001). The quern is the precursor of the stone mill, which consisted of two horizontal (circular or conical) stones placed one on top of the other (Cappelli et al. 2020). A tool called a rind supported the upper stone, creating a slight gap between the two grinding surfaces. The upper stone was rotatory, while the lower one was stationary (Walker and Eustace 2016). In twelfth century, watermills were introduced from the Byzantine Empire since Croatia has always been rich with rivers and streams (Kolar-Dimitrijević and Wagner 2007). The mills were often jointly owned by several houses, home cooperatives, or the whole village. Many peasants have long been faithful to their old watermills, and they used them even when they could already get better quality flour much faster milled in the steam and motor mills. After World War II, many watermills were demolished. In Dalmatia, there are still numerous watermills and pillars that have cultural and historical significance as monuments of rural architecture and the economic past. Recently, a watermill on the Roški waterfall was restored to be kept as a cultural heritage monument within the Krka national park area (Živković 2010) similarly a mill in Srednji Marasovića within the Paklenica national park was also saved. Some watermills such as Benzona (Antoničin mill) on Žrnovnica River and Gergeljev mill in Starigrad (near Koprivnica) are still in use today.

For bread-making, different types of flour were used in Dalmatia and in the Adriatic islands. On the island of Krk, wheat, millet, sorghum, barley, corn, rye, and buckwheat were used (Randić 2001; Briški and Jarec 2014). In the Imotski region of Dalmatian hinterland, bread was made using wheat flour. Bread was made once a week with a mixture of corn (maize) and barley flour or some other cereals, while white bread was made and consumed on extremely rare situations, such as holidays (Kocković Zaborski 2017).

Written recipes for traditional *peka* bread generally do not exist, the know-how is transferred verbally from generation to generation by oral tradition (Gamulin and Vidović 1967). Women almost exclusively performed the bread making tasks. Similarly as other types of bread, *peka* bread is made with just a few simple ingredients: flour, water, salt, and a portion of reactivated ‘old’ dough. A piece of bread dough was always kept as starter feedstock for the next bread making occasion, often wrapped in a cabbage leaf. Before subsequent bread making, starter was reactivated by adding water and leaving to ferment for several hours or overnight until it rises and show bubbles. A needed portion of flour was sifted into a large wooden bowl, and using a wooden spoon, a well was created in the center. Pre-fermented dough, a portion of lukewarm water, and salt were added into the bowl next. Then these ingredients were mixed together by hand or with the use of a wooden spoon. The remaining flour and the rest of the lukewarm water were added alternately, until all of the mixture was homogenized. The dough was stickier and softer than most European bread doughs and is more akin to flat bread dough types. Sometimes, a small amount of olive oil was added. The dough was kneaded gently until becoming smooth and uniform in consistency. A ball of dough (about 1 kg) was covered with cloth and left to rise for several hours in a warm place until it doubles in volume. Then, the dough was dusted with small amount of flour, and kneaded a second time by pulling the edges towards the middle, so that air is captured in the dough as much as possible. The dough was formed into a circular shape. Sometimes shallow cuts were made diagonally across the top surface. Meanwhile, as the dough was finally left to rise, a fire was lit on the hearth. Wood from dried grapevine, juniper, and thorn branches is ideal for making a fire as it produces good embers. The wood must burn completely to produce suitable embers. At the same time, the *peka* cover was placed nearby to heat up. The hearth must not be too hot as it would cause the bread to burn. When the hearth reached the optimum temperature, the embers are put on the side. After rising, the sufficiently leavened dough, now in the circular shape of the *peka* cover is placed on the hot surface dusted with flour or greased with oil. The dough is then first covered with the *peka* lid, and then the embers are put on top for baking. After about half an hour, the *peka* would be opened allowing for the steam to be released, and the bread was rotated for even baking. Hot embers were once again used to cover the *peka* to provide heat to complete the baking. The bread was baked for about 50 min, depending on how strong the fire was, and until the crust was golden brown in color (Nadvornik 2013). To test the completeness of the baking, a woman would knock on the loaf of bread with her hand and by experience would know by the right sound whether the baking was complete. The embers and ashes were swept away, and the *peka* would be put aside so that the bread would stay clean. Lastly, the bread was lightly sprinkled with cold water and allowed to cool for about 30 min, and set vertically so that only a small part of the loaf touches the table surface. Afterwards, the bread was wrapped in a kitchen towel, where it could be kept for up to a week. The bread had an extended shelf-life and prolonged freshness that allowed it to be carried on voyages by sailors and fishermen.

4 Contemporary Processes of Making *Peka* Bread

Tradition is extremely important in preparing any staple food such as bread. The tradition of baking under a *peka* has remained in Zagora and other parts of Croatia until today, as a true specialty. Nowadays in Croatia, *peka* bread is made in restaurants, as well as in small craft, medium sized, and large commercial factories. White wheat, brown wheat, rye and corn breads are made traditionally following old-fashioned recipes without using additives or according to adapted formulations (Table 4.1). Nevertheless, the global trends in bakery, such as convenience health concerns, and sustainability (Grunert 2013), are beginning to reflect in the modern manufacture of *peka* bread.

According to The European Food Information Resource (EuroFIR 2014), traditional food is a food with a specific feature or features, which distinguish it clearly from other similar products of the same category in terms of the use of 'traditional ingredients' or 'traditional composition' or 'traditional type of production and/or processing method' (Cerjak et al. 2014). Traditional foods are also often related to local foods and artisan foods referring to specific ingredients, location of the production, and know-how (Cayot 2007; Dunne and Wright 2017). Artisan foods are foods produced by hand or traditional methods, using specially selected ingredients to produce products which are superior in quality and taste (Dunne and Wright

Table 4.1 Typical ingredients used in approximate amounts in making *peka* bread

Ingredient	Amount (% at flour basis)
White wheat flour	100
Whole wheat flour (common wheat, spelt)	0–100
Rye flour	10–30
Corn flour	0–100
Seeds (sunflower, sesame, and flax) or sprouted grain	0–10
Water	650–800
Compressed yeast	0–3
Sourdough	0–20
Poolish/sponge	0–20
Olive oil	0–1
Malt	0–1
Salt	1.8
Bakery improver	0–0.5

2017). The demand for knowledge about the artisan food and the need for skilled artisans is continually increasing also in Croatia.

In attempt to reproduce a traditional bread, the possibility to find the ingredients which were used before is seriously questioned. Old cereal species and varieties that were widely used in the past have been replaced by modern bread wheat. Nowadays, strong flours made from generally hard wheat varieties that have high protein (about 12%) and high gluten content are used in bread making. Beside the cultivation of wheat and other cereals, the milling process has advanced technologically. Instead on quern, wheat is predominantly milled on industrial roller mills. Sometimes, artisanal bread makers use small amount of flours ground on stone mills. The stone milling is more traditional method which is the simplest technique for milling whole grains. Chiefly, it is preferred by organic food producers because of its positive effects on the bread volume, texture, nutty flavor, higher concentrations of macroelements, microelements, and polyphenols, and popularity among consumers (Cappelli et al. 2020). On the other hand, roller milling also has clear advantages including greater efficiency and flexibility, less heat generation, and better dough rheological performance (Cappelli et al. 2020).

The other important choice that strongly affects different features of bread is the method of dough leavening. In modern *peka* bread production, an old dough that was kept from previous occasion of bread making to be used as a pre-ferment has been replaced with polish, sourdough or baker's yeast. The polish is obtained after fermenting the mixture of flour, water and yeast for about 12 h. Sourdough is prepared by traditional method of spontaneous fermentation using naturally present microbiota or with use of commercial starters of lactic acid bacteria and yeast. In small craft bakeries, polish and/or sourdough starters are used as an exclusive means of leavening.

Though simple at first glance, baking under a *peka* requires a great deal of skill and experience. Artisan bakers have to undergo special training for using craft and artisan techniques and equipment for kneading, rounding, proofing, and baking under *peka*. Modern bread manufacture that involves a mechanical dough-handling processes of kneading, dividing and shaping might be too rough for lower-strength, higher-hydration artisan doughs (Orecchio and Papuzza 2009). Thus, the dough is kneaded by hand, the proofing period is long, and baking is done traditionally with cast iron *peka* lid surrounded and covered with embers. Still, medium size bakeries use some innovative methods including high-speed mixers and retarded proofing (Fig. 4.2). For the kneading of dough from strong wheat flour, intensive mixing is preferred since it can provide a strong gluten network. The use of retarded proofing applied in traditional bread helps to meet the seasonal demand for freshly baked bread, particularly during the summer. Bread is baked on the hearth or a deck oven using wood as fuel, often at night.

Generally, the demand for *peka* bread can be hardly met by the supply provided by traditional bakers. Industry slightly modifies the concept of this traditional bread but allows consumers its wider availability for accessible price at different regions. They use industrially roller milled, strong wheat flour, and compressed yeast for leavening, dry sourdough or bakery improvers (Table 4.1). The ingredients used in bakery improvers vary but typically contain one or more functional ingredients that comply with the 'clean label' rules but prolong textural and microbial shelf life. In

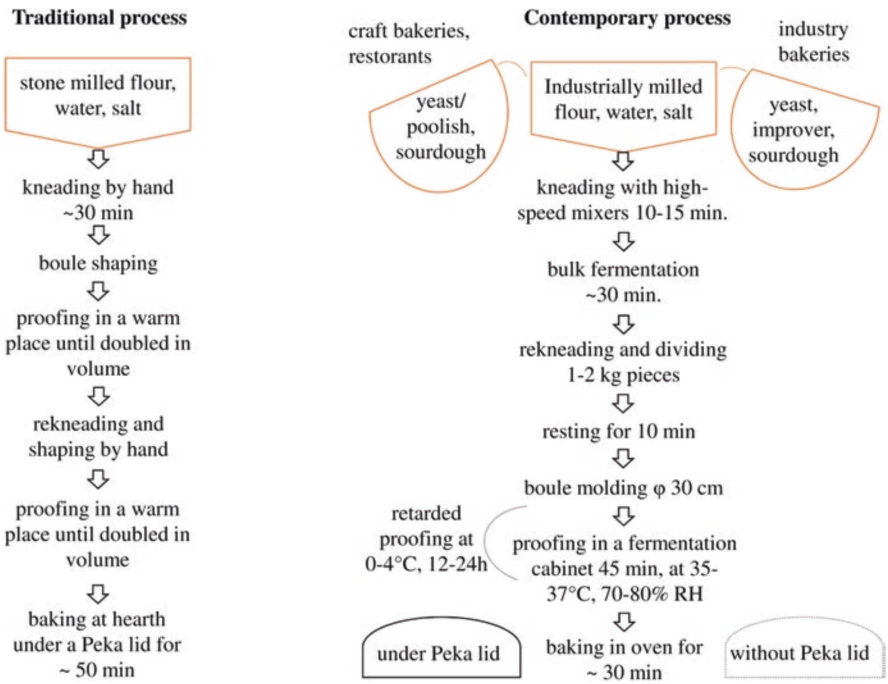

Fig. 4.2 Flow chart of traditional and contemporary processes of making bread under *peka*

contrast to small and craft bakeries, industrial bakeries are either fully or partially automatized. The industrial processing method consists of using high-speed mixers for kneading, short bulk fermentation, automated dividing and shaping, and shorter proofing time in chambers with controlled temperature and humidity, and baking without the *peka* lid (Fig. 4.2). Industry ovens mostly use natural gas are the main sources of energy. They can consist of moving belts made either of slats or woven wire, but fireclay (*chamotte*) base is preferred. Bread is packaged in ways which currently enhance the perception of safety.

At the restaurant and artisanal bakeries, bread is produced and sold fresh to consumers at the same location often at a premium price. In restaurants, *peka* is served with lunch or dinner and is great as an appetizer with cheese or olive oil. Beside bread, *peka* can be used for making different famous meals from fish or meat (Žaper 2004). Family farms also organize direct distribution of traditional food to Croatian consumers (Renko and Bucar 2014). Industry produced bread is distributed as retail, wholesale, in-store, and through foodservice reasonably priced. Traditional food such as *peka* bread is environmentally friendly because it is produced not far from the place of living, thus contributing to sustainability, but Croatian consumers lack such environmental awareness (Cerjak et al. 2014).

5 Characteristics of *Peka* Bread

The *peka* bread has common yet peculiar characteristics. The bread from the contemporary production has the outer appearance resembling to traditional bread, but there are variations depending on the selection of ingredients and processing method. Generally, is a big round loaf, often weighting from 0.70 to 1.5 kg, but sometimes even to 3 kg. Artisanal products can differ from batch to batch in their appearance and weight, due to hand dividing and shaping. The bread has a rustic look, it is usually crusty, sometimes with flour dusting or bubbles on the top (Fig. 4.3). The bread diameter is regularly over 30 cm, and the central height is from 7 to 15 cm. The crust thickness varies from 3 to 5 mm; it is golden-brown, and uneven in color. The crumb color varies from white to brown depending on the flour used for bread making. The crumb has an open crumb structure, with irregularly distributed and elongated pores (Fig. 4.3). The texture of the crust is characterized by its crunchiness whereas the crumb is soft, moist, elastic, and a bit chewy. Bread taste is slightly sweet and salty. Its aroma depends on the flour type, as well as the fermentation and baking processes. The method of baking bread under the *peka*, traps the developed aroma in the bread. The bread from industrial production (Fig. 4.4) baked without the *peka* lid, is usually less aromatic, due to the difference in baking but also because of shorter fermentation process. One of the main differences in the process of elaborating fermented baked cereal products are the fermentation conditions (Cayot 2007). Prolonged dough fermentation increases the concentration of aroma precursors produced by yeast and lactic acid bacteria. Retarded dough fermentation which is characterized by a refrigeration step of the

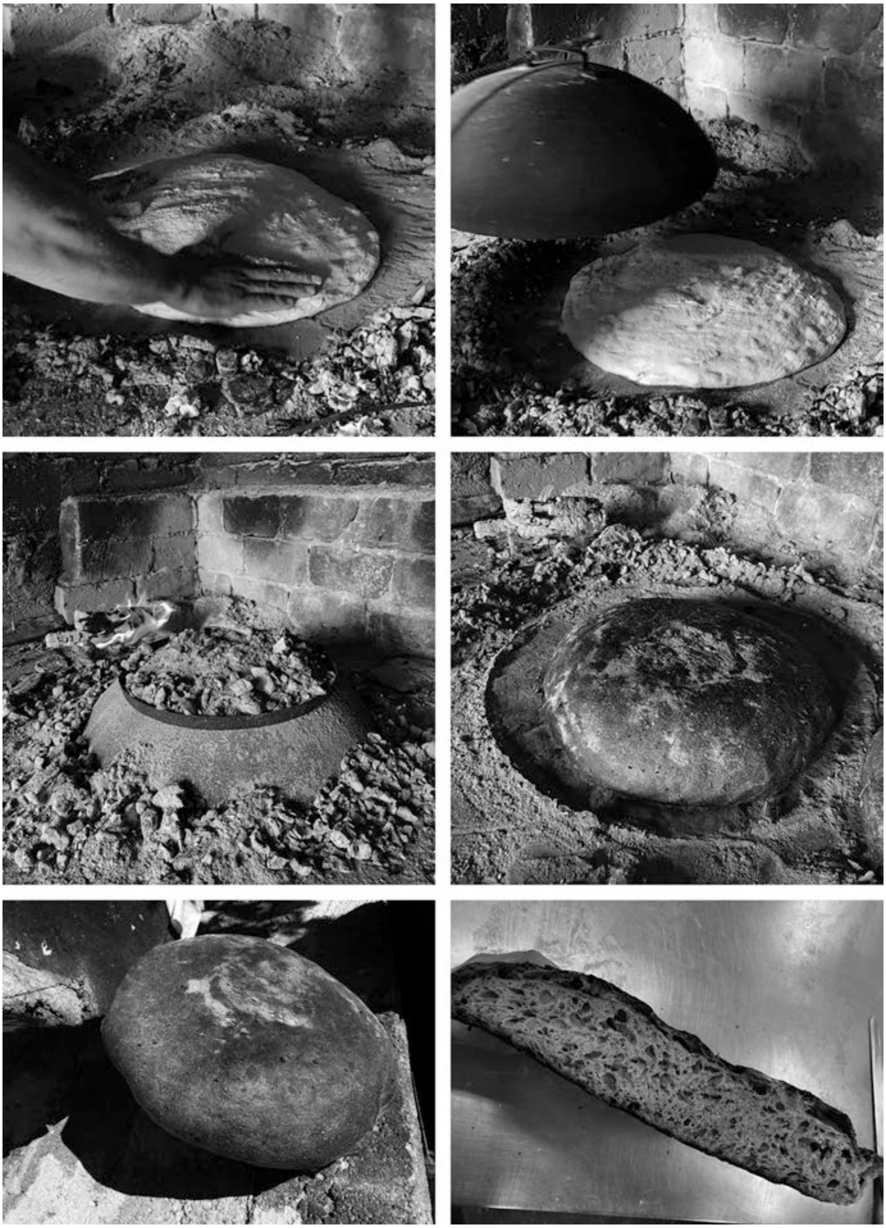

Fig. 4.3 Artisanal method of making *peka* bread: dough placed on a hearth (*upper left*), covering the dough with *peka* lid (*upper right*), *peka* lid covered with hot embers (*middle left*), bread at the end of baking (*middle right*), outer appearance of baked bread (*bottom left*), and cross-section of bread (*bottom right*)

Fig. 4.4 Outer appearance (*left*) and cross-section (*right*) of *peka* bread from contemporary industry production. (*Courtesy of Borislav Dopudja*)

dough, results in an increase in production of compounds from Mallard's reactions (Galey et al. 1994). The resulting bread has more colored crust but a less intense spicy note and a reduced stale off-odor (Zehentbauer and Grosch 1998). In addition, bread which is baked on hearth has warm woody aroma. The type of aroma present (bread or wood aroma) significantly affects the choice of brown bread (de Wijk et al. 2018). Added aroma does not affect the liking and wanting, but affects food choice behavior, where brown bread is preferred more often in the presence of warm wood aroma (de Wijk et al. 2018). The rarity of flavor and/or texture of traditional products is the main reason for the renewed interest (Rosell 2019). Still, the sensory characteristics of the *peka* bread have not been characterized and documented. The task to characterize the traditional product remains to be done.

In Croatia, as in other countries, consumers perceive traditional foods as natural, healthy and trustworthy products, which are produced without chemicals (Cerjak et al. 2014). Still, the tendency of increasing the nutritional quality of bread and bakery products is extremely high (Rosell 2019). Bread and other cereal products have been included in the basis of the human diet since earliest times. In the past, due to the limitations of milling process, whole grain bread was the most consumed bread, but with the development of milling process, white bread became the more common choice. Although consumers are more pleasure than health oriented, they may rationally choose the more healthy choice than white bread for themselves and their family members (de Wijk et al. 2018). For consumers who look for healthier products, these desires can be met by including more whole grains or seeds when making *peka* bread. Compared to refined flour, whole grains are richer sources of dietary fiber, micronutrients and bioactive compounds which have numerous benefits for human health.

Bakers can further explore the healthiness trend by using sourdough which has many proven health benefits such as retarded starch digestibility leading to low glycemic responses, improved mineral bioavailability, enhanced nutritional content and bioaccessibility of bioactive compounds (Poutanen et al. 2009). Long fermentation time permits the yeast to break down some of the components that are potentially toxic for some predisposed individuals such as fermentable oligo-, di-, and monosaccharides and polyols (FODMAPs) (Loponen and Gänzle 2013). Besides its positioning as healthier, sourdough bread easily reaches authentic flavor, improved texture, and extended shelf-life.

Breads such as *peka* which have a higher proportion of crust have been reported to raise capillary blood glucose more slowly than a corresponding loaf (Glatzel and Rettenmaier 1962). Still, the baking on firewood might increase the concentration of genotoxic and carcinogenic compounds such as polycyclic aromatic hydrocarbons (PAHs) in bread. The wood smoke generated in baking of bread contains, depending predominantly on the condition of oven, a large variety of PAHs, including the most carcinogenic ones (Orecchio and Papuzza 2009). Yet, the average content of PAHs in the bread is lower than the limit set by European regulations and the average consumption of such product makes little concern for consumer health.

6 Attitudes of Croatian Consumers Toward Traditional Food and Gastronomic Offer for Visiting Tourists

Culinary habits are developed depending on social, geographic and historical aspects, and transferred from one generation to another (Žaper 2004). Croatian cuisine today can be best understood as a union of three cuisines: Romanic, Germanic and Slavic (Renko and Bucar 2014). Recently, Croatia passed a transitional phase from a gastronomic standpoint. Namely, a return to traditional food is noticed in public, at festivals and in restaurants, as well as in the private life of the individual, which is related to the strengthening of regional identity (Renko and Bucar 2014).

Croatian consumers define traditional food using global concepts: heritage, elaboration (made in a specific way), linked to a region, special occasions, health and sensory attributes (Cerjak et al. 2014). They believe that traditional food is a food with original, unique taste (Renko and Bucar 2014). They describe that traditional food resonates with their fond childhood memories, celebrations, and the pleasures of family togetherness (Cerjak et al. 2014; Renko and Bucar 2014). For Croatian consumers the meaning of traditional food is positive, but does not contribute of their food purchases. The main motives of Croatian consumers regarding purchase of traditional food are health or support of local farmers(Cerjak et al. 2014). In Croatia, the domestic consumers are mostly worried about the higher prices of traditional food, while the foreign visitors cannot come to know about such foods due to the inadequate and insufficient promotion of Croatian gastronomic offer (Renko and Bucar 2014). In recent years, a progress has been made in the creation of traditional Croatian gastronomic offer (Skryl et al. 2018).

Apart from its role in the manufacturing industry, agriculture, and economy, food plays an important role in tourism. For some tourists, the gastronomy is the main motive for traveling (Skryl et al. 2018). Gastronomy is an integral part of the tourist experience. Although Croatia has a big potential for growth and development based on the rich gastronomy tradition fused with Mediterranean ingredients, this potential is still not sufficiently used (Skryl et al. 2018). Most of foreign tourists perceive Croatian food products as very tasteful, healthy, and wholesome (Renko et al. 2010). They regularly buy bread and bakery products when they visit Croatia. Bread is no longer considered as a complement to the dishes served in their restaurants but a fundamental part of the offering (Martínez-Monzó et al. 2013). However, large numbers of tourists experience difficulty in obtaining and consuming local food in Croatia (Renko et al. 2010).

7 Conclusions and Future Perspectives

Bread baked under *peka* is a delicacy that has been rooted in Croatian tradition for thousands of years. Due to its simple ingredients and equipment, it has always been widely available to most people, and has become an indispensable part of traditional Croatian cuisine. Making *peka* includes baking bread on a stone oven with the help of a bell-shaped lid made iron and covered with ember. Although it seems simple, it takes time, patience, and experience to prepare. *Peka* bread has a unique appearance and flavor; it is crispy on the outside and moist on the inside. *Peka* has been and will continue to be a popular method of preparing bread and numerous dishes throughout Croatia. *Peka* bread can easily satisfy even the most demanding palate and revokes nostalgia. Although the contemporary processing is not the same as it was thousands of years ago, the bread itself can be even better from a sensory and nutritional point of view. Still, bakeries should include more and more local ingredients and consider the use of biomass instead of firewood for baking to deliver to consumers, a product with a lower carbon footprint. Moreover, its traditional specialty and geographical origin deserves to be protected and its name registered for an even stronger reputation of the product.

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Chapter 5
Traditional Breads from Cyprus. The “Arkatena”

Maria Katsounotou, Eleni Xenofontos, and Dimitrios Tsaltas

1 Introduction

Bread is the most staple food that takes on so many forms and is consumed all over the world. It’s one of the main parts of our meals and is what has always been on the tables of poor and rich people. It can be made from any kind of flour (cereal, legume flour, carob flour etc.) and contains some kind of leavening agent, seeds, sweeteners such as beetroots, fruit juices, grape must, honey, vinegar, very matured fruits, hops, carob syrup, while taking the form of pitta, flatbread or a huge loaf with a crispy crust. Bread baking is an art that exists from the beginning of the times and is a part of the identity of both culture and geography of its regional origin (De Vuyst and Neysens 2005).

Good traditional bread is difficult to find nowadays, since this art is somehow losing its grip but there are people that are trying to keep the tradition alive and others that create their own recipes. Traditional breads such as Bojkowski chleb owsiany (Poland – grape must sourdough bread), Pannetone (Italy – sweet leavened bread with candied orange), Münchner Brotzeitsemmel (Munich, small rolls made with sourdough), Scaddateddha (Italy, small ring-like shaped dessert with sourdough, sugar and aromas), are some examples of sourdough bread and desserts prepared all over the world and are close to extinction either due to the difficulties regarding their preparation or the fact that knowledge for making them is not widespread (information taken from the website of The Ark of Taste). Industrialized white bread leavened with baker’s yeast, containing additives that increase its shelf life, has taken over the markets since its introduction in the twentieth century (Carnevali et al. 2012). The salvation of traditional bread is an issue that everyone

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should be concerned about. There are recipes scattered in regions all over the globe that should be made known to a wider audience.

Legumes are not usually used for bread making. Still, traditional bread using legumes either ground or whole, have been part of the culture of some countries. They've recently gained the attention of being used in bread in order to increase the nutritional value of both legumes and dough through the process of fermentation. Moreover, people are beginning to realize the importance of high quality, nutritious and cleanly produced food while starting to follow a healthier lifestyle by changing their diets. The Mediterranean Diet has always been about promoting a balanced nutritional lifestyle and according to it, legumes are supposed to be consumed at least once a week (Kiskidinoglou and Trampa 2007) (In accordance with the Mediterranean diet pyramid today). They contain an important amount of minerals, vitamins, carbohydrates, antioxidants, proteins, amino-acids, fibers and a small amount of lipids. Some legumes lack various types of amino acids. Fortunately, most people choose to consume them with cereals, thus, the amino acids that are lacking from each of these food groups, complement each other. Legumes' proteins are low in amino acids that contain sulfur but have high amounts of lysine, whereas cereals have sufficient amount of sulfur containing amino-acids, but not lysine (Yousif and Safaa 2014). Worldwide, the combination of cereals and pulses helps fight malnutrition and nutrient deficiencies. Legumes are also beneficial when it comes to lowering the risks of cardiovascular diseases, type-2 diabetes, digestive diseases, obesity, overweight and some types of cancers (Gobbetti et al. 2019).

Functional foods, super foods, enriched with nutritional components and especially fermented products are starting to gain attention. They are associated with a healthy gut microbiome which in return is connected to the well-being of our brain and eventually our psychology (Kinross et al. 2011; Martin et al. 2018; Liu and Zhu 2018; Oliphant and Allen-Vercoe 2019). Fermenting any kind of food improves its nutritional aspect, organoleptic character and increases its functionality and shelf life. It removes unwanted factors that might interfere mainly with the digestion process or are toxic to humans (Steinkraus 2002).

This chapter presents a particular traditional bread from Cyprus, called Arkateno (plural Arkatena), which has the peculiarity of being made from the foam that is created after the anaerobic fermentation of chickpeas that takes place when they are submerged in hot water. It takes its name from the word "arkatis" which means worker in Greek and it indicates the hard work and effort that's being dedicated in order to make them. A comparison with the similar bread from Greece, called Eftazymo, is also discussed. Eftazymo takes its name from the word "Aftozymo", which in Greek means that it ferments itself without the help of any other leavening agent, including sourdough starters. They have similarities but also differences that make them both unique. They are both challenging to make and are only prepared by very few people.

At Cyprus University of Technology (CUT) an ongoing research tries to recreate the process of arkatis production in order to try and comprehend what happens during the submerged fermentation of chickpeas, and some preliminary data are reported. In order to collect the material for this chapter the authors have also visited

Omodos village and interviewed the local producers of Arkatena, recording issues they encounter when they try to collect this foam. What came to light were the problems they have to face each time a new batch of arkatis is started, which mainly concern its ability to leaven the bread. Sometimes they might get a foam that is strong and able to increase the volume of the bread, but many times not, and sometimes they are even not be able to collect any foam at all. It is also important to note that arkatis can't be stored for future use but should be used as soon as possible. These interviews helped understand the potential problems of this process for Arkatis preparation, which will be discussed later in this chapter.

2 Sourdough

Sourdough history dates back many years, with its beginning estimated to be around 77AC, documented by Pliny the Elder in Egypt (Gobbetti et al. 2016). The practice of leavening bread is also dating back to Egypt around 1500AC (Hammes and Ganzle 1998), as depicted on murals that were found (Corsetti and Settanni 2007). It was a part of the European diet long before that and its study on the other hand begun very recently, approximately 100 years ago (Corsetti and Settanni 2007). Its popularity started unfolding again, even after being replaced by baker's yeast in the nineteenth century, due to its organoleptic characteristics, its extended shelf life and mostly due to its positive contribution to human health (Pételet al. 2017). It has also been reported that the glycemic response to sourdough bread is lower (Hammes and Ganzle 1998).

Sourdough starts from flour and water. A fermentation process is carried out by the microorganisms that exist in both ingredients but also in environment that surrounds the dough. *Lactobacillus*, *Leuconostoc*, *Pediococcus*, *Weissella*, yeasts (such as *Saccharomyces cerevisiae* and *Candida*), Enterobacteria, fungi, Gram-positive and Gram-negative, aerobic and anaerobic bacteria are some of the microorganisms present (De Vuyst et al. 2016; Gobbetti et al. 1994; Minervini et al. 2014). Its diversity derives from the type of flour whose content might be different every time, from batch to batch, and from the environment, which is also linked with the cultural, geographical and historical background of the product (Minervini et al. 2014). The main microorganisms, that are responsible for carrying out the fermentation process, are microbes from the Lactic Acid Bacteria (LAB) group and yeasts with ratio usually 100:1, respectively. Studies have shown that this ecosystem is composed by more than 50 species of LAB – mostly of the genus Lactobacillus – and from more than 20 species of yeasts (Corsetti and Settanni 2007) mostly *Candida* and *Saccharomyces* (De Vuyst and Neysens 2005). *Bacillus cereus* and *Staphylococcus aureus*, which are both unwanted, may also contaminate the sourdough (De Vuyst and Neysens 2005). The most significant metabolic reactions that take place are acidification (by LAB), flavor development (by LAB and yeasts) and the leavening of the dough (yeasts and heterofermentative LAB species). *Saccharomyces cerevisiae* is not a microorganism that exists in the raw materials and it probably derives from the bakery environment, where is so often being used and came to be a part of the microbiome of the equipment and the air of the bakeries and eventually of the sourdough (De Vuyst and Neysens 2005). It ferments all the soluble carbohydrates of the flour and contributes to the carbon dioxide and ethanol production through glycolysis. The first sugar to be hydrolyzed by homofermentative LAB is starch, which breaks down to amylases and lactic acid is produced, while heterofermentative LAB produce, apart from lactic acid, carbon dioxide, acetic acid and/or ethanol. Acetic acid is accountable for shorter and harder gluten, whereas lactic acid helps give more elasticity to the dough (Corsetti and Settanni 2007). This can also vary and be manipulated and by the presence of other compounds.

The factors that play a major role in the fermentation process can be endogenous and exogenous. Both types of microorganisms (endogenous factor) have to endure in order to carry out all the metabolic activities that take place, since they will be in a stressful environment. The temperature (exogenous factor) and water activity (endogenous factor) also play a crucial role affecting the microbiological and enzymatic (amylase) activity (De Vuyst et al. 2016; Gobetti et al. 1993). The quantity of soluble carbohydrates (maltose, sucrose, glucose and fructose) varies in every flour type and since each microbiological species ferments and catabolizes carbohydrates at a different pace, there's an interaction between them, crucial to the outcome of the sourdough (De Vuyst et al. 2016; Gobbetti et al. 1994). Stressful environment can have a huge impact on the microorganisms and the type of products that will be produced. According to Hammes and Ganzle (1998), nitrogen sources, minerals, lipids, fatty acids, enzymes, all part of the cereal grains are also contributing to the outcome of the fermentation. Additionally, parameters, such as added salt, backslopping steps and time intervals between them, play a key role in both, permitting and repressing, the growth of the existing microbiota. The following table (Table 5.1) shows which parameters have influence over the sourdough microflora interactions and how (Minervini et al. 2014).

Throughout this whole process, we observe the change of the organoleptic characteristics. The gluten network is strengthened, and alongside with the development of carbon dioxide, we get the stretchy texture and the bubbles that are visible after the baking of the bread (De Vuyst et al. 2016). When the gluten network is more endurable, it can hold the gas that is produced. Moreover, in the same article it is reported that alcohols, metabolites, amino acids, esters and ethanol are what give bread the pungent, astringent odors, the sweetness and aromatic flavors. However, most of the aromas emerge during baking (Corsetti and Settanni 2007). Up until recently, 196 volatile compounds were detected in sourdough (aldehydes, esters, alcohols, ketones, acids, furans, pyrazines, lactones, sulfurs, alkanes and others) (Pétel et al. 2017). Sweetness, sour, bitter, fruity, fresh, cocoa, buttery, citrusy, flowers, oil, honey, cinnamon and more, were some odors of the sourdough aromatic character that have been described (Pétel et al. 2017).

Sourdough can be categorized into three types – type I, II and III.

Type I is the traditional one, generally firm dough that requires daily propagation in order to maintain the activity of the microflora at high metabolic levels (Hammes and Ganzle 1998), (Carnevali et al. 2012). Optimum levels of temperature are

Table 5.1 Endogenous and exogenous parameters of the sourdough that affect the activity and interaction between the present microorganisms

Parameter	Main effect(s)
Specific technological parameters	
Dough yield (DY)	Dough weight multiplied with 100 where dough weight is the sum of flour, water, starter inoculum, and other ingredients. The higher the amount of water, the higher the DY and water activity. Longer fermentation time favors LAB instead of yeasts proliferation
% sourdough used as inoculum	Decreases the pH of the dough influencing the growth of LAB and yeasts
NaCl	Stimulates growth of LAB when concentration is low but if high it decreases the growth of both groups, LAB and yeasts
Redox potential	Keeps balance between homofermentative and heterofermentative LAB
Fermentation time and temperature	Combination of temperature and time will determine the balance among microorganisms
pH	Dominating microorganisms that can endure low pH will survive and carry out the fermentation, lower pH increases yeast growth
Water activity	Influences LAB/yeasts ration; enzyme activity
Number of back-slopping steps	The environment becomes more specific and selective so fewer microorganisms survive
Storage temperature	Cold stress as a cause of selective pressure towards more prominent microorganism
Not fully controllable parameters	
Flour	Introduction of contaminant microorganisms; slight modification of nutrient composition
Indigenous microbiota	Differs from batch to batch

around 20–30 °C and pH between 3.9 and 4.00 (Hammes and Ganzle 1998) (Corsetti and Settanni 2007). Its activity is mainly accounted to prominent heterofermentative LAB and some yeasts, including *Saccharomyces cerevisiae* (Corsetti and Settanni 2007). Most of the carbon dioxide is produced during the high metabolic activity of the microbes (De Vuyst and Neysens 2005).

> Traditional, type I sourdoughs encompass pure culture, pasty sourdough starter preparations from different origin (type Ia), spontaneously developed, mixed culture sourdoughs made from wheat and rye or mixtures thereof and prepared through multiple stage fermentation processes (type Ib), and sourdoughs made in tropical regions fermented at high temperatures (type Ic). (De Vuyst and Neysens 2005)

Type II sourdough is usually a liquid dough which consists mostly of pH-resistant LAB (Carnevali et al. 2012). According to the same source, in order to help the bread rise using type II sourdough, it is required to add conventional baker's yeast to help with the fermentation, the leavening and to also suppress any spontaneous yeasts from developing in combination with high temperatures. They are used as dough-souring boosters (Corsetti and Settanni 2007). They reach pH under 3.5. Type II is also the foundation for type III sourdough. Type III are dried LAB and require baker's yeast for leavening. They are added as flavoring amplifiers and their activity is based on different temperatures (Montemurro et al. 2019).

In Cyprus there is a huge history with sourdough since it's been a part of the tradition and religion for so many centuries. People still prepare sourdough bread; it is called "Prosforo" (meaning: given to) if used for religious purposes and it is taken to the church to share it with people as it symbolizes the body of Christ and something He blessed. Moreover, there are types of bread, rusks and deserts that are prepared using sourdough. Every village would have its own traditional recipes. Women used to prepare bread for any kind of celebration and for every phase of the circle of life. Birth: 15 days before a woman gave birth, her relatives would prepare what is called Lehoushouthkia (Λεχουσσιούθκια). They are small pieces of sourdough bread crackers that were passed through a thread and were offered to people when they visited the mother. Two to three days before christenings, bread with sesame was prepared to be offered at church. Name-days were another occasion bread was a part of. At weddings, there were so many types of bread prepared and they differed from region to region. A very interesting ones were small ring shaped sourdough bagels, called "koullourouthkia" (κουλλουρούθκια) in Cypriot dialect. They were mixed with cotton buds, coins, wheat and rice and where thrown at the newly married couple when they entered their new home, thus symbolizing fertility, prosperity, happiness and health. These are some of the examples showing the importance of bread in the lives of people.

Bread has also been a part of Cypriots' daily life since antiquity. Not only as something to consume, but also something that is being adored. It has a ritualistic nature. Apart from those offered at births, weddings, funerals, christenings as mentioned above, they also represent something decorative, called «πλουμιστό», ploumisto. When Cypriots bake bread, it's never without respect. Women used to decorate bread with various shapes and stamps for special occasions: flowers, birds, grapes, crosses, geometric shapes and they were either carved with knives or canes and called ploumidia (πλουμίδια). Each bread was unique and each bread showed the effort every woman put in this art.

(The above information was taken from interviews, oral testimonies and from the book Ploumisto Psomi by Dorita Voskaridoy, 2011).

3 Fermentation

> The processes required for fermented foods were present on earth when man appeared on the scene… When we study these foods, we are in fact studying the most intimate relationships between man, microbe and foods.

Prof. Keith H. Steinkraus, Cornel University, 1993 (Selhub et al. 2014).

Fermentation is an unavoidable aerobic or anaerobic procedure that happens to all organic substrates in nature by the microorganisms that surround them when their decomposition begins. There are different levels of fermentation and foods that undergo this process can be edible, but after some time they can cause food poisonings to humans and animals. On the other hand, there are products that need to go through this process in order to be safe for consumption. Humans started using this process when they realized that food can be preserved with this method. Later, two additional reasons were acknowledged and explored: (a) the organoleptic characteristics that each product acquires after the process of fermentation, taste-, texture- and odor-wise; and (b) the increased digestibility and/or enhancement of nutrient content and bioactive compounds resulting from the microbial growth and their interaction with the substrate. This second attribute gained a great interest in recent years where a non-healthy digestive system has been related with many diseases of many organs and systems of the human body (Forsythe et al. 2009). The consumption of fermented products may support a healthy digestive system in preventing and even fighting some diseases due to their probiotic content (Ahmed et al. 2015). The first raw ingredients that humans fermented to alcohol were fruits (Lee and Park 2017) and later on discovered the fermentation of cereals to alcohol – beer and wine – which was more complicated (Aldsworth et al. 2017). Nevertheless, fermentation has mainly been used in order to extend the shelf life of food, which is achieved mainly by antifungal and antibacterial compounds that are generated (Montemurro et al. 2019). LAB are extensively used for fermenting food and are naturally occurring on a vast quantity of products. According to the same research, the by-products of these microorganisms that occur during fermentation have been studied for their exhibited inhibition towards unwanted pathogens or other spontaneous unwanted microbes. These by-products are organic acids, carbon dioxide, ethanol, hydrogen peroxide and diacetyl, various antifungal compounds, bacteriocins and other antimicrobial peptides.

Throughout the years more and more discoveries about fermentation helped understanding the undergoing physicochemical changes following the microbial development and can now “manipulate” the process and related factors (internal and external) in order to deliver optimal desired outcome. De Vuyst and Neysens 2005, state that fermentation is mainly carried out by LAB, either homofermentative or heterofermentative, with the latter being more dominant ones especially for traditional products. There are two types: those submerged in a nutrient broth or water, and those that take place on a solid substrate rich in minerals and nutrients.

Through this process, raw food gains better and more intense organoleptic characteristics, unwanted or toxic substances are removed, indigestible carbohydrates or proteins that cause intolerances break down, nutritional content may increase and shelf life is extended (Jay et al. 2005).

4 Legumes, Nutritional Aspect and Fermentation

Legumes, or Pulses, have been a part of the Mediterranean diet for a very long time as they are an important staple constituent of people’s daily diets. In the past, where meat used to be a luxury – consumed a few times throughout the year or even once a year, legumes provided a crucial amount of protein with high biological value, essential amino-acids, carbohydrates, fibers and important minerals, vitamins, oligosaccharides and phenolic compounds (Gobbetti et al. 2019; Yousif and Safaa 2014; Granito et al. 2001). Up to today, in poor countries, in religions that require fasting and even groups of people that choose to follow a new way of life, such as vegetarianism or veganism, legumes consumption is an important alternative. It is better when they are being accompanied by cereals, because the total amount of available protein increases as the necessary amino acids found in each food group would complement each other. The downside of eating a lot of legumes lies in the many anti-nutritional factors (e.g. oligosaccharides) that they contain. They can cause a lot of bloating and, as a result, the digestibility of the proteins and availability of the amino acids are significantly decreased. There are ways of removing these components: submerging the legumes in water, cooking or fermenting them. Fermentation of legumes with or without other ingredients (e.g. cereals) helps with the reduction of these anti-nutritional factors (Montemurro et al. 2019). Studies show that legumes that undergo fermentation have reduced anti-nutritional components, increased protein and fiber availability, increased mineral and vitamin content and even higher antioxidant activity (Granito et al. 2001). Fermented products are getting a lot of attention in the past few decades as it's been recognized that they aid in maintaining a healthy gut microbiota, resulting in a healthier state (Kinross et al. 2011; Moeller 2017) . In general, when the process of fermentation is carried out – mostly by bacteria – the nutritional aspect of the initial product, the appearance, the organoleptic characteristics, shelf life etc. improve.

Scientists have been trying to incorporate more legumes in products such as bread, baked goods, pasta and even baby food. In this way, legumes are more accessible while simultaneously contributing to healthier, more nutritious food products. Furthermore, since people are becoming more sensitive to intolerances, gluten-free bread is something that's risen to attention (Altobelli et al. 2014).

Pulses have a positive impact on human health. They can be considered as functional foods since they contain a great amount of proteins of high biological value and fiber. Moreover, starch digestion happens in the colon where fatty acids of small carbon chain are produced by the local microbiota and these fatty acids contribute in maintaining the balance of the gut microbiota, strengthening the epithelium, and the functionality of the colon by the absorption of nutrients and also by suppressing the growth of any potential pathogenic microorganism (Hatzikamari 2009). Also, according to the same research, legumes contain minerals with high bioavailability. Yousif and Saffa 2014, state that bioactive compounds have shown to help prevent: chronic diseases, types of cancer, type-2 diabetes, cardiovascular diseases, digestive system issues and obesity or overweight. It is known that increased consumption of fiber reduces the probability of cardiovascular diseases always in combination with a healthy lifestyle which of course is directly related to the environment everyone lives in, their genetics and their way of life. Fermented foods derived from cereals and legumes are an important part of the human diet in Southeast Asia, the Near East, and parts of Africa. They are also becoming important in the diets of the Western world, due to their high nutritive value and organoleptic characteristics battling all the above western diet – related diseases.

4.1 Chickpeas

Chickpeas (*Cicer arietunum L.*) are a nitrogen-fixing legume. They belong in the *Fabaceae* family and are being cultivated in semi-arid environments, all over the world with India being the first in production (66% of global chickpea production) (Rawal and Navarro Kalamvrezos 2019).

They are a great source of protein with high biological value, carbohydrates – digestible and non-digestible (fibers), calcium, magnesium, phosphorus, potassium, vitamins such as riboflavin, niacin, thiamine, folic acid, beta-carotene and some small amounts of non-saturated lipids, such as linoleic and oleic acid. They lack amino acids with sulfur but they are rich in lysine. On the other hand, they contain enough anti-nutritional elements which can be reduced by cooking, soaking, peeling and fermenting them (Hatzikamari 2009).

When collected, chickpeas and all legumes in general, are protected from any external microorganisms by the pods that they grow in. During their processing, the pods are removed. Coming in contact with soil and the surfaces at the place where the dehulling takes place, the pulses are no longer protected from environmental contaminants. Chickpea fermentation research have been carried out and show that microbes that live on the legume (*Lactobacillus*, *Leuconostoc*, *Streptococcus*, *Pediococcus*, *Bacillus*, *Clostridium* and yeasts) are capable of hydrolyzing proteins, lipids and sugars (Hatzikamari 2009; Saad et al. 2016; Hatzikamari et al 2007; Katsaboxakis 1996) if grown in a fermentation inductive environment.

5 Traditional Breads – Arkateno

In Cyprus, chickpeas are used in order to prepare one of the most traditional breads of the island, Arkatena. Arkatena is a very aromatic kind of bread that can be consumed fresh or in the form of rusks. The story of how their recipe arrived to Cyprus goes back to 1860 at Omodos village where a woman from Smyrna named Hatzistasou arrived on the island. Here, she met Mr. Hatzinikoli, who she married and stayed with in this village. She was the one responsible for the dissemination of the Arkatena recipe between the locals. The elder women would teach their young daughters and anyone interested, so the recipe was passed down to next generations and to their protégés through oral narration of tradition. At first, the recipe was a secret well-kept. According to people that are still alive to recite the stories, those that wanted to bake this bread, would exchange a plate of flour with a plate of arkatis (explanation follows in the next paragraph) with Hatzistasou. When they returned home they would start the back-slopping and the preparation of the dough. Usually this process – back-slopping – takes place up to 5 or 6 times. After some time, another woman, Annou, succeeded Hatzistasou. Slowly but progressively, the reputation of this woman preceded herself and people from nearby villages (Pahna, Dora, Anogyra, Mandria, Platres, Vasa, Kilani, Arsos, Fini) visited Omodos and were accommodated by the people there until they learned the craft of Arkatena making.

(All this information was taken from a video on YouTube, created by Cyprus National Commission for UNESCO and their channel on the website with title: "Arkatena bagels of Omodos, 2015, Community Council of Omodos/Nicolas Kontolemis, from oral testimonies of people interviewed form Omodos and from websites)

5.1 *Arkatena – Preparation*

The base of Arkatis is unwashed, cracked chickpeas – not chickpea flour. The procedure starts 4 days before the day for baking the bread. The cracked chickpeas, cinnamon, ginger, cloves and bay leaves are put in a jar and then submerged in hot water. The jars are sealed tight and left in a warm place for 24 h. In the first 24 h, foam is created on top of the water (Fig. 5.1). An intense, mostly sulphuric-smell can be easily detected as the fermentation takes place in an anaerobic environment.

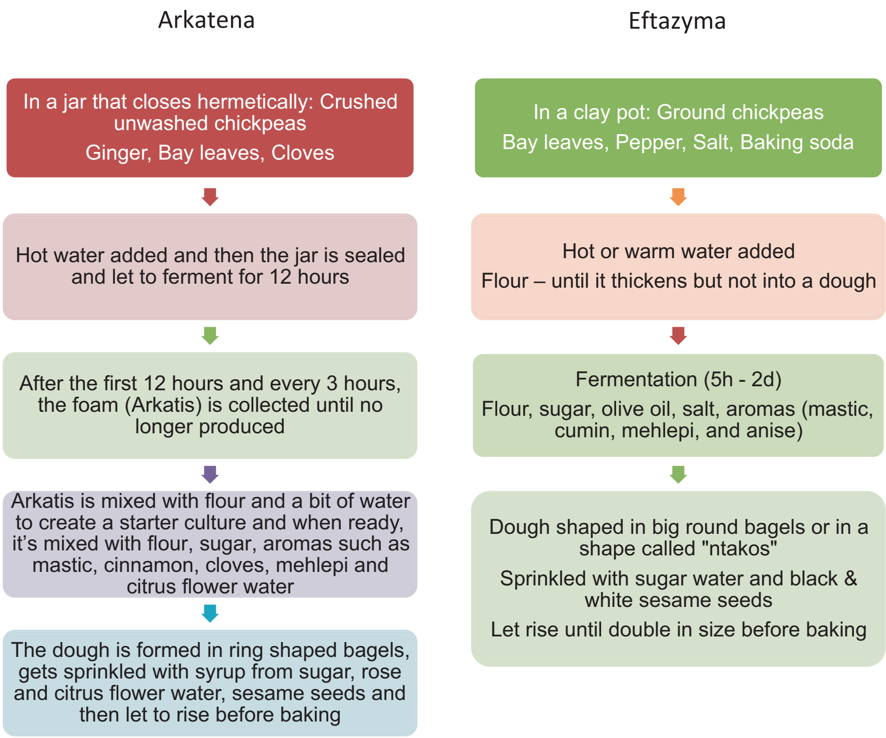

Fig. 5.1 Recipe flowchart for Arkatena and Eftazyma

This foam is called Arkatis which means "worker" in Greek and shows that it takes time and hard work to collect it and use it in order to prepare this bread. The foam is collected every 3 h as long as it's still produced and this might take up to 3 days untilan adequate quantity is collected. Extra care is given not to collect water alongside with the foam, because the dough will smell badly. This is also the case with chickpea flour not being used as it would be carried out in the foam and ending up in the bread making it smell bad as well. After each arkatis collection, water is added and the jars are sealed again. Flour is added to the foam with some water and a kind of liquid sourdough starter is created. For every batch of foam that is collected, more flour and water is added to the starter – just like normal sourdough back-slopping (adding more flour and water to the mother dough every day in order to refresh it and keep the microorganisms active). When the foam stops accumulating, the starter is then added in a bigger amount of flour, sugar, salt and aromas as mastic, cinnamon, cloves, mehlepi and citrus flower water. More water is added only if necessary. The dough is then let to rise and when ready, shaped in rings, sprinkled with syrup prepared with sugar, rose water, citrus flower water, and sesame seeds, and let to rise once more before getting baked in a wood oven. If people want to consume them as rusks, when the oven is cooled down to a lower temperature, the bread is placed inside for a few more hours in order to dry gradually. Arkatena are usually consumed during breakfast with some zivania (Cypriot grappa) and olives, halloumi cheese, tsamarella (sundried goat meat with oregano) and vegetables and it's what people took to work to eat during their breaks in the past. Two Arkatena producers from Omodos, explained in the interviews the difficulties they face every time they try to collect arkatis. Firstly, it takes a lot of time and effort to collect the foam, as it is a manual process difficult to automate. At the same time it might not be possible to get any foam at all. According to them, the temperature of the water added in the vases seems not to make any difference (boiling hot or warm). Additionally, arkatis might not always be strong. This means that the yield of the dough will be very little and the addition of baker's yeast might be necessary to meet the consumer's demand. Chickpea origin is not related with the strength of the fermentation, although some batches seem to be problematic. Finally, the temperature of the fermentation is never stable as they depend on the weather. In the winter it's more difficult to collect arkati since incubators are not used for the vases and the optimal temperatures occur during August when the weather is really warm in the village. That's why it was mostly offered during the celebrations of 15th of August (Orthodox Christians celebrate the dormition of Theotokos – Virgin Mary). Today Arkatena production is found in the villages of Omodos and Kilani in both fresh and dried (rusks) form. Of course, nowadays Arkatena baking is performed in electric or gas industrial ovens as the market demands are high and these products reach all Cypriot towns and supermarkets and can also be found in some Cypriot food product stores in Australia, England, Greece and USA. Unfortunately, another shortcut of commercial "Arkatena" is the use of baker's yeast exclusively and those can be easily differentiated by their very light/fluffy texture. On the contrary the Arkatis-made rusks are denser and harder.

A preliminary study of the engaged microbiota via culture based techniques was performed by our research team at the Cyprus University of Technology to light up the mysterious fermentation of chickpeas for the production of Arkatis and Arkatena. The experimentation aimed to identify the culturable microorganisms accountable for the fermentation of the chickpea carbohydrates and the production of the foam for a period of 12 h (12 h). Microbes were isolated from water samples at 0 h, 3 h, 6 h, 9 h and 12 h using Plate Count Agar (PCA) at 30 °C for 2 days in order to determine the total count of the bacteria, Kanamycin Aesculin Azide Agar Base for Enterococci, incubated at 37 °C for 3 days. MRS with natamycin for pour plating technique for Lactic Acid Bacteria, incubated at 30 °C for 5 days, M17 for Cocci, incubated at 30 °C for 2 days and Potato Dextrose Agar (PDA) for Yeasts isolation, incubated at 30 °C for 3 days. In addition, Reinforced Clostridia Medium was used in small tubes with 1% Agar plug on top of the medium for the detection of acidifying, gas producing microbes such as *Clostridium* spp., which was incubated at 37 °C for 48 h. Pure cultures were selected and identified via 16S rDNA sequencing.

No yeast, molds, LAB and Clostridia were detected. The predominant microorganisms isolated and identified were *Bacillus cereus*, *Brevibacterium halotolerans* and *Bacillus subtilis*.

Regarding the foam characteristics, it smelled like Arkateno and not strongly sulphuric, while the pH was 4.

Similar studies with chickpea fermentation have been carried out and on the next table (Table 5.2) the microorganisms that have been isolated and found in relevant bibliography are presented. *Bacillus* spp. and Clostridia, as potentially gas producing microbes, can contribute to foam formation. The absence of LAB or fungi is likely due to the pasteurizing effect of boiling water added at the preparation of the ferment.

Table 5.2 Microorganisms isolated from various studies of fermented chickpeas

Microbes reported	Bibliographic source
Bacilli: *Bacillus cereus*, *B. thuringiensis*, *B. licheniformis*	Hatzikamari et al. (2007a, b) and Hatzikamari (2009)
Clostridia: *Clostridium perfrigens*, *C. beijerinckii*	
No yeasts were detected	
Bacillus, *Corynebacterium*, *Lactobacillus*, *Pediococcus*, *Micrococcus*, *Clostridium*	Katsaboxakis (1996)
Bacillus megiterium, *Bacillus subtilis*	Saad et al. (2016)
Bacillus cereus, *Brevibacterium halotolerans*, *Bacillus subtilis*, *Agrobacterium tumefaciens*, *Rhizobium pusense*, *Enterobacter hormaechei*, *Enterobacter cloacae*, *Bacillus tequilensis*, *Bacillus halotolerans*, *Bacillus licheniformis*, *Bacillus haynesii*, *Bacillus paralicheniformis*, *Bacillus sonorensis*	Katsounotou M., Xenofontos E. Tsaltas D. Results from preliminary not published data performed at the Cyprus University of Technology

5.2 *Eftazyma*

Eftazymo (plural Eftazyma) is similar to Arkatena and is prepared in scattered regions in Greece, mostly by islanders, Crete (Kastamonitsa, Heraklion etc.), Kalymnos, Pserimos but also in mainland and other areas. It is usually accompanied by cheese, Raki (a kind of grappa) and olives and is what people also used to take to the fields when they were working. Its preparation is also connected with religion and celebrations such as Christmas, Easter, 15th of August, weddings, christenings and name days.

The differences between Arkatena and Eftazyma lay mostly in the first step. Ground chickpeas are used instead of cracked ones. However, some still prefer the cracked ones, since they are added in the dough with the water they were fermented with, and give texture to the bread. As mentioned earlier, in Cyprus is said that if water from arkatis is added in the dough, the bread will smell badly, which is a puzzling issue. Nevertheless, they add hot water to the chickpea flour that some people might boil with bay leaves (to give it some aroma), a bit of salt, pepper, baking soda and some flour until it thickens (careful not to turn into dough) and let it ferment for 5 h or even up to 2 days. If cracked chickpeas are used, the process that takes place is the same as with arkatis. Instead of arkatis, the Greeks call it Kounenos (Κουνενός). In the Cretan dialect, it means a short and light sleep – a nap. Kounenos was also the clay pot that people used for storing honey or butter, but also drink water or wine from. Clay was preferable to any other kind of material, because it helps maintain temperature stable for a longer time. Kounenos has to smell bad to make sure that it worked. When it’s ready, then the addition of flour, sugar, more salt and aromas such as mastic, cumin, mehlepi, anise and olive oil takes place. No more water is usually added so they have to be careful with the quantity of the flour used. Then, it is shaped in big round bagels or long loafs that they cut in smaller pieces that they stick together again to create the shape called ntakos. They get sprinkled with sugar water and then with black and white sesame seeds. They need another hour to double in size and then are ready to be baked. Traditionally the baking part takes place in a wood oven and the favorite part of the people is when the bread comes right out of the oven and they get to share it immediately. It is said that when it’s warm, it’s the best time to try it. Nowadays conventional ovens are also used for baking. If people want to make them into rusks, they let the oven cool down and then place the bagels inside for hours until dehydrated. From region to region, the recipe differs a lot. The ingredients, the aromas and the time of the propagation, vary.

Both, Arkatena and Eftazyma are complicated recipes and only a handful of people are still preparing them today. They were associated with superstitions. Women would go into extreme measures in order to ensure the success of their baking, such as burning tires to cover the smell of them. The whole process would start around midnight, which is the time most connected to magic. It is called the devil’s bread, as they didn’t use any sourdough to prepare it and it would rise by itself with the help of the chickpeas. Some chose to add normal sourdough so that it wouldn’t be considered “diabolical”. A golden ring was put in the water that was used for kneading in order to prevent the bread from going stale. No one shared the recipe with their neighbors, as it was believed that the bread was going to be a failure. They believed that this bread was easily affected by "the evil eye", a Greek expression which essentially means the bad energy that people emit when they glare malevolently at others when they are unaware. The following figure (Fig. 5.2) shows the recipes and differences between Arkatena and Eftazyma.

Information for Eftazyma was collected mostly from a couple of YouTube videos where people from variousregions of Greece were demonstrating the recipe of Eftazyma, each one with their own recipes and variations, while narrating the origin of and reasons why Eftazyma are prepared the way they are.

Oral information: Professor David Sutton, Southern Illinois University.

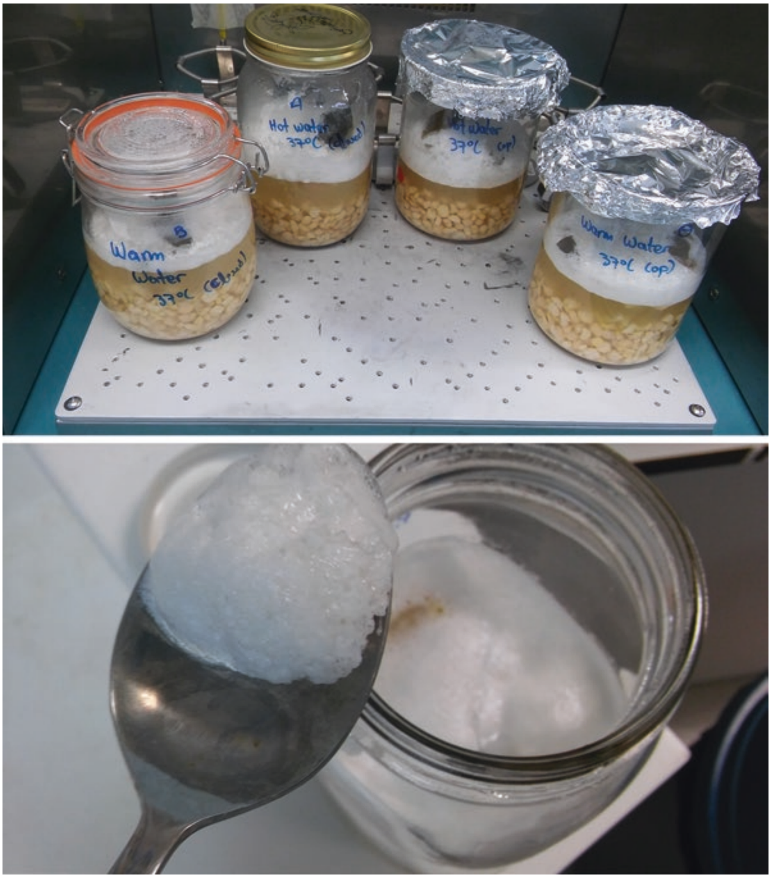

Fig. 5.2 Arkatis foam created from fermenting split (cracked) chickpeas incubated at 37 °C for 12–48 h

5.3 Similar Breads

Idli, Dosa, – India.

Idli: rice (*Oryza sativa L.*) and black gram (a type of bean – *Phaseolus mungo L.*) are soaked separately for 4–6 h or even overnight. Optionally, fenugreek can be added at this point in order to boost the flavor. Next, the beans are turned into a paste and the rice is coarsely ground and then are both combined together. They are then left to ferment once again overnight and double in volume. Some of this mixture can be stored as a starter culture for future batches. The Idli batter mixture is then placed in molds and ready to be steamed. It's savory and usually served for breakfast. (Reddy et al. 1982) (Nagaraju and Manohar 2000).

Dosa: Dosa is a kind of flat rice pancake made with fermented rice and black gram flour batter with a sprinkle of salt. The process is similar to Idli with the difference that more water is added to it to make it thinner and when it's baked it forms a flat, thin or thick crepe.

(Oral information: Deepak Kumar, Student at University of Gastronomic Sciences, Italy, Pollenzo)

Faina – Argentina/Farinata – Italy (Genovese people moved to Argentina and the recipe started becoming famous there but also in other countries of South America).

This bread is made with chickpea flour, water, olive oil, rosemary and salt. The flour and water are mixed together and then put in the fridge for 2 h or overnight stirring from time to time – the fermentation is not carried out the same way as in arkatis or kounenos. When ready, rosemary, olive oil and salt are added, and then it is cookedin an oven on a cast iron pan to create a crispy, aromatic thin bread.

(On-line cooking websites: https://www.196flavors.com/argentina-faina/, https://www.tasteatlas.com/faina)

6 Discussion and Conclusion

The microflora of flour and legumes varies from region to region, but also from the environment surrounding them during any form of fermentation. This shows the indisputable connection with their geographic origin. This is why so many researches showed different results regarding the microbes accountable for sourdough and legume fermentation. The species accountable for the fermentation belong mainly to *Bacillus* spp., *Clostridia* spp., *Lactobacillus* spp., *Pediococcus* spp., *Micrococcus* spp., *Leuconostoc* spp. and yeasts (Hatzikamari 2009; Katsaboxakis 1996). *Clostridia* are the ones that produce most of the gas. From these groups of microbes, *Bacillus* and *Clostridia* are spore-forming organisms and the toxins they produce are harmful for humans and cause food poisonings. These types of toxins might develop during the processing of products such as Arkatena and Eftazyma. It seems that during the fermentation of chickpeas, but also the way the final product is treated, suppresses the production of any kind of these toxins rendering it safe for consumption. According to Hatzikamari (2009) when mice were treated intravenously with the water from the production of Eftazyma, in order to check the toxicity of the water, no mice showed any poisoning symptoms.

To close, it is important to say that recipes such as these should definitely be salvaged and never get lost through time, since they are a part of the identity of each region they come from. Moreover, it is essential to take advantage of science in order to help identify and overcome difficulties people have to face during the production of traditional products, although it should be done without changing the character of the product in any way that makes them non-traditional. Therefore, their continuity will be ensured as more people will be encouraged to try and recreate them on their own.

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Chapter 6
Traditional Breads from Germany

Martin Göttlich, Jamie A. Brown, and Markus J. Brandt

1 Introduction

Germany is a bread country and bread culture is listed in the German Inventory of Intangible Cultural Heritage (Deutsche UNESCO-Kommision 2019). Over 3000 varieties of breads are listed in the German bread register (www.brotregister.de), which was founded by the association of German artisanal bakers. One reason is the different soils and climatic conditions within Germany which results in cultivation of all main bread grains: rye, wheat and spelt. The other reason for these many bread varieties is in history. Until the beginning of nineteenth century, Germany was only a confederation of around 300 small- and medium-sized states, each with its own legislation. That favored the development of regional cultures and therefore also breads and traditions. Due to this richness in breads only the most popular breads are here described briefly.

Some of these breads go back to Roman times and the Roman limes reflect the preferences for bread types within Germany. In the Northern part of Germany rye and a higher acidity of breads is traditional, whereas in the Southern part wheat and sweet baked goods or the use of bread spices (caraway, aniseed and fennel) are preferred. That may be connected with brewing techniques. In the North bottom fermenting yeast (lager-brewing) was used for brewing with barley, which is not suitable for baking. Whereas in the South top fermenting yeast (ale-brewing) was available from brewers as they also brewed beer from wheat. From that top-fermenting wheat beer yeast nowadays baker's yeast has been developed (Oura 1983) And that is the reason why bakers and brewers were often in the same guild.

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Table 6.1 Distribution of bread types within Germany (*Zentralverband des Deutschen Bäckerhandwerks e.V.* 2020)

Bread types	Distribution sales in Germany 2019 (%)
Mix breads	24.6
Toast breads	24.1
Seed breads	15.7
Whole meal ore coarse grain breads	11.6
Wheat breads	7.7
Rye breads	6
Spelt breads	3.4
Other breads	6.9

2 Classification of Bakery Goods

The most important quality descriptions for breads in Germany are regulated in the "*Leitsätze für Brot und Kleingebäck*" (1994, guidelines for bread and rolls). A violation of these guidelines is punished by food authorities as consumer's irritation or fraud. They define the amount and type of flour in wheat, rye, wheat mix and rye mix breads or the minimum content of other ingredients. These descriptions of foods are written by a state commission consisting of delegates of consumers and science, industry and food authorities. There exists also a quality norm for flours (DIN 10355) and it is used to classify the German wheat, rye and spelt flours in different type numbers. The flour type number indicates the amount of ash (in mg) obtained from 100 g of the respective dry-mass flour. If a flour composition does not fit into these standard quality criteria, it is called cereal milling product.

The most important breads in Germany are wheat and rye mix breads (also called "Graubrot" which means grey bread and relates to the grey crumb color), with a market share of roughly a quarter of the total sales. In the second place are toast breads with almost the same amount whereby toast breads are not really traditional for Germany, even if toast breads are very popular and the share on the market is increasing in the last decades. Toast breads are followed by seed breads and whole meal or coarse meal breads with another quarter; they are frequently manufactured with a mixture of wheat and rye flours. Pure wheat and rye breads have only a quite small share of the total bread market (Table 6.1)

3 Sourdough, Mixers and Ovens

Traditionally all breads were produced and leavened only with sourdough. These sourdoughs belong to the group of type-I sourdoughs (Gänzle 2006a), meaning that they kept continuously active with the ability to leaven doughs without the addition of baker's yeast. With the increasing emergence of baker's yeast, sponge doughs came up, as yeast was not a cheap ingredient before World War I. On the countryside farmers remained longer with sourdough leavening as the shelf-life of breads is longer compared to yeast leavened bread (Maurizio 1903). As spontaneous sourdough fermentations have some risks regarding the resulting bread quality, commercially sourdough preparations based on successful sourdough fermentations came up as microbial starter cultures in 1910 (Brandt 2014) These cereal-based starters are until now the predominant starter cultures for bread baking in Germany. Preliminary stages before the main dough are, in Germany, distinguished between those without intended use of microorganisms (known as soakers) and those with intended use of microorganisms. The latter consists of sourdoughs, either focused on acid production or on leavening with less acidity (natural yeast). Preferments, where baker's yeast is propagated in the dough are also in use (called sponge) for wheat.

Mixers
Whereas in the past spiral mixers and lifting mixers where both often used in German bakeries, nowadays the most used mixer is the spiral mixer. The spiral mixer brings energy into the doughs very fast and belongs to the intensive mixers. It protrudes from the wall of the bowl to the middle of it. The bowl is rotating and thereby feeding the spiral with dough. Even small amounts of dough can be mixed in this highly efficient mixer type. Other types of mixers like twisting mixers, circular impact mixer/blender, double cone mixer and horizontal mixer are also used for bread production but very rarely and cannot be seen as standard in German bakeries (Schünemann and Treu 1988).

Ovens
One of the most often oven seen in Germany is the deck oven or multi-deck oven. From bakeries with one shop to the medium size industrial bakeries, this oven type is used very often. There are many reasons for that like the flexibility in terms of temperature control and small space requirement. Tunnel or continuous ovens with different type of belts are used in most industrial bakeries, but the number of this type of ovens is low compared to deck ovens.

Small bakeries also use sometimes wood heated ovens but normally this is used for specialty breads and is not the mainly used oven. Baking breads in rack ovens is also done by some bakeries but it is not suitable for every bread type. Pan breads for example can be baked quite well in this kind of oven.

4 Rye and Mixed Breads

Rye breads in Germany need to contain minimum 90% (w/w) rye flours (*Leitsätze für Brot – und Kleingebäck* 1994). The addition of rye flour to bread recipes has an influence on the dough and bread quality (Schünemann and Treu 1988). It leads to changes in the color of the dough and the bread crust and crumb (Fig. 6.1). With increasing amounts of rye flour, the bread crumb becomes darker. The bread dough properties also change, chiefly the doughs are more plastic and less elastic and loose

Fig. 6.1 Mixed breads from wheat to rye. The amounts from left to right are 100% wheat flour, 80% wheat and 20% rye, 60% wheat and 40% rye, 40% wheat and 60% rye, 20% wheat and 80% rye, 100% rye

the stability with increased amounts of rye. This leads to a reduced gas retention capacity and, therefore, a reduced bread volume and a denser bread crumb. Therefore, 100% rye breads are baked very often in baking pans. Breads with rye flour have also a stronger flavor. This comes from the flour itself and from the fact that for traditionally rye and rye mix breads, but also for wheat mix breads, the use of sourdough is obligatory (Neumann et al. 2006). Mixed breads are named after the dominating cereal, e.g. a rye mixed bread is based on >50% of rye flour.

The enzymatic activity of α-amylase in rye flour was significantly higher (sprouting on the field) in the past than in the current rye varieties (Brümmer 2017). The enzymatic activity in combination with the low gelatinization temperature of rye of 49–56 °C, made sourdough to become an essential ingredient to achieve good rye bread quality. The α-amylase from rye flour degrades the gelatinized starch to smaller sugars. Without a significant pH reduction, the α-amylase activity would weaken the crumb structure in such a way that the bread crumb could rip from the crust during the baking process and it would not be elastic anymore. In the worst scenario, it could happen the crumb collapse to a lump of dough and made the bread uneatable. Nowadays, the rye flour qualities have changed to flours that can be baked without any pH reduction and still achieving a bread with an intact crumb. The reason why sourdough is still used and necessary, is the great impact on taste, aroma, elasticity, freshness, shelf-life extension and digestibility, besides the improvements obtained during the production process, such as the greater proofing stability and proofing tolerance (Neumann et al. 2006).

4.1 Sourdough Schemes for Rye Processing

For the propagation of rye sourdough, several fermentation processes (Detmold schemes, Berlin short sour, salt sour, etc.) were developed (Neumann et al. 2006), all having advantages and disadvantages. All those fermentation processes are based on two main schemes, the one-stage and the multistage procedures (Fig. 6.2). It must be underlined that all these detailed procedures work well, but in practice they all must be re-adapted to the specific conditions and workflow of the bakery.

The **multistage fermentation** (Fig. 6.2) has the advantage that it keeps continuously the sourdough in a high microbial active state, so called exponential growth phase. The level of microbial activity depends, beside from other factors, on fermentation times and the amount of sourdough used as starter culture, *i.e.* the so

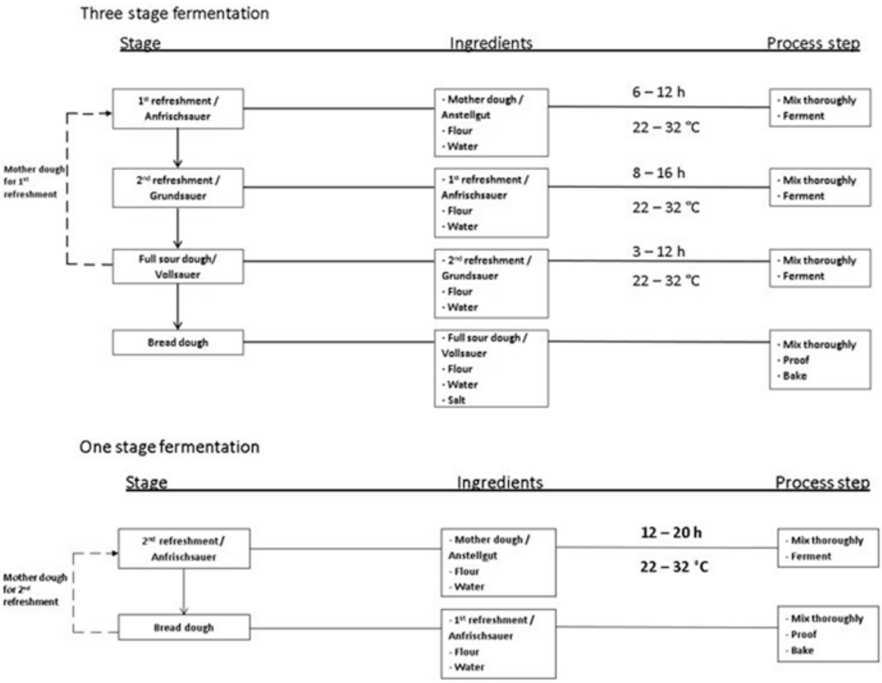

Fig. 6.2 Typical fermentation schemes for rye sourdough processing: multiple-stage (top) and one-stage (bottom)

called mother-dough. Under the right circumstances it is possible to produce breads without baker's yeast. Usually these sourdoughs achieve higher concentrations of acetic acid in relation to lactic acid as one-stage processes. Nevertheless, the working tolerances of these sourdoughs are quite short and small deviations in the production process may lead to a major impact on sourdough quality and final bread. As a result multistage fermentations need to be controlled very well. Multistage sourdoughs have usually a lower TTA (Total Titratable Acidity) and a higher pH-value compared to long one-stage fermentations (Spicher and Stephan 1993). This enables higher dosages of sourdough, *i.e.* higher parts of fermented flour to achieve the same TTA and pH-values of breads with long one-stage fermented sourdoughs. As the amount of lactic acid in relation to acetic acid is often lower (*ca.* 70:30 to 60:40, w/w) in multistage fermentations and since the acetic acid is more effective in the protection against molds, it is possible to achieve a longer shelf-life in the multistage fermentations when compared to breads manufactured with long one-stage sourdough fermentations. Additionally, different ratios of acetic to lactic acids result in changes in the aroma and taste. The biggest difference can be detected in the aroma, which is normally stronger in breads from multistage fermentations, since, when compared to the lactic acid, the strong acetic acid aroma volatilizes easier and is therefore more noticeable.

The **one-stage fermentation** (Fig. 6.2) with fermentation times of 15–24 h is generally easier to handle, because of its lower microbial activity compared to multistage sourdoughs. Usually, the amount of sourdough starter (mother-dough) used in the recipes is smaller than in multistage processes. These one-stage sourdoughs (uncooled) have a longer process tolerance of more than 4 h without major differences found in the sourdough quality and further in the final bread, as the microorganisms are in the stationary growth phase. This is another reason for its popularity. On the other hand, one-stage fermentations do not present the same leavening properties, chiefly the microbial activity is lower than in multistage fermentations with the consequence that leavening without baker's yeast is possible but not recommendable. Quite the contrary, as breads made with one-stage fermentations show longer proofing times and a different bread quality at the end compared to multistage processes, like dense bread crumbs or too sour breads.

The ratio of lactic to acetic acids in one-stage fermented sourdoughs is normally 80:20 to 70:30 (w/w) in contrast to the usual ratios found in multistage fermentations (*ca*. 70:30 to 60:40, w/w). This can be explained by the higher TTA, the long fermentation time and the fact that acetic acid is mainly formed at the beginning of the sourdough fermentations when electron acceptors as fructose are available (Gänzle 2006b). Using this type of sourdough fermentation leads usually to sensory milder baked goods when compared to multistage fermentations with the same bread TTA level. Chiefly because lactic acid is less strong noticeable in terms of flavor, compared to acetic acid (Rothe 1974) and the addition of lactic acid is higher when using one-stage sourdoughs.

4.2 Examples of Types of Rye Breads

In Fig. 6.3a a Farmer's Bread (*Bauernbrot*) is depicted. In Farmer's bread at least 2/3 of the acidity must be originating from sourdough fermentation, as described in the German guidelines (*Leitsätze für Brot und Kleingebäck* 1994). Country breads (*Landbrote*) are also very common all over Germany and the content of acids has to be mainly originating from sourdough microorganisms. Depicted in Fig. 6.3c is a Berlin country bread. It is typically covered with flour with a rustic crust and made as a free loaf with long or round shape. The name *Kommissbrot* (bread for military troops, Fig. 6.3b) is originally from its common use in the army in former times. It is baked in a pan and has a shiny crust, its crumb is very dense with very small pores. All these breads have strong sour taste and aroma. The TTA of such breads will be around 10 with a pH-value of approx. 4.3.

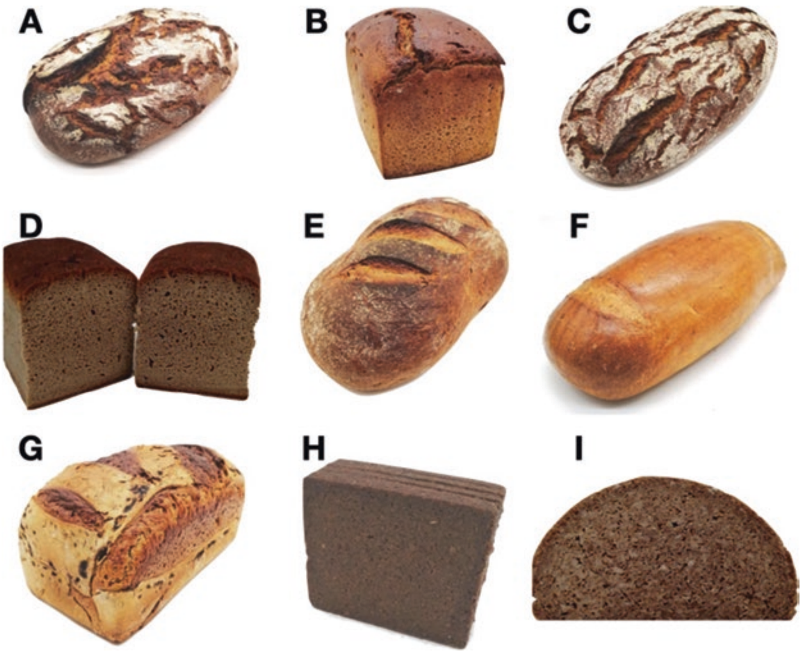

Fig. 6.3 Examples of rye and rye-mixed breads common in Germany (description see text). (**a**) Farmer's bread (*Bauernbrot*), (**b**) traditional military bread (*Kommisbrot*), (**c**) Country bread Berlin-type (*Berliner Landbrot*), (**d**) Country bread Paderborn-type (*Paderborner Landbrot*), (**e**) Black Forest bread (*Schwarzwälder Brot*), (**f**) Bread Kassel-type (*Kassler Brot*), (**g**) Flamed bread (*Gersterbrot*), (**h**) *Pumpernickel*, (**i**) Whole-grain bread from Northrhine-Westphalia (*Rheinisches Vollkornbrot*)

4.3 Rye Mix Breads

Rye mixed breads are very popular in Germany. To produce rye mix breads, the amount of rye flour is between 50% and 90% (w/w) of total flour. At least the rye part is fermented by using sourdough starter or ripe sourdough.

Paderborner Landbrot (Paderborner country bread) (Fig. 6.3d) has a pan bread shape and is baked close to each other, which means the long sides touches the next bread, so the sides are soft and have no crust like the top side.Another example of a rye mixed bread is Heathland bread (*Heidebrot*). It is usually a long free loaf bread with flour on the sides and the top side without flour. All these breads are still quite strong in taste and aroma but usually a bit milder than pure rye breads. The TTA will be depending on the ratio of rye and wheat flour and is approx. 6–10 with a pH-value of approx. 4.3–4.5.

4.4 Wheat Mix Breads

To produce wheat mix breads, more than 50% (w/w) and less than 90% (w/w) of the flour is from wheat. These breads are leavened with sourdough or with baker's yeast. Examples are *Kasseler Brot* (Fig. 6.3f), which is a long free loaf bread with 2 cuts on the edges and a shiny crust and Black forest bread (Fig. 6.3e). This is another typical local bread which is made as a round or long free loaf. The surface can be covered with flour and it has a thick and very dark crust. Wheat mix breads are usually mild breads with smooth taste of acid and less strong aroma, which is caused by the lower amount of sourdough compared to rye or rye mix breads. These breads also contain rye sourdough, rarely a wheat sourdough. The mild character of the breads is also shown in TTA, which will be approximately 4–6 and the pH-value will be approximately 4.6–4.8 depending on the ratio of the flours.

4.5 Pumpernickel

Pumpernickel (Fig. 6.3h) is a typical Westphalian specialty bread listed as food with protected geographic indication (Regulation EU/1241/2014) During the centuries Pumpernickel has developed more and more to a delicacy bread and nowadays is not baked in every bakery. One reason is that the baking process does no fit properly in the working day of bakers. A other reason is the equipment. For artisan bakers it is too expensive to invest into a special oven or steam chamber. But the biggest reason is that industrial bakeries had explored intensively this kind of bread. So the Pumpernickel has disappeared more and more out of the artisan bakery shops. Nowadays, it is a kind of sophisticated bread and can be found in supermarkets. The baking process of Pumpernickel bread is very singular. Actually, it is not a baking process. Instead, it is a steaming process over 16 up to 24 h in special ovens or in steam chambers. The baking or steaming time needs to be at least 16 h. Moreover, for a high quality Pumpernickel with a good dark crumb color a baking or steaming time of 20 to 24 h is recommended. Also the baking temperatures are different from regular breads. Alternatively, the Pumpernickel can also be baked in a special tin or in a steam chamber, where the temperatures are between 100 °C and 170 °C (Doose 1948). The long baking time and the lower baking temperatures gives to the Pumpernickel bread different benefits which are characteristic for this kind of baked goods. During the steaming process the reducing of sugars and the amino acids lead to the characteristic browning (Maillard reaction). This reaction is typical for the browning of all kind of breads. However, in the Pumpernickel process the Maillard reaction has much more time for the different and complex reactions and so the crumb of the Pumpernickel gets the very characteristic dark, slightly blacker crumb color. In parallel, the caramelization is another reaction which gives the crumb a sweet caramel taste. Characteristic for the non-crust Pumpernickel bread is the sweet and sometimes sweet and sour taste and a unique flavor. So, the dough process in this case is very important and can be divided into three different variations.

- Only sweet and not with a sour taste Pumpernickel bread. In this case the Pumpernickel bread is baked without sourdough and up to 0.4% (w/w) baker's yeast (based on total amount of the groat).
- Sweet and mild acidity Pumpernickel bread. In this bread variation, a sourdough amount of 7–10% w/w (calculated on total amount of the groat) usual plus an amount of baker's yeast of 0.3% w/w (based on the total amount of the groat).
- Sweet and sour taste Pumpernickel bread. Here the amount of sourdough is between 10–30% w/w (based on total amount of the groat). Therefore, the bread has a more intensive flavor overall. The addition of baker's yeast is not required in this bread variation.

4.6 Other Specialty Breads Based Mainly on Rye

Specialty Bread Produced with Special Treated Milling Products:

Steinmetzbrot: In a wet peeling process the bran of the grain's gets removed, the whole grain gets burst and are gently baked in tins.

Schlütterbrot: Traditional whole meal rye bread with 10–15% "Schlütter-Flour" based on total amount of flour. That special whole meal flour is treated with heat and steam. During that process the starch of the flour gets more pre-gelatinized. In addition, through to the enzymatic activity more reducing sugars are formed which results in a sweeter taste in the final baked bread.

Specialty Bread with Special Dough Preparation:

Loosbrot: unfermented rye whole meal bread. Typical is a long soaking process of the complete bread dough for up to 2 days. The bread gets a good sliceability and freshness. Nowadays, the traditional manufacturing process is controversial, because a spontaneous fermentation can induce a failure in aroma and taste and lower the quality of the bread.

Simonsbrot: Predominantly the "Simonsbrot" is a whole grain or groat bread, sometimes also with use of wheat. Grains are soaked and sprouted with warm water for 12–16 h, which results in a high enzymatic activity. After that process, the moist particles get squeezed and pressed resulting in a moist and wet dough. The dough is baked in special tins or in a steam chamber for approximately 12 h. Traditionally, the rye flour variation of these breads gets proofed with sourdough.

Specialty Bread with Special Baking Processes:

Gersterbrot (Fig. 6.3g): Typically, from the Northern Germany, this bread is made of rye or mixed rye and wheat flour. In the past the proofed breads were placed into the oven while these were flamed up to have enough heat for the final baking. The direct contact with the flames formed a roasty skin with burnt parts and builds a crust. After this short flaming process, the breads are baked at lower temperatures. The crust gets a cut underneath the flamed crust to keep the slightly roasted crust structure and avoid a spontaneous crust cracking. Nowadays, the bread gets flamed by using special flaming applications before baking.

4.7 Coarse Grain Breads

For the manufacturing processes of breads with a high amount of grains, groat or whole meal groat it is essential to use a pre-dough system prior to bread dough kneading. If not applied, grains remain hard in the final bread. In the Groat bread manufacturing the pre-dough method is summarized together in the group of soakers without the intentional use of microorganisms: Soaker, Hot soaker and Boiled soaker (Brümmer and Huber 1984).

Soaker's, in any case, are used to optimize the quality of the baking goods, like an improved bread dough behavior and water uptake in the dough manufacturing. Also, the sensory value gets improved by a better mouth feeling, a moister crumb and a better natural freshness of the breads. Each soaker method has its own pros and cons and needs to fit into the requirements of the breadmaking production.

4.7.1 Soaker (*Quellstück*)

In this case, only cold or lukewarm water is added to produce the soaker. Mostly the dough yield is between 180 and 200. The soaking time goes up to 16 to 24 h at room temperatures. The swelling development of the groat compounds is, in comparison to the other soaking doughs, quite slow. Especially bigger groat particles or even whole cereal grains are not soaked enough in this method and that causes a worse fresh keeping in the final bread, when compared with the other methods. Also, from the microbiological point of view this process is to be taken cautiously. The low dough/water temperature and the long swelling process is, in fact, lead to a spontaneous fermentation and can cause failures in the resulting bread quality. A endogenous microbiota can grow and develop and have a negative effect on the texture and total flavor of the final bread. Yet, the freshness and the shelf-life of the breads can be negatively be influenced as undesired microorganisms may grow. Beside this, the addition of the amount of soaker is relatively high. It variates between 30% and 60% of the total amount of milling product in the final bread recipe.

4.7.2 Hot Soaker (*Brühstück*)

Hot soakers are prepared by the addition of hot (70 °C) or boiling (100 °C) water. Due to the high temperatures used, the starch in the groat partly gets gelatinized and also the swelling process is quicker. A higher water content or dough yield between 200 and 220 is necessary. Due to the accelerated swelling process, the soaking time of a hot soaker is shorter, usually taking between 3 and 4 h. The dosage on total amount of cereal milling product in the final bread recipe is 20–40%. The application of Hot Soakers is commonly established in bread recipes which contain more coarse particles or more roughly coarse groat or even whole grains.The Hot Soaker gives to the bread a good freshness and moiste crumb.

The Hot Soaker presents some limitations and challenges, particularly in the case of storage of a Hot Soaker under uncontrolled temperature conditions. Due to the fact that the starch from cereals gets gelatinized during the hot soaking process, the starch is more accessible to enzymatic degradation. Especially endogeneous glucoamylase and ß-amylases set maltose and glucose free (Gosaert et al. 2005). As a consequence, this fermentable sugars can be metabolized by the existent microorganisms to organic acids. Thus, increasing the acidity. So, the TTA of the Hot Soaker under uncooled conditions could be even higher compared to a regular Soaker.

4.7.3 Boiled Soaker (*Kochstück*)

The biggest difference between a Hot and a Boiled Soaker is the boiling process by itself, which gives to the Soaker that name. The groat, seeds or grains are considered to be completely treated by heating treatment when the complete mixture of milling products, seeds and water reaches altogether a temperature of 100 °C. In comparison to the hot soaker process, much more starch gets gelatinized in the boiled soaker process due to the applied higher temperature. Furthermore, the swelling process is also very quick. Due to these specificities of high starch gelatinization levels and high water uptake, the dough yield needs to be much higher compared to a Hot Soaker or a regular Soaker. The dough yield in Boiled Soakers is between 300 and higher, depending on the raw-materials which being used, like rye, wheat or oil seeds. By applying this soaking methodology, even whole grains and bigger particles of the groat get fully soaked or swollen and gelatinized. The freshness of breads which contains a Boiled Soaker is much better compared to the other described methods. The final bread dough can reach a higher amount of total water and the bread gets a moisty crumb. The amount of Boiled Soaker to be added to the bread recipe is limited. The maximum dosage on the total amount of milling product in the final recipe is 20–30%. Higher amount causes deficits in the bread volume and can make the bread crumb too sticky and wet.

Comparison of Soaker Systems

As literature on these pre-dough systems applied for whole and coarse grains is limited, a basic comparison of the soakers was performed. In Fig. 6.4 the time-course of the pH and TTA values during soaking are depicted. More or less after 5 h of "spontaneous" fermentation by the natural microbiota present in the milling products within the different soakers starts to increase the acidity. Due to the fact that most of the microorganisms disappear during the boiling process, the TTA of the boiled soaker is significantly lower than obtained through other soaker processes. Similar effect is observed in the hot soaker. Due to the lower temperatures in

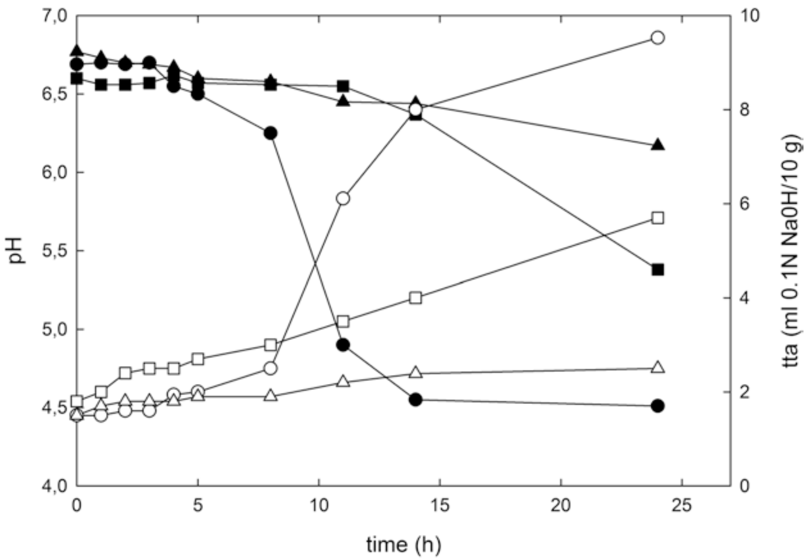

Fig. 6.4 Development of ph (black) and total titratable acidity (white) during a soaking process: soaker (●), hot soaker (■) and boiled soaker (▲)

Table 6.2 Cell counts of soaker types after 24 h of soaking

	Total cell count (cfu/g)	Lactic acid bacteria (cfu/g)	Yeast (cfu/g)
Soaker	1.8×10^9	1.5×10^9	1.6×10^4
Hot soaker	1.1×10^9	7.9×10^7	2.2×10^3
Boiled soaker	4.1×10^8	<100	<100

cfu/g: colony forming units per gram soaker

the hot soaker some microorganisms may survive to the heating treatment and may contribute afterwards to the increase of the acidity during the next 24 h.

The application of hot and boiled Soakers has one critical disadvantage: *Bacillus* endospores have been isolated from flour and other raw materials (Bailey and von Holy 1993) and are part of seed-borne endophytic microbiota (Li et al. 2020). Outgrowing bacilli may produce rope-spoilage in bread (Röcken 1996) and their growth is activated by heat (Aoki and Slepecky 1973) As, especially with boiled soaker (Table 6.2) the competing microbiota is destroyed, breads prepared with boiled soakers tend to rope-spoilage, if not prepared with additional sourdough for pH reduction. In the process of soaking at room temperature, autochthonous bacteria from the flour (Table 6.2) can grow, which results in drop of pH and increased TTA (Fig. 6.4). Due to such spontaneous fermentations the quality of a soaker is very variable.

Traditional Bread with Hot Soaker Application: Rye Whole Meal Bread from North Rhine-Westphalia

Each region in Germany has its own specialty bread. Especially in the North of Germany, the Rye Whole meal Bread (Fig. 6.3i) is very popular and has a long tradition in artisan bakery's and nowadays also in industrial bread factories. This bread is traditionally made with sourdough from whole meal groat and also with a soaker or a hot soaker. The bread is very compact and it is usual to slice it into very thin bread slices. Typical of these kinds of breads are the white spots in the bread crumb (Fig. 6.3i). The spots are not swollen rye grains or rough parts of the rye whole meal groat which were added in the final bread dough and not soaked before. Indeed, they are grains that cannot swell enough water in the "short" resting and proofing times. As a consequence, after the baking process they are visible in the crumb. In this case it is not a loss in quality at all but rather a special sign of the quality in these kinds of breads. Most of the bakers, especially the traditional artisan bakeries, often adding one or two scoops of rye grains into the bread dough just 5 min before the kneading process is finished to increases in number of these spots in the final bread.

Due to the sourdough fermentation in combination with the Hot Soaker application and the long resting and kneading times, these breads get a very good freshness and a natural good shelf-life. Finally, the use of whole meal groat increases its nutritional value.

5 Wheat and Spelt Wheat

5.1 Wheat Preferment and Sourdough

A preferment (sponge dough) is a yeast based fermentation, and belongs to type-0 sourdough (Gänzle 2006a, b). It is only used to produce wheat based baked goods. Each preferment fermentation starts with the addition of new baker's yeast in every batch. One target is to improve the taste in baked goods. Usually preferments with long fermentation times of 12–20 h are used to achieve this (Seiffert 2006). But in contrast to sourdoughs, preferments are much milder in aroma and taste, especially in terms of sourness. In preferments with long fermentation times the amount of yeast is lower (0.1–0.2% (w/w) on flour base) and the temperature (22–25 °C), too (Seiffert 2006). With this method pH-values of 4.5–5 can be achieved. The pH reduction is caused mainly by lactic acid bacteria originating mainly from baker's yeast preparation itself (Gänzle 2006a). Preferments with shorter fermentation times of 2–3 h are usually made with higher amounts of yeast (1–2% (w/w) on flour base) and higher temperatures of 25–28 °C (Seiffert 2006). As each batch of preferment is started new with baker's yeast and the flour (or flour mix) and yeast quality can fluctuate, the quality of preferments, especially with long fermentation times can change also from batch to batch. But of course there are many ways to produce preferment and like sourdough fermentations it depends on the bakery and it's workflow, how the fermentation is performed.

In contrast to preferments wheat, sourdough fermentations starts with an active sourdough (2nd refreshment) or sourdough starter. The most common fermentation process is the one-stage fermentation over 12–16 h and 25–30 °C (Seiffert 2006). Obviously, wheat sourdough will make breads more aromatic and bring all the vantage and disadvantages to the bread and breadmaking. Like more freshness, longer shelf life and a more elastic bread crumb. In terms of a more aromatic bread, it is shown that in the first 3–4 h bread with preferment and wheat sourdough are both aromatic. Afterwards the bread with wheat sourdough keeps his aroma while the bread with preferment loses his (Seiffert 2006). As above mentioned, microorganisms coming from flour and baker's yeast can start to multiply in preferments, especially in preferments with long fermentation times and led to different preferment and bread qualities. This unsteadyness of preferments makes wheat sourdough to a potential more reliable and safe process as the microbiota is stable in well produced sourdoughs and ensures a constant quality. The amount of fermented flour that will be used for the sourdough production is 5–10% (w/w) of the total amount of flour (Gänzle 2006a, b).

Wheat sourdough made with wheat flour type 550 achieves TTA values of 9–13 and pH-values of 3.7–3.9, in one-stage fermentation over 12–16 h. Generally, this is depending on the microbiota of the sourdough starter and processing parameters, which applies to every sourdough fermentation. Mild wheat sourdoughs, in Italy called lievito naturale, contain higher amounts of yeast in relation to strong wheat sourdoughs. They are fermented shorter and at lower temperature in order to prevent an extensive acid production. Here it is possible to achieve TTA values of 5–8 and pH-values of 4–4.3.

5.2 Wheat Flour Based Baked Goods

Baked goods composed entirely by wheat flour are very popular. Typically, white wheat flour is taken to produce these baked goods. They are primarily leavened with baker's yeast in a direct process or with yeast preferments. The use of wheat sourdough is not so frequent, whereby there is a trend of using wheat sourdoughs for wheat bread, rolls and even pastry production, rather it is for marketing reasons or to bring changes in the quality of baked goods.

Traditional German wheat Bread Recipes

White wheat bread (*Weißbrot*) is frequently made in a straight dough process. Baked in pans with a lengthwise cut respectively crack in the middle. This bread is also very often made as a free loaf in long or round shape. The surface is very shiny and with cuts. The crumb is soft and spongy with an even pore structure. *Stangenweißbrot* or *Kaviarbrot* (bar bread or Kaviar bread) is a long shaped bread with a shiny crust and cuts and looks like a French baguette. Usually it is made of the same dough used for white bread. As these breads are made often without sourdough, the taste is very mild and the aroma yeasty and minimal alcoholic. The TTA of these breads are around 2 and the pH-value approximately 6. This process is very simple and easy and good results regarding visual aspect and shape, and high loaf volume can be achieved straightaway. The direct process gives more flexibility and safety in the bread manufacturing. Regarding longer freshness and much aroma this process is usually not the best choice when compared with preferment or sourdough fermentation.

*5.3 Moistened Bread or Scooped Bread Out of the Bowl (***Genetzte***s or,* **Ausgehobenes Brot***)*

The "*genetztes Brot*" (Fig. 6.5a) got its origins in the South of Germany, in the Swabian Alps and in the Swabian part of Bavaria. The specificity of these bread is that flour is not used as separating agent for the sticky dough but water instead. Mostly it is a Mixed Wheat Bread with a flour ratio from 70/30 (wheat/rye), 80/20 up to 90/10 depending on the geographic region and the bakeries. Often it is also found as a mixture of wheat and spelt flours. The usage of sourdough in these kinds of bread varies between bread with the absence of wheat sourdough or sponge and a light acidification with rye sourdough.

The bread dough needs a bulk fermentation or a proofing time at ambient temperature for at least 3 h. Sometimes the proofing takes up to 6–8 h (or overnight), in that case it is with a reduced amount of baker's yeast. After the bulk fermentation, the bread is scooped out of the bowl with wet hands. The bread needs to be covered completely with cold water. Traditional the bread dough is placed directly on the oven plate and is baked with a lot of steam. The shaping with wet hands gives to the final bread a very shiny crust and an irregular crumb structure. The bread dough itself is very soft and needs a bit of experience by the bakers, especially for the wet shaping process. The dough pieces need to be formed very quickly without losing much carbon dioxide (CO_2); which was formed during the bulk fermentation.

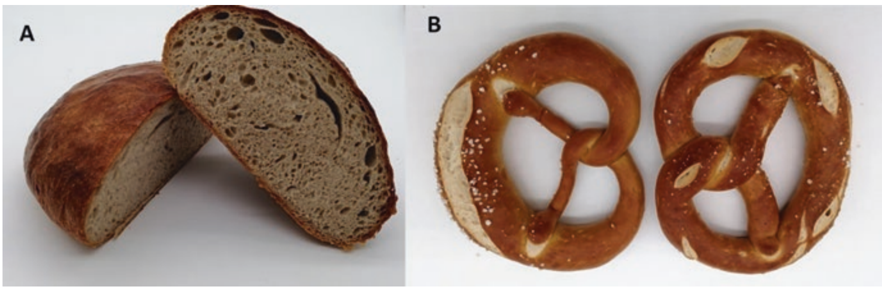

Fig. 6.5 Wheat specialities from Southern Germany (**a**) *Genetztes Brot* (**b**) Pretzels (*Laugenbrezel),* left Swabian type, right Bavarian type

Alternatively, it is dropped down to the oven plate from a scoop. After shaping, the bread is traditionally baked directly on the oven plate. As machinability of these doughs is very low, only artisan bakers manufacture this kind of bread.

5.4 Lye Articles and Pretzels

There are two typical and distinct types of Pretzel's in Germany. One from Bavaria and the other from Baden-Württemberg. The differences between those two types are that the Bavarian Pretzel's has a regular thickness and they are not being cut before going into the oven. Therefore, the cracks are more irregular and "wild". The Pretzel's from Baden-Württemberg have thin "arms" and a thicker part in the middle (Fig. 6.5b). They are cut before getting into the oven and the cutting is bright after the baking (Krauß 2003). The word "*Breze*l" was formed out of the Latin word *brachium* for arm and over the years the name *Brezel* or *Brezge* was formed. Nowadays, the Pretzel is the emblem or coat of arms of the German baker's guild. In the last centuries, the Pretzels were proofed by using spontaneous fermented sponge dough. Today, the bakers use baker's yeast and add often a mild sourdough (depending on the region of South Germany). The traditional way of producing Pretzel's is with a cold and firm dough. Too warm and moisty doughs cause detrimental effects in the quality of the baking good. The Pretzels are also being baked without steam and using high temperatures (±240 °C). The firm dough with fat (traditionally lard) inside gives the final baked Pretzel's a typical white crumb color with a fine pore structure and provides a short bite in the mouth feeling. The most typical process in the manufacturing of Pretzel's is the usage of lye/sodium hydroxide.

After the proofing time the Pretzel's should build a little skin by taken them out of the proofer cabinet. Often, they are put into the cooler to form a skin and to get more stability. After that the Pretzel's get covered with sodium hydroxide with a concentration between 3% and 4%. The sodium hydroxide reacts with the flour compounds which is recognizable when the Pretzel's gets a yellowish color. The popular and intense crust color is a result of the Maillard reaction which is more intensive under alkali conditions. The dry skin on the surface of the Pretzel's avoids the lye to absorb to quick and the proofed dough pieces gets more stable. Also commonly used nowadays is to deep freeze the proofed and lye covered Pretzel's. In this case the Pretzels can be baked during the day according to the customer's demands.

5.5 Leavened Sweet Pastry

Likewise, the history of bread, the sweet pastry has also a very long tradition in Germany, especially in the Southern part. Compared to the traditional German Wheat Bread doughs, the sweet pastries are different in their quantitative content of fat (mostly butter) and sugar. The amount of sugar and fat influences the dough behavior of sweet pastry. Especially the proofing of these kinds of doughs gets influenced by the addition of fat and sugar. Also, it is common to add sultanas or other fruits in the sweet doughs. In the sweet pastry, the variation between fat and sugar is significant for its final quality. In Germany, during the ages, three different types of sweet pastry were developed: A light version; a medium version; and a heavy version. Those variations of the pastry dough differentiate each other in the amount of fat and sugar. The fat and sugar amounts are between 5 and 10% based on the total amount of flour in the light pastry version, whereas in the heavy version the fat and sugar amount goes up to 50% based on total flour amount.

Traditional and most famous baking goods made with sweet pastry are:

Light pastry: Rusk (*Zwieback*), Danish pastry (*Plunder*), Currant Buns (*Rosinenbrötchen*), Light plaits (*Hefezopf*), Sweet Pretzels (new year, Palm Sunday), Sweet cone (*Milchbrötchen*), "Berliner"-Doughnuts (fried, also at carnival).

Medium pastry: Several short breads and cakes, Butter Cake (*Butterkuchen*), Sweet Plaits (*Hefezopf*, Fig. 6.6a), Seasonal baked goods, like Easter Bread with fruits or *Mutschel*, Nut Plait (*Nußzopf*), Poppy Seed Cake.

Heavy pastry: German Christmas *Stollen*, Ring Cake (*Guglhupf*).

The proofing of different baking goods depends on the amount of fat and sugar in the pastry recipe. In principle, as higher the fat and sugar amount is, as higher yeast amount is required to be added in the final pastry dough. A higher amount of especially sugar leads to higher osmotic pressure within the baker's yeast cell.

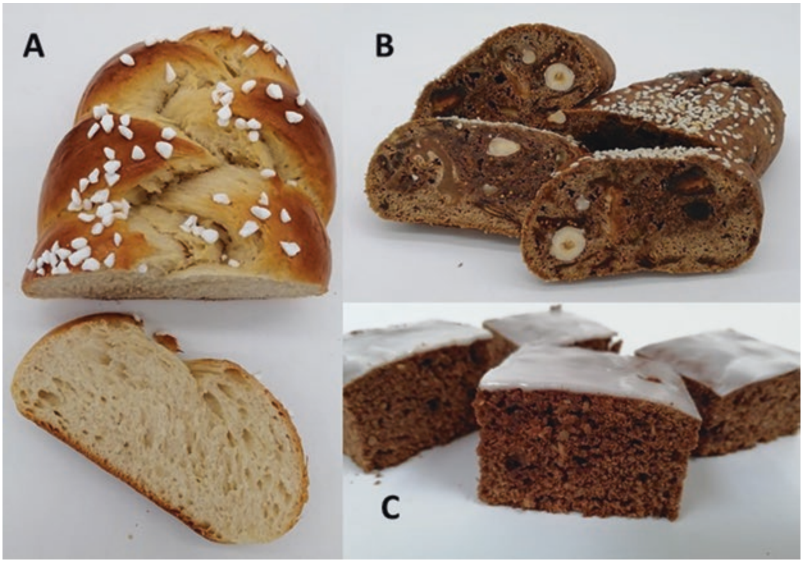

Fig. 6.6 Sweet baked goods: (**a**) *Hefezopf*, (**b**) *Hutzelbrot,* (**c**) Gingerbread (*Lebkuchen*)

Consequently, the yeast activity gets slower and the baker needs to add more yeast or use sponge dough to compensate the loss of activity and get a suitable proofing time.

Sugar not only influences the gassing power of the yeasts but also so influences the dough behavior. A higher amount of sugar in the pastry dough makes the dough softer and stickier. To compensate this stickiness and to have a better manufacturing/modeling, the percentage of water in the pastry dough recipe needs to be reduced. A similar effect is observed with higher amounts of fat in the pastry doughs. Also, here the water in the dough needs to be reduced to allow manufacturing. Beside this it is necessary to keep the dough quite cold, especially the doughs with higher fat amounts. The dough temperature should not be below 24 °C and simultaneously not above 30 °C. The optimal temperature depends on the type of fat, which is being used. Briefly, a pastry dough with butter should not get a dough temperature after kneading of 24–26 °C. If the used fat type is margarine the dough temperature can be higher, between 26 °C and 28 °C.

In parallel, the dough development especially the gluten structure needs to be developed properly during the doughmaking. The high fat amount in pastry doughs has a high impact to this process in the same way the high amount of eggs or emulsifiers. So thus, the right dough temperature during kneading is essential. The dough needs to develop a good gluten structure to have a good gas retention capacity and in parallel, simultaneously it does not get too warm during the dough preparing. Too warm dough temperatures makes the dough too sticky which negatively influences the manufacturing. Simultaneously leads an underdeveloped gluten structure to a smaller volume in the final pastry good. For that reason, it is common, especially in the pastry doughs with a higher fat amount, to use an indirect dough production using sponge dough or a polish. This is especially common in the production of German Christmas Stollen. The pastry doughs with a higher amount of sugar and fat needs also a longer dough resting time. As higher the amount of fat and sugar as longer needs to be the dough resting time. This needs to be required to get the best results for a high-quality pastry good.

5.6 Spelt

Spelt has a longtime tradition in the South – West of Germany and is cultivated there since Roman times (Miedaner and Longin 2017). Spelt rolls need to contain a minimum of 90% of spelt flour of the total amount of flour. Most baking goods from spelt are leavened with baker's yeast and mainly contain spelt sourdough or yeast preferment. A typical bread roll from Swabian are the "*Seelen*", which are sold the whole year, but in former times it was the bread for All Souls' Day. The taste and smell is very mild, the crust is crunchy, the crumb is soft, open, irregular and with big pores. The crust is often covered with salt and caraway seeds. Nowadays, they can be found all over Germany but they originally belongs to Upper-Swabia. The soft dough has a long resting time of several hours. Long pieces are taken from the dough, with wet hands and baked directly.

6 Gingerbread and Other Specialties

Gingerbread (Fig. 6.6c) has a very long tradition as Christmas cake or cookie. Depending on the region, there are different instructions and recipes, which are all unique for each city where gingerbread is produced. The Gingerbread as we know appeared in the twelfth century and was manufactured in different German monasteries. The most famous cities where the Gingerbread has its oldest tradition are Aachen, Nürnberg and Pulsnitz in the North of Germany. These cities developed themselves in the sixteenth century to Gingerbread production centres within Germany. Separate guilds of gingerbread bakers (*Lebküchner* or *Lebzeltner)* were formed. One reason for the popularity and rise of the Gingerbread in those areas was, that in those times the cities were close to trade routes of spice sellers. Very special for the Gingerbread are the ingredients used to produce a high-quality baking good. Ginger, honey, cinnamon, cardamom, coriander, vanilla, aniseeds, cloves, nutmeg and pimento are only a summary of the different Gingerbread spices. Honey was for a very long time the only sweetener which could be used to produce sweet baking goods. Gingerbread is, therefore, one of the oldest sweet baked goods in the world. The high amount of honey in the recipe gives to the Gingerbread a very long shelf-life. The qualities of ginger breads are regulated in the *Leitsätze für Feine Backwaren* (1991).

Leavening of Gingerbread

An important part in the manufacturing of Gingerbread are the gas building agents. The main gas building agents or raising agents are the potash and the so called salt of hartshorn (*Hirschhornsalz*) which is a mixture of ammonium carbonate, ammonium-hydrogen-carbonate and ammonium carbamate. While the gingerbread dough gets baked (temperatures above 60 °C), the salt of hartshorn results in water, CO_2 and ammonia gas. The water evaporates and contributes to the volume of the baking good, whereas ammonia gas is released. Due to this reason the usage of "salt of hartshorn" is only allowed in flat baked goods where it is guaranteed, that the ammonia gas can evaporate completely from the baking good.

Potash (Potassium carbonate) in combination with organic acids forms CO_2 and gives to the Gingerbread a porous structure. Therefore, the potash was used in combination with a natural dough acidification by using sourdough (Wernicke 1954). However, the potash makes by itself the baking good flat, thus an additional gas producing agent is needed. Potash is produced through the leaching of plant ash and acquired its name from it.

Nowadays is common to make the dough for the Gingerbread months ahead from the main Gingerbread consumption. Thus, it is also an indirect dough manufacturing process with long fermentation time.

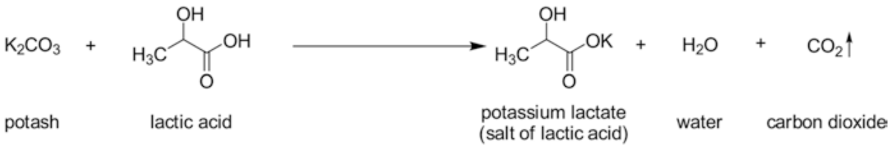

Fig. 6.7 Reaction of potash in ginger bread production

The Gingerbread dough is produced with the main components (Rye flour, Wheat flour, Sourdough, Honey, Egg) except of the raising/gas building agents and the spices. After the storage time, the potash and the salt of hartshorn are dissolved in cold water as warm water accelerates the chemical reaction of the raising agents. Then spices, solved potash and salt of hartshorn are kneaded into the storage dough. After kneading the dough is ready for shaping and baking. During the baking process it is recommended to open the vent and allow the ammonia gas to evaporate from the oven.

The usage of the abovementioned stored dough for the Gingerbread gives to the baker's several benefits. In brief, the stored dough gets enough time to swell during the storage time which makes the dough less sticky and is, therefore, better for production. The LAB which are present in the sourdough, are the main responsible for the acidity and therefore promotes the CO_2 formation from the potash during the baking process. It is common to use between 10% and 15% fermented flour in the Gingerbread recipe (based on the total amount of rye flour) (Fig. 6.7).

7 *Hutzelbrot* (Fruit Bread)

The traditional Swabian *Hutzelbrot* (Fig. 6.6b) is a specialty spice bread with origins in the Black Forest and the Swabian Alps. "*Hutzeln*" are originally only dried pears, but now are all kinds of dried fruits are named this way. In the past, this special bread was based on regular bread dough. For the Christmas season, the farmers sophisticate this bread with special ingredients, mostly with dried pears and apples. Over the years, the addition of more distinct and expensive ingredients like dried dates, figs, plums and apricots are added. Yet, more expensive nuts like walnuts and almonds are added as well as spices like cardamom, fennel, cinnamon and aniseed. The specialty bread has a long dough fermentation and is traditionally made with sourdough. Nevertheless, over the years and as a consequence of the development of baking improvers and the whole baking business, the use of sourdough in this bread was often being replaced.

The *Hutzelbrot* firstly comes to the German Christmas tables on the 24th of December and was traditionally consumed up till the 6th of January. Thus, the bread is commonly manufactured once a year at Christmas season. Even today, the bread can only be bought during Christmas season.

The fruit mixture (dried pears, plums, figs, dates, sultanas, etc.) needs a proper preparation before being slowly kneaded into the final Fruit Bread dough. The pears and the plums need to be roughly chopped and soaked overnight in, at least, 90 °C hot water. The figs also need to be soaked in this hot water and being chopped before per hand. The bid seed in the dates need to be peeled out. Afterwards, all fruits are soaked overnight before they can be slowly mixed into the final Fruit Bread dough. After the resting time, it is common to divide the dough into pieces of 550 g. Because the dough is very soft and sticky, the bakers resort to the use of water to model the bread into a round or long shape.

After a short final proofing of approximately 20 min, the Fruit Breads are baked at a temperature of 190 °C for 40–45 min. After baking, the breads are glazed with a dextrin solution. For this glaze process, the bakers prepare a mixture of 100 g of dextrin and 800 g of water. The mixture gets boiled shortly. The glaze gives to the Fruit Bread a very nice and shiny appearance.

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Chapter 7
Eftazymo: A Traditional Greek Bread Leavened with Fermented Chickpeas

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1 Introduction and History of "Eftazymo" Bread

The consumption of traditional foods, including sourdough breads, is generally associated with beneficial attributes (Brandt 2007; Catzeddu 2019; Rizzello et al. 2014). This is due to the use of natural raw materials, absence of chemical additives, naturalness of the preparation process, superior organoleptic characteristics and health benefits. Focusing more on conventional foods, these products were "ignored" from the modern lifestyle and their consumption was limited.

In addition, the introduction of "bakery yeast" (*Saccharomyces cerevisiae*) early in the twentieth century, facilitated the bakeries; yeast leavened the bread in much shorter time than the sourdough, bread quality was guaranteed, and the making process was not a laborious work anymore. The preparation of sourdough breads was limited in some bakeries, monasteries, and housewives, with passion for artisanal bread making (Brandt 2007; Catzeddu 2019).

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Most of the sourdoughs used for bread leavening are prepared with wheat or rye flour and the dominant microflora that drives the fermentation consists of lactic acid bacteria and yeasts in ratio 10:1 to 100:1 in a typical sourdough process (De Vuyst et al. 2017; Gobbetti 1998). Alternatively, in Greece and other Mediterranean and Balkan countries (Ertop and Coşkun 2018; Hatzikamari et al. 2007b; Pasqualone et al. 2004), as well as in the Middle East (Kyyaly et al. 2017), the leavening of bread has been reported to be made by the autochthonous fermentation of chickpeas (*Cicer arietinum* L.) and the fermentation to be carried out by the indigenous spore formers bacilli and clostridia (Gunduz et al. 2020; Hatzikamari et al. 2007b; Katsaboxakis and Mallidis 1996; Kyyaly et al. 2017).

Use of legumes for bread leavening was referred by Pliny the Elder, who lived during the first century. In his work *The Natural History,* (Book XVIII, Chapter 26) he refers to the various kinds of leavens used in the Roman Empire for breadmaking, among them a leaven based on legumes. Specifically, he wrote: "*When barley bread used to be made (means bread), it was leavened with the meal of the fitch* (ervum) *or else the chicheling vetch* (a diminutive kind of chickpea, *Lathyrus sativus* L.), *the proportion being, two pounds of leaven to two modii* (an ancient unit of volume, equivalent to 8.645 L) *and a half of barley meal*."

Legumes have been used in the human diet since antiquity and comprise an important asset of the Mediterranean diet. Pulses contain considerable amounts of proteins, minerals, fibers and vitamins and amongst them, chickpeas play a significant role also in the Middle Eastern countries diet, since almost 7500 years ago (Kislev and Bar-Yosef 1988).

In developing countries, the fermentation of legumes or legume-cereal mixtures represents a traditional method of food processing resulting in a wide variety of fermented products. In India, the most popular fermented products based on chickpeas are the traditional Khaman and Dhokla (Sreeja and Prajapati 2020). Khaman is a steamed baked, spongy cake with a hint of savory flavor from a simple combination of gram flour from ground skinned black chickpeas, spices, and herbs. Fermentation of legumes increases their digestibility and nutritional value, remove antinutritional factors as trypsin inhibitors and phytate, and finally renders the grains soft, thus eliminating or minimizing cooking time and fuel requirements (Desphande et al. 2000). Additionally, when combined with cereals, the nutritional value of the final products increases, as cereals 'protein lacks some essential amino acids such as lysine, while legume protein is rich in lysine but poor in methionine, cysteine and tryptophan. Therefore, their combination is complementary (Boukid et al. 2019).

Eftazymo bread is also known as "chickpea bread" bread in Greece but different local names exist, like "roftenio" or "roufteniopsomi" in the Regions of Western Macedonia and Epirus in Northern Greece, "arkateno" on the island of Cyprus (from *arkatis* that means 'worker'), "afrenio" in Kos island (from *afros* that means 'froth'), "gorgi" and "gourgenio" in Samothraki island, "kryfo" in the communities of Sarakatsani, an ethnic Greek population subgroup (from *kryfo* that means 'secret') (Psilaki and Psilakis 2001). The most famous Eftazymo is that of Crete Island where it is also produced in the form of rusks. "Eftazyma rusks" can be found everywhere in the Greek market. In some mountainous areas of Crete Island (Kastamonitsa in Heraklio and Kroustasin Lassithi Regional Units), every August, a festival is hold with traditional local products where visitors can watch the traditional process and taste Eftazymo bread and rusks (source: Cultural Association of Kastamonitsa).

There are different versions related to the meaning of the word "Eftazymo". It consists of the prefix "efta" (seven) and "zymo" (ferment). There is a misunderstanding that the word Eftazymo means "kneaded seven times", but this actually does not describe the specific process of making the Eftazymo bread. In fact, initially, it was named "afto-zymo" (self-fermented) and the prefix "efta" is a phonetic variation of "afto" over the years.

Eftazymo was made mainly for special religious events such as at Easter, on the 15th of August-on the Assumption of Mary, and weddings. There is a ritual that is usually linked with this bread before a wedding ceremony: The bread is cut by a special knife into pieces and offered to the guests, referred to as "protopkastos", an idiom word of Kozani region, meaning something that is served for the first time at the beginning of a new life (Hatzikamari et al. 2007a, b). Eftazymo, usually made with wheat or barley flour but mixtures of wheat, rye and barley are used as well.

2 Traditional Preparation of Eftazymo Bread

Following testimonials and personal communication with old ladies from Voion area, in Kozani Regional Unit, the housewives started the preparation of Eftazymoon the previous day, in the early afternoon, in order to knead the bread the next morning. The process is literally a submerged fermentation of coarsely grounded chickpea seeds for 18 h, for the production of a chickpea-starter to be used as a leavening agent. Chickpeas, grounded with traditional bronze mortar and pestle, were soaked in boiling water in a clay pot and kept warm (~40 °C) overnight, until a thick layer (3–4 cm) of froth was formed on the surface of the water and a distinctive aroma was released, both indicators of a successful fermentation. The mixture was fed with 1 cup of chickpea flour and 1 cup of hot water at some point (stage 1). The water used at this stage was a previously prepared infusion of dried basil or bay leaves with anise and black pepper which varied depending on the region of origin of the recipe and the spices and seasonings available locally. The process continued the next morning, where the frothy liquid (following draining if needed to remove coarse material) was mixed with common wheat flour and warm water to the consistency of a porridge and left to ferment further for a couple of hours to double or triple its volume, on occasional stirring (stage 2). The next step was to mix the sourdough of stage 2 with flour and produce the final bread dough (stage 3). Women used to knead this to a soft dough with their hands, shaping it into bread loaves, then allowing them to rest in a warm place to rise (stage 4) and were then placed in the oven on an oiled pan for baking (stage 5). Usually, this bread was topped with black and white sesame seeds before baking in traditional wood fired ovens (Fig. 7.1, photos kindly provided by the photographer Vassilis Drossos). This type of bread

Fig. 7.1 The traditional process of molding the dough into spiral loaves (**a**) and baking in wood fired oven (**b**). (Photographer: Vassilis Drossos)

kept its freshness for longer time, a great advantage in those times where the bread was homemade and prepared usually once or twice a week. The chickpea fermentation liquid needed to be used freshly made every time.

This initiation of the chickpea starter culture was traditionally prepared in a clay pot because it has the advantage of low heat transfer coefficient, thus maintaining the desired temperature for long. The clay pot was usually nestled under blankets near the fireplace especially during cold winter nights. There are many superstitions about Eftazymo bread. People believed that the process is prone to the 'evil eye' (bad luck) and thus, when the house ladies were preparing Eftazymo, they had to be alone without telling anyone what they were up to in order not to get jinxed. There were many times that the chickpea starter culture was not successful; therefore, they had to blame the 'evil eye'. However, in the case of a successful process the battery dough of stage 2 was proudly shared with neighboring households to be further processed into Eftazymo by them. Eftazymo was elsewhere called the "devil bread", since the dough was leavened without "divine intervention" as opposed to another traditional sourdough that was made with the Holy water or the basil leaves that the priest handed to women on 14th of September after the liturgy of the Exaltation of Holy Cross (Psilaki and Psilakis 2001). Both basil and bay leaves are symbolic and part of the orthodox ritual and this may explain their incorporation in the recipe apart from functional or sensorial reasons. Another verbal ritual states that house ladies had to bath on the day they were kneading, before starting the process. Nowadays, the above superstitions have faded away.

Two typical traditional recipes are reported in Table 7.1. The first is of the Crete Island (Psilaki and Psilakis 2001), that is also widespread in other regions of Greece where Eftazymo is traditionally made, with small local variations, mainly in the seasonings used. The second one, is from Northern Greece and differs in the first stage of starter preparation (Voutsina 2002). More specific, raw and roasted chickpeas are used not soaked in water, but in a batter made of wheat flour which was then left to ferment till foamy. As also referred previously, it is common practice in Crete to make Eftazyma rusks. For making the rusks, the final dough is shaped in oval loaf, cut with a sharp knife in slices 2 cm thick, and baked t for half the time needed, then separated individually laid on an oven pan till fully baked until dry.

Table 7.1 Two traditional recipes of Eftazymo bread originated in different areas of Greece

Recipe 1: Eftazymo bread, Cretan Island and other regions in Greece (home recipe)	Recipe 2: Eftazymo bread, northern Greece (bulk recipe)
Ingredients:	*Ingredients*:
1 cup ground dried chickpeas	5 kg of durum wheat flour
2 cups water (not chlorinated)	150 g coarsely chopped raw chickpeas
Seasonings (4 bay leaves, ½ teaspoon black pepper kernels and anise, in Crete, dried basil in Western and Northern Greece)	150 g coarsely chopped roasted chickpeas
1.5 teaspoons fine salt	1/4 glass of ouzo (spirit flavored with anise)
2 tablespoons olive oil	1 teaspoon of salt
White and black sesame seeds	A sprig of dried basil
3.5 cups of bread wheat flour	
Chickpea starter preparation:	*Chickpea starter preparation*:
Bring to boil 2 cups of water with the seasonings. Discard the seasonings, mix one cup of the infusion with the ground chickpeas in a clay pot and then allow it to rest in a warm place for 12–16 h until a thick froth is formed on the top. This frothy liquid is called *kounenos* (Crete), or *revithomaya* (elsewhere in Greece)	Place 500 g of wheat flour in a clay pot and mix with hot water to form a smooth batter. Add the coarsely chopped chickpeas (raw and roasted), the ouzo, the salt and the basil. The mixture is stirred and allowed to rest in a warm place until foamy (~4 h)
Sourdough:	*Sourdough*:
Add 1 1/2 cups of bread wheat flour into the mixture (after removal of coarsely grounded dried chickpeas), and let it rise in a warm place until it triples its volume (2–4 h)	In another bowl add 1 kg of wheat flour with 2 teaspoons of salt and then pour the foamy chickpea starter, drained from the coarse particles. Mix and gradually add some warm water to obtain a battery dough. Cover it and allow to rise further
Final dough:	*Final dough*:
In the previous sourdough, add the rest of the scented water, 2 cups of bread wheat flour, the olive oil and salt and knead until a soft dough is formed	Transfer the previously prepared mixture in a large bowl and add 3.5 kg of flour, 7 teaspoons of salt and knead to an elastic and soft dough by adjusting the amount of warm water added
Molding:	*Molding*:
Mold the dough to a long string and form a spiral like a snail. Brush the surface with water and sprinkle the sesame seeds. Let it rise in a warm place until almost doubled in volume (2–3 h)	The dough is shaped into loaves and left to rise again
Baking:	*Baking*:
Bake in a wood fired oven, well burnt for about 1 h	Bake in a wood fired oven, well burnt, for about 1 h

3 Chickpeas as a Raw Material for the Starter Culture

The cultivated chickpea, (*Cicer arietinum* L.) is a legume crop that originated in the Middle East but is generally cultivated in many countries with a temperate climate, mainly for its seeds that are rich in protein and essential amino acids as well as fiber

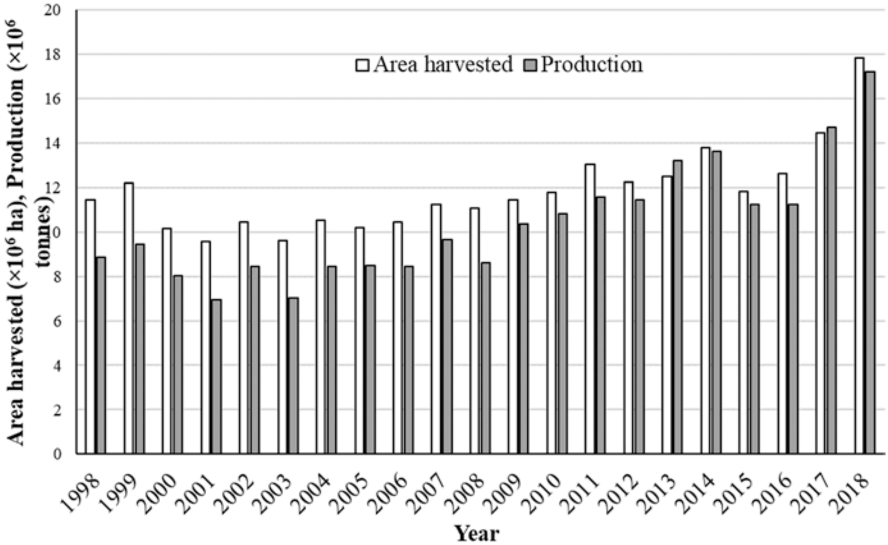

Fig. 7.2 World area harvested ($\times 10^6$ ha) and production ($\times 10^6$ tones) of chickpeas during period 1998–2018 (FAOSTAT 2020)

content. According to FAO (FAOSTAT 2020), there is observed a continuous increase in the cultivation area and the production of chickpeas during the last 20 years (Fig. 7.2).

There are 2 main types of chickpeas one of Mediterranean and Middle Eastern origin (Kabuli) and the other of Indian origin (Desi) differing in the morphological characteristics of the seeds. Kabuli type chickpeas are characterized by the large seeds of creamy light color whereas the Desi type seeds are smaller in size with a darker color. In a study there were reported values of Kabuli chickpea seed mean weight of 26 g/100 seeds and of Desi type 21 g/100 seeds (Khan et al. 1995). Global market is more attracted to Kabuli type of chickpea, with European, North American, South African and the Middle East showing a high need for this commodity (Varshney et al. 2013).

As a food legume, chickpea seeds' chemical composition is primarily made of two major components carbohydrates and protein with variable chemical composition depending on the chickpea type. In addition, the cultivation conditions of the seeds also influence their chemical composition. The reported values in the literature for the composition of the seeds are really variable (Table 7.2). The moisture reported for chickpea seeds varies from 5.9 to 10.6% in different studies (de Almeida Costa et al. 2006; Huang et al. 2007; Sotelo et al. 1987; Xu et al. 2014). According to Khan et al. (1995), the mean values for protein, fat, carbohydrate, crude fiber and ash in Desiare25.4, 3.7, 47.4, 11.2, 3.2 g/100 g and for Kabuli 24.4, 5.1, 55.8, 3.9, 2.8 g/100 g. Carbohydrates represent the main chemical class of chickpeas comprising 55.8% and 47.4% of the seeds in Kabuli and Desi, respectively (Khan et al. 1995). Moreover, the amount of crude fiber reported is higher in Desi (11.2%) than

Table 7.2 Values reported in the literature for the chickpea chemical composition

	Composition	Literature
Moisture (%)	5.9–7.5	Sotelo et al. (1987)
	7.79	de Almeida Costa et al. (2006)
	10.6	Huang et al. (2007)
	6.47–7.38	Xu et al. (2014)
Ash (%)	2.8–3.4	Sotelo et al. (1987)
	2.67–3.40	Xu et al. (2014)
	3.24–3.28	Wang et al. (2010)
	3.15	de Almeida Costa et al. (2006)
	3.4	Han and Baik (2008)
Fat (%)	3.0–6.6	Sotelo et al. (1987)
	6.25–6.45	Xu et al. (2014)
	5.8	Huang et al. (2007)
	6.69	de Almeida Costa et al. (2006)
	1.6–7.8	Sreerama et al. (2010)
	4.64–5.68	Wang et al. (2010)
	6.1	Han and Baik (2008)
Proteins (%)	16.9–20.7	Sotelo et al. (1987)
	21.9–26.8	Xu et al. (2014)
	21.27–22.94	Wang et al. (2010)
	14.5–26.9	Torutaeva et al. (2014)
	23.0	Huang et al. (2007)
	18.5	de Almeida Costa et al. (2006)
	20.5	Han and Baik (2008)
	20.9–25.27	Dhawan et al. (1991)
Carbohydrates (%)	63.6–68.9	Xu et al. (2014)
Fiber (%)	2.62–4.01	Xu et al. (2014)
	3.9–11.2	Khan et al. (1995)
	9.88	de Almeida Costa et al. (2006)
	15.38–24.56	Wang et al. (2010)
	2.6–9.1	Sotelo et al. (1987)
Starch (%)	34.9–42.9	Xu et al. (2014)
	38.23–45.13	Wang et al. (2010)
	50.4	Huang et al. (2007)
	48.6	Han and Baik (2008)

in Kabul (3.9%) (Khan et al. 1995). Great differences reported for fibers in Table 7.2 are also depended on the method used in these studies. Wang et al. (2010) reported that the amount of total dietary fiber is 24.56% and 15.38% in Desi and Kabuli chickpea samples, respectively. Moreover, they reported that soluble fibers represent 5.6% of Desi total dietary fiber content and 8% of Kabuli.

Proteins represent the second most abundant component of chickpea being slightly higher in Desi type (25.4%) than in Kabuli (24.4%). Fat and ash represent minor components with 5.1% and 2.8% of the seeds in Kabuli type and 3.7% and

3.2% in Desi type of chickpea (Khan et al. 1995). In an early study, the Mexican varieties of raw chickpeas did not vary much in chemical composition (Sotelo et al. 1987). Based on Table 7.2 this is true for moisture, ash and fat content but not for protein, fiber and starch where there is observed a high variation in the reported data.

Legumes contain a range of valuable macro and micronutrients such as low digestible carbohydrates, essential amino acids, fatty acids, as well as a high amount of micronutrients i.e., bioactive compounds and minerals. Starch is the main component of carbohydrates in chickpea seeds and plays an important role in the physicochemical properties of respective foods. The amount of starch vary depending on the type and variety but the Kabuli type shows a higher amount compared to the Desi type (Wang et al. 2010). The slow hydrolysis and resistance to digestion that this legume exhibits is mainly due to the starch structural and molecular characteristics. The chickpea starch granules are made of small and large granules with sizes ranging between 9 and 70 μm (Zhang et al. 2016). The shape of starch granules in chickpea seeds is reported in the literature from lenticular shape (Milán-Noris et al. 2017; Yniestra Marure et al. 2019) to ovoid and globular irregular (Demirkesen-Bicak et al. 2018) or elongated and spherical (Zhang et al. 2016) possibly due to environmental factors. Chickpea starch internal structure has a typical C-type pattern typical of legumes with high content of resistant starch (Yniestra Marure et al. 2019). According to Yniestra Marure et al. (2019), the molecular weight of chickpea starch varies depending on the variety between $2–3 \times 10^5$ g/mol for amylose and $1–3 \times 10^8$ g/mol for amylopectin. It was reported that it has higher amylose content with values varying in different studiesfrom27.2% (Huang et al. 2007), 32.61% (Zhang et al. 2019), 35.9–41% (Yniestra Marure et al. 2019) to 46.5% (Yañez-Farias et al. 1997). The peak gelatinization temperature that depends on the structure and physicochemical characteristics of chickpea starch is high, approximately at 68–69 °C, a factor that affects the cooking process (Yniestra Marure et al. 2019). According to Chung et al. (2008) factors such as gelatinization temperature, gelatinization enthalpy, relative crystallinity, and chain length distribution of amylopectin affect the digestibility of the legume starch. Part of the starch is reported as resistant starch thus resisting digestion and functioning as fiber. Resistant starch represents 0.87 and 2.19% of the total starch in Kabuli and Desi type, respectively (Wang et al. 2010). In their study, de Almeida Costa et al. (2006) reported a much higher value (3.39%). Cooking was reported to increase resistant starch content in chickpeas possibly due to the retrogradation of starch after gelatinization (Wang et al. 2010).

According to Dhawan et al. (1991), the protein content of chickpea is made mostly of globulin (53.44–60.29%) followed by glutelin (19.38–24.40%), albumin (8.39–12.31%) and prolamin (3.12–6.89%). The globulin in chickpea, consists of the 11S (legumin-like globulin) and 7S (vicilin-like globulin) (Freitas et al. 2000). According to them, the vicilin-like globulin is made of a great number of polypeptides with no disulphide bonds with molecular weight varying from 10 to 70 kDa, whereas the legumin-like globulin consists of a fewer number of polypeptides but with the widespread presence of disulphide bonds. Legumin-like globulin proteins could be further discriminated based in their molecular mass to light (20–25 kDa) and heavy group (35–50 kDa).

Chickpea is also a rich source of essential amino acids. In general, protein quality evaluation is based on the concept of amino acid score that reflects the biological value of proteins based on the content of their limiting amino acids. The profile of amino acids is considered to be complementary to those of cereals and thus recommended to obtain a well-balanced plant-based diet (Friedman 1996; Young and Pellett 1994). In their study Young and Pellett (1994) reported 19% protein, a 100 limiting amino acid (LAA) score and a 115 Lysine score. The legumin-like fraction is superior in terms of total essential amino acids and biological value the vicilin-like fraction (Singh et al. 1988).

According to Padhi et al. (2017) the oil contained in chickpea fat samples was made mostly of unsaturated fatty acids, composed primarily of polyunsaturated fatty acids (PUFA, 61.54–63.73%) and monounsaturated fatty acids (MUFA, 21.24–23.29%), whereas the saturated fatty acid (SFA) content ranged from 14.37 to 15.01% being favorable from a cardio-protective perspective. In their study, Ryan et al. (2007), reported similar value for SFA (13.7%), a higher value for MUFA (34.2%) and lower for PUFA (52.1%) in a chickpea sample.

Beside of being a rich source of proteins for humans, especially in vegetarian diets, chickpea represents a significant source of minerals. In general, the legumes are rich in minerals but their accessibility is hindered by the presence of the so-called antinutrients such as phytic acid that creates complexes with metal ions (Urbano et al. 2000). The availability of minerals in chickpea is higher due to the low phytic acid concentration and the presence of considerable amounts of carotenoids which are reported to increase mineral absorption in humans (Thavarajah and Thavarajah 2012). Chickpea is a good source of calcium, zinc, magnesium, potassium, iron, copper and phosphorus (Table 7.3). It was reported that the main macro and microelements present in chickpea vary widely among varieties (Dragičević et al. 2018). Besides the elements reported in Table 7.3, chickpea can be considered a source of dietary Se. In their study, Thavarajah and Thavarajah (2012) reported values in the range of 15.3–56.3 μg/100 g noticing that these amounts are depended on the growing location and the available in soil Se.

Chickpeas are a source of bioactive compounds such as carotenoids, tocopherols and polyphenols, which are recognized to provide health benefits through their antioxidant activity (Table 7.4). Padhi et al. (2017) observed that the concentration of tocopherols varies among the cultivars without discriminating Kabuli and Desi type chickpea. Moreover, they observed that the most abundant isomer was γ-tocopherol with values varying from 125.97 to 141.75 μg/g dry matter, followed by α-tocopherol (3.19 ± 21.57 μg/g dry matter) and δ-tocopherol (7.06 ± 12.63%). Additionally, chickpea contains appreciable amounts of other phytosterols such as β-sitosterol, campesterol, and stigmasterol showing values of 159.8 ± 7.1, 21.4 ± 0.7, and 23.4 ± 0.7 mg/100 g, respectively (Ryan et al. 2007).

In their study, Padhi et al. (2017) determined the amount of carotenoids present in the chickpeas. They reported that values ranged from 35.13–58.18 μg/g dry matter in the samples that they examined, with lutein being the main component (8.23–17.35 μg/g dry matter), followed by zeaxanthin (1.38–2.06 μg/g dry matter). These values are higher than those reported from Ashokkumar et al. (2015)

Table 7.3 Micro and macro elements composition of chickpea as reported in the literature

	Composition	Literature
Ca (mg/g)	0.517–0737	Dragičević et al. (2018)
	1.309	Özcan et al. (2013)
	1.18–1.84	Torutaeva et al. (2014)
	0.94–1.97	Thavarajah and Thavarajah (2012)
	0.817–1.650	Wang et al. (2010)
	0.984–1.620	Tirdiľová et al. (2020)
S (mg/g)	1.809	Özcan et al. (2013)
	2.07–2.91	Torutaeva et al. (2014)
K (mg/g)	10.440	Özcan et al. (2013)
	8.000–13.270	Torutaeva et al. (2014)
	9.945–10.600	Wang et al. (2010)
	7.32–11.26	Thavarajah and Thavarajah (2012)
	6.988–7.616	Tirdiľová et al. (2020)
P (mg/g)	2.810	Özcan et al. (2013)
	2.39–5.35	Torutaeva et al. (2014)
	26–37	Thavarajah and Thavarajah (2012)
	3.940–4.515	Wang et al. (2010)
	1.770–2.675	Tirdiľová et al. (2020)
Mg (mg/g)	0.451–0.603	Dragičević et al. (2018)
	1.18–1.72	Torutaeva et al. (2014)
	1.470–1.690	Wang et al. (2010)
	0.969–1.299	Tirdiľová et al. (2020)
Na (mg/g)	0.398	Özcan et al. (2013)
	0.010–0.095	Tirdiľová et al. (2020)
Fe (mg/g)	0.015–0.0531	Dragičević et al. (2018)
	0.046–0.067	Thavarajah and Thavarajah (2012)
	0.150	Özcan et al. (2013)
	0.041–0.121	Torutaeva et al. (2014)
	0.046–0.055	Wang et al. (2010)
	0.034–0.050	Tirdiľová et al. (2020)
Mn (mg/g)	0.010–0.022	Dragičević et al. (2018)
	0.001–0.037	Torutaeva et al. (2014)
	0.033–0.038	Wang et al. (2010)
	0.026–0.038	Tirdiľová et al. (2020)
Zn (mg/g)	0.015–0.053	Dragičević et al. (2018)
	0.034–0.069	Torutaeva et al. (2014)
	0.034–0.041	Wang et al. (2010)
	0.020–0.024	Tirdiľová et al. (2020)
Cu (mg/g)	0.046–0.117	Torutaeva et al. (2014)
	0.0066–0.0106	Thavarajah and Thavarajah (2012)
	0.0036–0.0041	Wang et al. (2010)
	0.007–0.010	Tirdiľová et al. (2020)

Table 7.4 Bioactive components and antioxidant activity of chickpea extracts from different varieties reported in the literature

		Levels	Literature
Bioactive components	TCC (μg/g)	35.13–58.18[a]	Padhi et al. (2017)
		9.2–31.3[b]	Ashokkumar et al. (2015)
		18.48–51.86[b]	Thavarajah and Thavarajah (2012)
	TTP (μg/g)	150.29–170.51[a]	Padhi et al. (2017)
	TPC (mg GAE/g)	0.436–0.972[c]	Tirdiľová et al. (2020)
		0.818–0.941[d]	Parikh and Patel (2018)
		1.47–2.87[a]	Padhi et al. (2017)
		2.2[d]	Han and Baik (2008)
		0.5–6.8[e] (mg CAE/g)	Segev et al. (2010)
	TFC	0.236–0.385[d] (mg RE/g)	Parikh and Patel (2018)
		0.10–1.08[e] (mg CAE/g)	Segev et al. (2010)
Antioxidant activity	DPPH (mg TE/g)	9.461–23.027[c]	Tirdiľová et al. (2020)
		0.576–0.829[d]	Parikh and Patel (2018)
		~5.5–8.5[a]	Padhi et al. (2017)
	ABTS (mg TE/g)	0.049–0.205[d]	Parikh and Patel (2018)
		0.375[d]	Han and Baik (2008)
	FRAP	2.211–3.118[d] (mg TE/g)	Parikh and Patel (2018)
		~0.440–2.200[a] (mg AAE/g)	Padhi et al. (2017)
		0.200–7.784[e] (mg TE/g)	Segev et al. (2010)
	ORAC (mg TE/g)	~5.000–12.260[a]	Padhi et al. (2017)

TCC total carotenoid content, *TTP* total tocopherols, *GAE* gallic acid equivalent, *CAE* catechin equivalent, *RE* rutin equivalent, *TE* trolox equivalent, *AAE* ascorbic acid equivalent
[a]Samples were cooked by boiling, extraction 70% MeOH, 0.1% HCl, (v/v)
[b]Samples were in raw form
[c]Samples were dried at 105 °C, 80% MeOH
[d]Samples were in raw form, 80% MeOH
[e]Samples were extracted with 50% acetone

(9.2–31.3 μg/g dry matter) in 121 genetically diverse of Desi (9.8–31.3) and Kabuli (9.2–23.1) chickpea accessions. Both studies agreed that Desi type chickpea showed higher carotenoid content than the Kabuli type. The lutein value in the 121 chickpea samples was 8.2 ± 2.37 μg/g dry matter being lower than the values reported from Padhi et al. (2017), whereas the zeaxanthin (6.2 ± 2.02 μg/g dry matter) values were higher. The β-carotene β-cryptoxanthin and violaxanthin values reported were 0.5 ± 0.31, 0.1 ± 0.03 and 0.1 ± 0.15 μg/g dry matter, respectively (Ashokkumar et al. 2015). In their study, Thavarajah and Thavarajah (2012) reported the presence of xanthophyll (90–197 μg/g), canthoxanthine (219–679 μg/g), and beta-carotene (1.88–4.31 μg/g) in the examined chickpea genotypes.

The value ranges for TPC (Total Phenolic Content) (expressed as GAE/g dry matter or mg CAE/g dry matter) in chickpea in the literature vary (Table 7.4). Not only the variety but and the processing as well as the extraction method affect these values. In their study, Parikh and Patel (2018) reported that TPC values of raw chickpea vary from 0.818 to 0.941 mg GAE/g dry matter whereas Han and Baik (2008) reported a much higher value of 2.2 mg GAE/g dry matter although the extraction procedure was similar. The determined values of TCP were in the range of 0.436–0.972 mg GAE/g dry matter for seven chickpea varieties (Tirdiľová et al. 2020). These samples were dried at 105 °C before grinding and then measured. Variety is responsible for the high variation in the values of phenolics and antioxidant activity. Segev et al. (2010) reported that TPC and antioxidant activities in various pigmented chickpeas were 13 to 30-fold higher than cream-colored varieties and that the bioactives are mainly located in the seed coat (more than 95% of the total). Although according to Han and Baik (2008), cooking decreased the TPC of the chickpeas, the Desi variety still showed significantly higher TPC and antioxidant activity compared to Kabuli variety (Padhi et al. 2017). Zhao et al. (2021) reported that the specie with an intense black coat color showed the highest values of total phenolic, anthocyanin and flavonoid contents among the 6 chickpea species studied.

According to Fratianni et al. (2014), the profile of phenolics revealed that catechin (147.49–178.21 μg/g), ferulic acid (5.03–8.37 μg/g), chlorogenic acid (4.2–7.37 μg/g) and gallic acid (5.42–6.20 μg/g) are the main phenolic compounds in the chickpea. On the other hand, Thavarajah and Thavarajah (2012) reported higher levels of gallic acid (32 μg/g), chlorogenic acid (1751 μg/g) and ferulic acid (1063 μg/g) but lower levels of catechin (16 μg/g). Moreover, they detected in their samples the presence of very high levels of quercetin (1679 μg/g) as well other phenolics such as hydroxyl benzoic acid (44 μg/g) and caffeic acid (23 μg/g).

Beside the health-protective effects of phenolic acids, carotenoids, and flavonoids, these compounds are recognized for their antioxidant potential (Table 7.4). Antioxidant capacity of chickpea was measured with different assays (ABTS (2,2-azinobis (3-ethylbenzothiazoline-6-sulphonic acid) diammonium salt) radical cation (ABTS·+)-scavenging activity, DPPH (2,2-diphenyl-1-picrylhydrazyl) radical radical-scavenging activity assay, ferric reducing antioxidant power (FRAP) assay, oxygen radical absorption capacity (ORAC) varies among the studies. It was observed that processing of seeds such as dry heating, not only reduced the phenolics concentration but also resulted in a decrease of antioxidant activity (Nithiyanantham et al. 2012). On the other hand, germination significantly increased TPC and antioxidant activity in chickpea (Gharachorloo et al. 2013).

Besides the amount of nutrients present in chickpea, there are reported the presence of so named antinutrients. Phytic acid present in chickpea varies depending on the variety and the study. Thavarajah and Thavarajah (2012) reported values from 5.8 to 13.6 mg/g whereas Wang et al. (2010) showed values from 9.6 to 0.6 mg/g. The amount of phytic acid varies according to the different milling fractions (such as dehulled cotyledons, embryonic axe, and seed coat fractions) of chickpea seeds. Sreerama et al. (2010) reported 9.82 mg/g phytic acid in the cotyledon fraction, 3.43 mg/g in the embryonic axes, and 0.79 mg/g in the seed coat. Presence of phytic acid was linked with the lowering of minerals bioavailability (Urbano et al. 2000). Iron bioavailability in humans is reduced if molar ratios of phytic acid to Fe are above 10 (Engle-Stone et al. 2005). Thavarajah and Thavarajah (2012) reported that this ratio varies depending on variety from 8 to 20. Tannins are polyphenols are also considered as antinutrients because of the adverse effect that have on proteins digestibility, due to complex formation. The amount of tannins reported for chickpeas Desi and Kabuli type are 0.21 and 0.04 mg/g, respectively (Wang et al. 2010).

Other compounds, namely of raffinose family oligosaccharides known and as α-galactooligosaccharides (raffinose, stachyose and verbascose) present in chickpea are considered responsible for unwanted gastrointestinal symptoms. Values of Raffinose 5.2 and 7.2 mg/g, Stachyose 16.7 and 21.3 mg/g and Verbascose 0.04 and 0.26 mg/g are reported for Desi and Kabuli type, respectively (Wang et al. 2010). In another study, the values reported vary from 1.22 to 1.87 mmol/100 g for raffinose, from 1.88 to 2.83 mmol/100 g stachyose, and from 0.06 to 0.14 mmol/100 g for verbascose (Gangola et al. 2014). According to Xiaoli et al. (2008), factors such as genotype and environment affect their content. In addition to raffinose, stachyose and verbascose they reported the presence of another glycoside identified as ciceritol, representing about 50% of the total α-galactooligosaccharides. Human gut lacks the α-galactosidase enzyme that is responsible for the hydrolyzation of these compounds, making possible their passage in the large intestine in their intact form. Intestinal microbiota uses them as a substrate producing gaseous substances (CO_2, H_2, NH_3) that are linked with flatulence, diarrhea, and stomach discomfort.

Moreover, in legume proteins there are naturally occurring low molecular weight proteins that have the ability to inactivate the digestive enzyme trypsin resulting in protein digestion impediment (Márquez and Alonso 1999). According to Wang et al. (2010), trypsin inhibitor activity values in Desi and Kabuli type are 8.29 and 6.41 mg/g, respectively. In general, soaking and cooking of chickpea seeds were reported to decrease the content of antinutrients present (Thavarajah and Thavarajah 2012; Wang et al. 2010).

4 Microbiological Changes During Fermentation of the Chickpea

Cereals and legumes are naturally contaminated with microflora, first during seed formation in the field and second during storage. These microorganisms can be easily multiplied under favorable conditions when soaked in water. According to Livingstone et al. (1992), the total bacterial count of chickpea is higher than that of wheat. The total count populations they found in chickpea was 21 times more than that found in wheat (11×10^5 and 52×10^3 cfu/gof dry material, respectively). Moreover, the same authors observed that chickpea seeds are more contaminated with bacteria than yeast compared to wheat. The count for yeasts and molds reported for raw wheat was 0.9×10^2 cfu/g, whereas for chickpea 0.3×10^2 cfu/g of dry material. Among the bacteria that were observed in chickpea seeds, *Staphylococci* (3×10^5 cfu/gof dry material) are found in the highest number followed by coliforms (77×10^3 cfu/g of dry material), while in wheat, these bacteria load was 73×10^2 and 2.7×10^3 cfu/g, of the dry material, respectively. Other bacteria they found in the seeds were *Streptococci* in counts 52×10^2 and 13×10^2 cfu/g of dry material and *E. coli* 14×10^3 and 2.2×10^3 cfu/g of dry material, in chickpea and wheat, respectively.

A few studies have been conducted concerning the microflora found in chickpeas on natural fermentation. In their study, Hatzikamari et al. (2007b) followed the two-step sourdough preparation process for the production of Eftazymo bread that simulated the typical traditional method in order to investigate the microorganisms present and developed from the chickpeas during fermentation. In the first step, coarsely ground chickpea seeds were soaked with boiling water (2:10 w/v) and the mixture was allowed to ferment for 16–18 h at 37 °C, until a thick frothy head was observed. During the second step, the fermented liquid, without removal of the coarse seeds, was mixed with wheat flour and left further at 37 °C for about 2 h until the volume was doubled (Fig. 7.3).

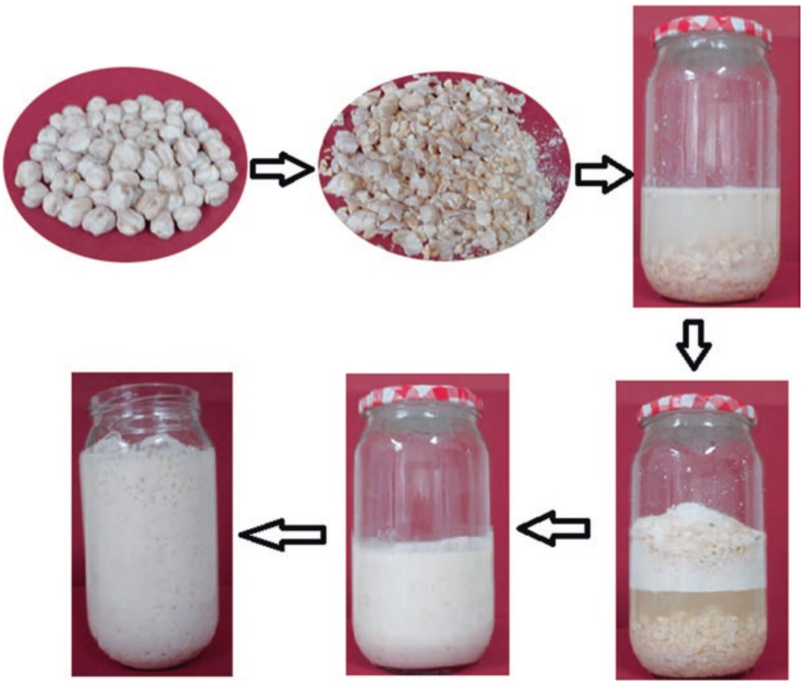

Fig. 7.3 Two-step sourdough preparation from grounded chickpea for laboratory production of Eftazymo bread. In the first step, coarsely ground chickpeas are soaked in hot water and allowed to ferment at 37 °C for 16–18 h. In the second step wheat flour is added and the fermentation continues till the volume was doubled. (Adapted from Hatzikamari 2009)

Addition of boiling water on soaking reduces the number of indigenous microorganisms and permits the survival mostly of spore-formers. Furthermore, with the addition of boiling water, the dissolved oxygen in water escapes, rendering a favorable environment to the anaerobes. Initially, low counts of bacilli are observed and almost no clostridia are detected. As the fermentation proceeds, bacilli counts increase in a fast rate to reach 7.94 $\log_{10}$ cfu/mL after 16 h and then remains constant until the end of the fermentation (18 h). On the other hand, the increasing rate of clostridia was very low during the first 8 h of fermentation, but afterwards, the rate increased significantly reaching at the end of fermentation, 7.81 $\log_{10}$ cfu/mL counts. The rapid increase in the population of clostridia after 8 h of fermentation is obvious from the formation of gas bubbles resulting in a thick froth on the surface of the liquid at the end of fermentation. Furthermore, the fast growth of clostridia after 8 h was probably enhanced by the metabolic activity of the bacilli which due to their amylolytic activities released reducing sugars to serve as carbon source for the growth of clostridia while lowering the Eh (redox potential) of the liquid, thus making the environment more favorable for clostridium species (Hatzikamari et al. 2007a, b).

The microbial population was found to belong to the *B. cereus*, *B. thuringiensis*, *B. licheniformis*, *C. perfringens* and *C. beijerinckii*. Existing diversity in the final population of sourdough depends on the origin of the chickpeas. This was obvious from the study of microbial diversity of the sourdough prepared with chickpea seeds from five different areas of northern Greece that revealed additionally the presence of *C. sardiniense*as as well.

As *B. cereus* and *C. perfringens* are known pathogens, Hatzikamari et al. (2007b) tested the safety of the product. They reported that no spores of the studied bacilli and clostridia were present in the chickpea fermenting liquid, but only their vegetative forms existed. The baking temperature is high enough to kill all the vegetative cells, thus eliminating the risk to reach the human intestine. It is well known that vegetative cells of *C. perfringens* sporulate and release diarrheal toxins in the intestine. Concerning *B. cereus* spores excrete toxin during exponential phase in the intestine causing food poisoning. The same researchers verified that isolates belonging to the *B. cereus* and *C. perfringens* do not form toxins during the fermentation step as tested by injection of fermentation liquid in mice. Under the above considerations it was verified that the final product is safe, as it is also proved by the safe consumption of Eftazymo since the old times.

Zamora and Fields (1979), found *L. casei*, *L. leichmanii*, *L. plantarum*, *L. helveticus*. *P. pentosaceous* and *P. acidilactici* on natural fermentation of chickpeas carried out at 25 °C for 4 days, a temperature much lower than that in the proccess of Eftazymo, thus explaining the dominance of lactic acid bacteria. However, none of these species is able to produce gas, necessary for bread leavening. The influence of chickpea fermentation temperature in the development and dominance of indigenous bacterial species, is documented in the research of Katsaboxakis and Mallidis (1996) where they study the microflora developed in chickpeas soaked in warter, at three different temperatures, 32, 37 and 42 °C. They found that in the lower temperature (32 °C) *Bacillus*, *Lactobacillus*, *Corynebacterium*, *Micrococcus*, *Pediococcus* spp. dominated, reaching maximum counts about 9.0 $\log_{10}$ cfu/mL in the fermenting liquid after 25 h of fermentation, while in the higher temperatures (37 and 42 °C) clostridia thrive and increased rapidly, reaching their maximum population above 9.0 $\log_{10}$ cfu/mL in the fermenting liquid during the first 12 h, despite their very low initial counts (about 2.0 $\log_{10}$ cfu/mL). They concluded that clostridia were the only microflora species responsible for gas production and the typical fermentation for Eftazymo bread.

Kyyaly et al. (2017), conducted a chickpea fermentation for bread production in Syria, similar to Hatzikamari et al. (2007b) but at a higher temperature (42 °C instead of 37 °C). They found a similar trend in growing populations of bacilli and clostridia but they reached maximum counts earlier in time, due to the higher fermentation temperature used. Bacilli were assigned in *B. cereus* group and clostridia identified as *C. sartagoforme*. From the lactic acid bacteria group, only *Enterococcus feacium* was detected, but it was growing slowly in relatively low counts and did not seem to affect the fermentation. *C. sartagoforme* was the only species that produced gas and characteristic aroma.

The fact that *C. perfringens* drives the fermentation in fermented chickpea liquid for bread production, is demonstrated also in the study of Gunduz et al. (2020). They examined the microflora in fermented chickpea liquids obtained from three commercial bakeries in Turkey where 13 bacterial genera were detected. Although lactic acid bacteria by the four main genera (*Lactobacillus*, *Enterococcus*, *Leuconostoc* and *Weissella*) were detected, most of the isolates belonged to *Clostridium perfringens* species.

5 Biochemical Changes During Chickpea Fermentation

During the fermentation process, microorganisms present in the chickpea flour utilize the micro and macronutrients for their metabolism bring about changes in the chemical composition of the dough matrix.

Within the 18 h of traditional fermentation of chickpea, Hatzikamari et al. (2007a) observed a decrease of the pH value from 6.72 to 5.35. Katsaboxakis and Mallidis (1996) reported an initial pH of 6.3 while the final pH values, following fermentation at 32, 37 and 42 °C for 12 h and 30 h were 6.22, 5.61, 5.66, and 4.89, 4.66, and 4.60 respectively. In their study reporting the changes during chickpea fermentation. Hatzikamari et al. (2007a) reported values for the total titratable acidity of 0.34% (expressed in lactic acid), similarly to Katsaboxakis and Mallidis (1996) who measured an acidity of 0.32% lactic acid, at the same temperature (37 °C). Besides the lactic and acetic acids, in the study of Katsaboxakis and Mallidis (1996) it was reported the production of butyric acid as expected by the metabolism of clostridia. In addition to the bacteria species predominating in the fermented chickpea liquid, temperature also influences the profile of acids produced; high temperatures favor the production of butyric acid (due to clostridia dominance) whereas low temperatures, favor the production of lactic acid. In the same study they reported that increasing the temperature change the ratio of lactic acid: acetic acid: butyric acid content (w/v) in the soaking water of ground chickpea seeds (2.02:1:1.55, 0.38:1:1.65 and 0.28:1:2.56 for 32, 37 and 42 °C, respectively).

As fermentation proceeds, it is also observed a change in the content of starch and proteins due to the production of different enzymes (Hatzikamari et al. 2007a). Most of the bacteria isolates present in the chickpea sourdough for the production of Eftazymo were able to hydrolyze starch (Hatzikamari et al. 2007b). Starch is gradually solubilized during the first 6 h of fermentation, and as the number of bacilli increases substantially, the degradation expected from the amylolytic activity of *Bacillus* spp. isolates takes place, resulting in significant starch degradation not only from the solubilized form, but also from starch granules. The produced amylases showed maximum activity after 10 h of fermentation resulting in a concomitant increase in the content of reducing sugars from 0.09 to 2.73 mg of glucose/mL of the fermentation liquid. The further decrease of reducing sugars till the value of 1.46 mg of glucose/mL of the fermentation liquid at the end of fermentation (18 h) is due to their use as carbon source by clostridia, for acid and gas production thus contributing to the acidity increment and dough rising, respectively. At the end of fermentation, glucose, galactose and sucrose content was reduced by 100%, 26.2% and 35.4%, respectively.

The microorganisms involved in the fermentation produce proteases that were detected after 12 h of fermentation resulting in an increase in the amount of peptides and free amino acids. In specific, free amino acids was increased fivefolds (from 367.9 to 1821.4 mg of leucine/mL of fermentation liquid), due to the hydrolysis of the high molecular weight proteins (≥62 kDa) and the aminopeptidase activity of leucine amino peptidase, that was mainly detected in bacilli (Hatzikamari 2009).

Besides the starch and protein hydrolysis the bacteria isolates can degrade the lipid content of chickpeas, producing free fatty acids in the fermentation liquid. The amount of free fatty acids slowly increases (1.43–1.96 mL NaOH 0.1 N required to neutralize 10 mL fermentation liquid) during the first 8 h of incubation due to the low lipolytic activity of bacilli, but the increase is much higher (up to 8.07 mL NaOH 0.1 N) when the clostridia population was fully developed, resulting in high levels of production of lipid-degrading enzymes (Hatzikamari et al. 2007a).

During the fermentation of chickpea multiple compounds with antifungal activity against a broad spectrum of molds are produced. According to different authors, the antimicrobial activity of protein hydrolysates is a result of the synergistic action of different peptides (Rizzello et al. 2016; Schettino et al. 2020). Thus, factors such as microorganisms present, the native proteins and the degree of proteolysis affect the final antifungal potential. Although, until now there is not any study investigating the antifungal activity of protein hydrolysates by bacilli and clostridia, it is generally recognized that this type of bread is by far less susceptible to spoilage than the conventional wheat counterpart.

On the other hand, fermentation helps in the reduction of antinutritional factors present in chickpea as flatulence factors. A decrease by 52% in raffinose content was observed (Hatzikamari et al. 2007a). Other members of the raffinose oligosaccharides family such as ciceritol and stachyose were also degraded by 15.9%

and27.2%, respectively. The activity of α-galactosidase reached a maximum of ~13 units/mL of fermentation liquidafter 12 h of fermentation, the enzyme invertase ~5 units/mL of fermentation liquidafter 8 h and cellulases ~30 units/mL of fermentation liquidafter 10 h. It seems that during fermentation, α-galactosides are degraded rapidly by clostridia since only *C. perfringens* isolates demonstrated a-galactosidase, activity (Hatzikamari 2009).

6 Impact of Chickpea Sourdough on Bread Functional Characteristics and Nutritional Value

6.1 Effect on Technological Properties of Bread

It is well known among the producers and consumers in Greece that staling and mold growth is delayed in Eftazymo, in comparison to yeast leavened breads. Recently, the incorporation of naturally fermented chickpeas in wheat bread, in the presence or not of commercial yeast, has attracted the interest of many authors (Chakraborty and Shrivastava 2019; Ertop and Coşkun 2018; Ertop and Şeker 2018; Gül et al. 2018).

Gül et al. (2018) reported that incorporation of chickpea-based leavening filtrated liquid extract in wheat bread, in general, affected positively the bread characteristics. The loaf volume increased and the moisture reduced, but the color of the bread was darker and denser in red hue. The crumb was harder than that of the commercial control bread on the first day but was almost the same with the yeasted bread (control) after 2 days of storage. In terms of general appearance, texture, mouthfeel and purchasing intention the bread with chickpea sourdough scored better than the yeast leavened bread, but was less preferable in terms of aroma and taste. They suggested its production for consumers who want a different taste and flavor of their bread. Increased volume in bread was also observed by Kyyaly et al. (2017), when *C. sartagoforme*, isolated from natural chickpea fermentation, used as starter, compared to yeast leavened bread, although the leavening time was longer.

Ertop and Şeker (2018) optimized the amounts of chickpea sourdough and yeast aiming to improve the quality of the bread. They recommended the use of 59.06 g of chickpea sourdough and3.39 g instant active dry yeast (based on 300 g flour) in order to obtain a bread with improved volume, crust color and pore structure as well as a sour, sweet and soft character. Moreover, they reported that the bread with chickpea sourdough had a thicker bread crust that prevented moisture loss during storage.

The use of chickpea sourdough in bread fermentation was found to increase the antioxidant activity, mineral content, microbial shelf life of the final product (Ertop and Coşkun 2018). Longer self-life of wheat bread with the addition of fermented chickpeas was demonstrated also by Kefalas et al. (2009) and Tulbek et al. (2003).

In an attempt to use chickpea sourdough for wheat bread at an industrial scale, Ertop and Coşcun (2018) added dried chickpea natural fermented liquid, with some modifications. They mixed the fermented liquid with wheat flour, let it stand for 26 h until pH reached 4.5, then they spread it as thin layer on baking paper in oven shelves and dry it at 35 °C. Its incorporation in the presence of yeast, compared to solely yeasted bread, achieved increased loaf volume and crust thickness as well as more homogenous pore structure. In terms of functional properties, the antioxidant activity and mineral content were increased. They concluded that the incorporation of dried chickpea starter prolonged shelf-life by delaying starch degradation (staling) and mold growth in the bread.

6.2 Nutritional Value of Eftazymo Bread

In the last years, fortification of wheat bread with legumes and other seeds like pseudocereals, in order to enhance its nutritional value is a common practice (Bigne et al. 2021; Boukid et al. 2019; Bresciani and Marti 2019; Rizzello et al. 2014; Santos et al. 2020; Sayaslan and Şahin 2018). As these flours may negatively affect bread quality, the research was driven to their incorporation as fermented material (sourdoughs), to improve the sensory and technological characteristics of the final product (Rizzello et al. 2014).

Based on the well documented nutritional value of chickpeas (essential amino acids, mineral elements, dietary fibers, vitamins, polyunsaturated lipids, antioxidants etc.) as extensively presented above in this work, Eftazymo bread especially when the grounded seeds are not removed from the fermenting liquid, has improved nutritional characteristics compared to wheat bread.

Additionally, fermentation of chickpeas increases the digestibility of proteins with subsequent hydrolysis of high molecular weight proteins, and reduces a-galactosides, a major factor associated with flatulence.

7 Conclusions

Eftazymo bread is closely linked with the cultural, social and even religious aspects of various local communities in Greece. It represents a type of traditional Greek bread prepared by a submerged fermentation of coarsely ground chickpea seeds for 18 h, for the production of a chickpea-starter to be used as the only leavening agent for bread production, a practice followed since ancient times. Specific microbial microflora comprising bacilli and clostridia species develops, with *C. perfringens* being the main driver of the fermentation that brings about changes in the substrate. This results in a final product with a distinctive taste and aroma. Moreover, the content of raffinose family oligosaccharides is reduced, high molecular weight proteins are hydrolyzed, thus improving the digestibility and enhancing the nutritional features of the bread. Besides, the shelf-life of the bread is elongated in terms of delayed staling and mold growth.

It is clear that chickpeas represent a good source of micro and macronutrients. Due to the high nutritional value, the use of chickpeas in a bread recipe has been proposed to increase the nutritional and functional properties of final bread, since the old times. Furthermore, Eftazymo bread successfully meets contemporary consumer's demand for natural, nutritious and healthier products, without chemical additives, exhibiting special organoleptic character, alongside a traditional notion.

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Chapter 8
Hungarian History of Cereal Cultivation, Processing and Sourdough Making

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Abbrevations

AD	Anno Domini
BC	Before Christ
FAO	Food and Agriculture Organization

1 Introduction

In Hungary, cereals, especially wheat, and bread, have been central to people's daily lives for many centuries. It is not only a basic food source, a key product of agricultural cultivation and one of the most important raw materials in the processing industry, but also a part of our culture. The celebrations of the harvest and the new bread, the ceremony for slicing bread, are all based on centuries-old traditions and are still alive today. As a result of the experience gained over a long period of time, and later of conscious selection and breeding, the good quality of Hungarian wheat became known throughout Europe. In addition, Hungarian inventors to the world, such as the Mechwart-type roller mill from the 1870s, or the development of the

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Farinograph from the 1920s have resulted in many technological and methodological developments.

The making of Hungarian bread and other bakery products, apart from minor differences, developed similarly to that of the other nations. Due to the fact, that sourdough formation is time-consuming, the nomadic and conquering people did not make fermented cereal products, typically flat breads were made from flours produced by hand grinding. The settlement, the founding of the state and the development of peasant self-employed farms created relative permanence that facilitated the preparation of leavening, maturing, and the practice of producing sourdough products. For centuries, until the middle of the twentieth century, the making of sourdough breads and later cakes was almost dominant in the kitchens of peasant homes or later in the city flats. In addition, in parallel with the economic development and the growth of urban living, independent bakeries also played an increasingly important role in supplying the population. This process led to the emergence of the baking industry and in the twentieth century to the change in the technology of bread production. Our chapter attempts to present this historical process. History of cereals in Hungary– origin, development and breeding.

1.1 Wheat

1.1.1 History of the Spread of Wheat

Wheat (*Triticum aestivum* L.) started to spread to Europe from the Middle East and reached the Carpathian Basin in about 2000 years. Archaeological excavations uncovered wheat pollen residues in the sediment of Lake Balaton – the largest lake of Hungary –originating from as early as 4000 B.C. Traces of naked dwarf wheat, hulled einkorn, club wheat and spelt dating back to the Chalcolithic were also found. Archaeological finds of the Bronze Age and the Roman times show that rather developed agricultural techniques had already been applied for wheat cultivation, which mainly involved naked bread wheat and dwarf wheat. By the time of the Hungarian conquest wheat was already cultivated at the Western side of the Danube, in a quite large area.

It is most probable that ancient Hungarians carried *T. vulgare var indo-europaeum f. Rutenicum* – an ancient wheat type – from their homeland (i.e. the Volga-Kama-Ural region) with themselves and found the same type in the Carpathian Basin too (Rapaics 1934). Furthermore, they might have had already knowledge of emmer, spelt, dwarf wheat, barley and millet cultivation. The archaeological finds of the period of the Hungarian land-taking as well as of the Árpád Era demonstrate that Hungarians grew naked bread wheat and dwarf wheat. As for written records, a royal document issued by King Béla III already mentioned wheat (1190), and the documentation of the Hainburg Castle (twelfth century) even reported about the exportation of the wheat grown in Hungary. According to records made in Ottoman Hungary (1570), households produced an average of 3–11.6 tons of wheat. Written documents from the seventeenth century indicated that different methods of cultivation were applied in different regions of the country. For example, in the Northern region, wheat was sown together with rye. In Transylvania, however, less amount of barley and rye were grown; on the other hand, einkorn wheat was quite popular.

1.1.2 The Beginnings of Breeding

Even in the nineteenth century, breeding did not exist; instead, some kind of mass selection might have been applied. To make distinctions, different names were given to each produced population/landrace, although, at that time, there was a confusion even around the names of the species (Gaál 1978). The more widely known 'Bánát wheat' (Lehoczky 1881) and the 'Kunhegyes' varieties (Pethe 1805) were mentioned in the contemporary descriptions just like the landraces of Mernye, Dörgicse, Taszár, Gölle, Dobsza and Vedéc (Farkas 1841; Szentiványi 1943).

The second half of the century brought fundamental changes to the Hungarian wheat cultivation too. The drought of 1863 had a huge impact on Hungary's wheat production. Wheat was brought into the country from Poland to outweigh the enormous yield loss; as a result, in Eastern Hungary, the original landraces were replaced by wheat of Polish origin (Lelley-Rajháthy 1955). At the same time, other foreign spring wheat varieties also made their way to the country (e.g. Milanese, Neapolitan, Sicilian = Egyptian, Tunisian) (Süle 1967; Grábner 1935). As a result of the extreme, particularly drought-prone Hungarian climate, in a couple of decades, the foreign landraces underwent changes; thus, when planned wheat breeding was launched in Hungary, typical landraces prevailed already again throughout the country (Mokry 1875). The first successes in Hungarian wheat breeding were achieved by Sámuel Mokry and later by Kálmán Kenessey and László Wagner. After a rust epidemic with disastrous consequences in 1873, József Zichy, Minister of Agriculture ordered to carry out breeding activities at educational institutions. The rust-resistant American variety 'Viktória', the Australian 'Port Adelide' and the English variety 'Square Head' were introduced to the country at this time as well. The latter is said to have evolved into the landrace known as 'Somogy naked wheat'. Szilvay, who crossed the English 'Nursery' wheat variety with the 'Bánsági' landraces, carried out the first crossings. At the end of the '70s, at the Diószeg manor, mass selection was applied to produce the Diószeg wheat varieties from the landraces of Upper Hungary. Fibras using a French landrace that migrated to Upper Hungary from the Hungarian Great Plain carried out selection of 'Diószegi 2'.

Regarding the genetic background of the landraces cultivated in the second half of the nineteenth century, they can be considered as crossings of several varieties. By exploiting the intra-landrace genetic diversity, our first renowned breeders – Elemér Székács, László Baross, János Minarik and Ödön Legány – bred a whole line of new wheat cultivars (e.g. Bánkúti 5, Bánkúti 417, Eszterházi, Diószegi, Hatvani, Székács, etc.), using individual and strict pedigree selection. Breeding activities did not change the traits of the varieties produced by selection and marketed before 1925: essentially, they were offspring of 'common Hungarian wheat', 'Diószegi' wheat and 'Somogy naked wheat'. The most renowned of them, however, was 'Székács 1055', a cultivar bred by Elemér Székács, which gained state recognition due to its excellent quality and agronomic traits.

In Bánkút, László Baross and Sándor Zechmeister began to experiment with the pedigree cultivation of the Hungarian wheat varieties originating from the Tisza Region; in 1917, they started the automnization process of the Canadian spring wheat called 'Marquis'. Automnized and awned 'Marquis' was crossed with 'Bánkúti 5' produced by the pedigree cultivation of the Tisza Region-wheat. Strains of 'Bánkúti 1201', 'Bánkúti 1205' and 'Bánkúti 1014' were selected from the cross-breeding derivatives by individual selection. They gained state recognition in 1931 (Lelley and Rajháthy 1955). This marked the beginning of wheat hybridization. As a remarkable result, in 1933, 'Bánkúti 1201' was nominated for the title of "Best Wheat" at the World Wheat Fair in Regina, Canada, thanks to its 84.25 kg test weight, 17.23% dry gluten and 49.45% wet gluten content. The Bánkút cultivars survived their breeder and were leading wheat cultivars in Hungary for a quarter of a century. Even in 1960, 69% of the production areas were occupied by them. Their production ceased after 1970 with the spread of mechanical harvesting, however, breeders preserved them in their collections as gene sources. Even today, they are often used in wheat breeding processes with the aim of improving quality. At present, the Centre for Plant Diversity in Tápiószele stores the seeds of more than 300 landraces and bred cultivars of old Hungarian wheat varieties.

As for wheat yield, it can be stated that in the sixteenth century it was 2–4 times greater than the sown amount. In the seventeenth century, the difference increased to 2–6 times greater and in the nineteenth century to 3–8 times greater (Perjés 1963; Gaál 1978). In the Research Communications published in 1906, Kossutány reported on the quality tests of the wheat grown in Hungary between 1900 and 1905 (Kossutány 1907). According to this report, the quality of the main landraces (e.g. the ones from the Tisza, Bánság and Bánát Regions) varied quite widely, however, the good quality of the Tisza Region and Bánság wheats could be highlighted.

1.1.3 Old Hungarian Wheat Varieties and Their Importance

Selection for traditionally high-quality and adaptable varieties and using genetically heterogeneous populations as gene sources are important factors in the production and breeding of new genotypes. Taking several traits of the old Hungarian wheat varieties into account, they are similar to the landraces in terms of being population-like and heterogeneous. 'Bánkúti 1201', cultivated in the first half of the twentieth century, was popular in Hungary. Its varieties in the neighbouring countries (e.g. 'Austro Bankut' and 'Austro Kolben' in Austria) as well as in more distant regions (like the 'Eroica' cultivar in Sweden, which was produced using a 'Bánkúti' strain) served as valuable breeding materials (Bedő et al. 1995; Vida et al. 1998). The pedigrees of several currently cultivated varieties can be traced back to 'Bánkúti 1201' too. Typically, the old Hungarian varieties have tall plant height (above 100 cm in average), thin straw, good drought resistance and are susceptible to diseases.

Besides, common properties of them are high protein and gluten content as well as good stretch resistance of dough. Based on quality tests carried out at the Agricultural Research Institute in Martonvásár between 1972 and 1975, 'Bánkúti 1201' had the highest protein (16.8%) and wet gluten (47.4%) content in the average of 4 years. Due to its rheological properties, it was steadily classified as quality enhancing wheat (Pollhamer 1981).

1.1.4 Recent Goals – On the Quality of 'Bánkúti 1201'

In the '90s breeders started to examine the reasons behind the high baking quality of 'Bánkúti 1201' (Bedő et al. 1995; Vida et al. 1998). As a result, a new, high-molecular-weight gluten protein (HMW glutenin allele) was identified (Juhász et al. 2001). Additionally, overproduction of a high-molecular-weight gluten protein named 1Bx7 was discovered in some lines of 'Bánkúti 1201' (Juhász et al. 2003). The latter has been proven to have positive effect on the baking quality of the dough. 'Bánkúti 1201' lines show significant versatility in terms of starch content and the functional properties determined by them (Rakszegi et al. 2003; Bánfalvi et al. 2020). Based on the above, there is significant of information about 'Bánkúti 1201' strains that serves as a solid basis for determining new breeding goals. One of these goals was to transfer the overproduction of Bx7 HMW glutenin protein to an offspring with more favourable agronomic traits. As a result of a several-year-long selection process, during which breeders used modern tools of biochemistry and molecular biology, a new line harbouring the gene responsible for the overproduction of Bx7 protein could be identified. The result of the breeding process was a new cultivar named 'Mv-Karizma', which is characterized by high quality parameters and stronger dough. However, as a gene source, the old Hungarian cultivar 'Bánkúti 1201' can be used not only for quality enhancing purposes, but its components supporting healthy nutrition – e.g. its potential to enhance fibre content – may also provide new prospects for the breeders.

Currently, in Hungary, there are 157 state-recognised winter wheat and 4 spring wheat cultivars: Among them, 26 are patented by the Cereal Research Non-Profit Ltd. (Szeged) and 35 of them by the Centre for Agricultural Research (Martonvásár), which are the two main wheat breeding institutes of Hungary.

1.2 Rye

Rye (*Secale cereale* L.) was originally a grass weed of wheat and barley and spread from Southwest Asia to Europe through Russia, Poland, Germany and Hungary. As the Northern European climate was more favourable for its spreading, it became an endemic species there. In Europe, the Eastern region of the river Rhine came to be the second homeland of rye. In higher mountains, at higher latitudes and in loose soil, the percentage of rye increased permanently and succeeded wheat. However, in those areas where rye did not become so widespread, the morphological traits of weedy ryes show great variation.

Ancient rye was characterized by brittle rachis along its entire length. Supposedly, wild rye species, which occurred as weeds, crossed spontaneously with the varieties having brittle rachises, and the less brittle offspring of these crossings started to spread. Later, purposeful selection contributed to the maintenance of rye varieties with non-brittle rachises. This process can still be observed in Western Asia today.

In Hungary, rye became a cultivated plant in the Bronze Age. Two types of rye were known at that time: common rye and large-grain, "rich" rye. In the first half of the nineteenth century, rye cultivation was significant in Hungary: 700,000–720,000 t of rye was produced on areas reaching 600,000–700,000 ha. Today, 120,000 t of rye is produced on a 60,000 ha area, which represents 1.2% of domestic cereal production. Although, its yield potential doubled during this time, this species gained significance through the involvement of sandy soils in plant cultivation. The most important rye breeders of Hungary were Rudolf Fleischmann, Miklós Horn, Zsigmond Papp, Vilmos Teichmann, Ferenc Bauer and Mihály Vágó.

'Kriszta' and 'Perenne' perennial rye cultivars gained state recognition in Hungary in 1998 and 'Gergő' in 2009. (They were bred by the Centre for Agriculture of the University of Debrecen in Kisvárda; the Fleischmann Rudolf Agricultural Research Institute of the Eszterházy Károly University in Eger and Béla Farkas in Karcag, respectively).

1.3 Barley

Even today barley's (*Hordeum vulgare* L.) place of origin is disputed; presumably, it spread from Eastern Asia. Today's cultivated species have a simple, diploid genome, but its wild relatives may have two or even three times greater (diploid, hexaploid) genomes too. Barley is one of the oldest cereals in the Carpathian Basin: it has been present here permanently since 6000 B.C. Considering its spikes, it has two-row and multiple-row varieties, while based on the presence of hull, there are covered and naked varieties too. Due to its hull, barley became widespread mainly in animal nutrition, although its products mixed with spelt were already baked and consumed by the Sumerians and the Egyptians in 4000–5000 B.C. (Lelley 1980). Barley has been used mainly for brewing from the earliest times. Since 7000 B.C., Sumerians in Mesopotamia already had brewing manufactories. In Europe, brewing and breeding of malting barley spread together with Catholicism since these activities were the privileges of the monks living in the monasteries. Thanks to its short growing season and excellent adaptability, it grows even under the most extreme climatic conditions. Still, Europe can be regarded as its homeland since more then 60% of the world's total barley production (FAOSTAT) is produced in Europe. In Hungary, barley is the third most important cereal. Most of the winter type barley and 2/3 of spring type barley are used for animal nutrition, only a small portion is processed by the beer industry. Currently 32 cultivars of two-row spring barley have state recognition in Hungary. The Fleischmann Rudolf Agricultural Research Institute of the Eszterházy Károly University in Kompolt bred 9 of these cultivars. Regarding winter type barley, we have 20 two-row and 44 six-row cultivars. From these, 6 and 8 cultivars, respectively, were also bred by the above-mentioned institute. Apart from that, both the Research Institute of Karcag of the University of Debrecen and the Cereal Research Non-Profit Ltd. in Szeged have 4 registered cultivars.

1.4 Oats

Presumably, cultivated oats (*Avena sativa*) is a secondary crop that spread throughout the temperate zones as a weed of wheat and barley. The oldest evidence of oat cultivation was found in the current area of the Czech Republic (originating from the tenth century B.C.). After the Hungarian land-taking, Hungarians started to grow oats probably as a result of Slavic influence. We might assume that it has been grown already in significant amounts from the twelfth century (travel notes of a german priest Ansberg, 1189), as King Béla III sent ships and carriages laden with oats as a gift to the horses of Emperor Frederick I. Cultivated oat varieties (white, black and naked oats) appeared in the eighteenth century (Gáti 1795). It is likely that all later varieties – like ‘large-grain’, ‘fodder’, ‘tufted’, ‘Jerusalem’ and ‘bristly’ – were offspring of these three (Wellmann 1933) old varieties (Tsötönyi 1931). Cserháti (1901) classified the old Hungarian oat varieties into two groups, based on their origins. The domestic varieties – like ‘White Hungarian’, ‘Black Hungarian oat grass’ and ‘Tatár’ – were divided into the group of flaggy oats; the foreign varieties – like ‘Doppau’, ‘Siberian’, ‘Canadian’, ‘Probste’, ‘Hoptown’ or ‘Milton’ – were classified as panicled oats. Nowadays, it is the fifth most important fodder crop; however, it is becoming more and more widespread in human nutrition as a breakfast cereal too. In Hungary, the most favourable area for oat production is Western Transdanubia since these plants grow well under cooler climate and in acidic soil. Hungarians were pioneers of cultivating oats together with summer Fabaceae. Oat and vetch and oat and pea combinations were already well-known even between the wars; they were able to produce more than 40 t/ha crop yield and 500 kg/ha raw protein. Currently, in Hungary, in the categories of oats and red oats, winter oats and sand oats, there are 12, 7 and 2 registered varieties in the National List of Varieties, respectively. The Centre for Agricultural Research in Martonvásár bred 4 varieties in the first category and 5 in the second category. The Cereal Research Non-Profit Ltd. in Szeged bred 2 varieties in each of these categories.

1.5 Millet

The first records of millet (*Panicum miliaceum* L.) cultivation date back to the period of 7000–5000 B.C., to the Chinese Empire. The first European archaeological discoveries of millet originate from the period of 5000–3000 B.C., from Eastern and Central Europe. Millet is the oldest cereal species cultivated in the Carpathian Basin: it was grown sporadically already in the middle of the Neolithic and has been grown continuously since the Bronze Age (Füzes 1977). The archaeological finds of the period after the Hungarian conquest demonstrate that millet was an important cereal, and millet porridge served as essential food until the appearance of maize. Three main types of millet were known at that time: old-grain Cziczfark Millet from the Great Plain, small-grain Fuzzy Millet and Cane Millet with yellow and thin glumes (Nagyváthy 1791). In the thirteenth century, under the reign of István V, millet was the main subject of tithe. In the same period, semi-nomadic Cumans invaded Hungary and brought several usages and processing methods of millet with themselves. Millet was grown almost by all farmers in Lower Hungary and in the region of Međimurje. Some descriptions mention yellow, red and grey millet (Pethe 1805), while other descriptions specify white, yellow and black millet varieties (Tsötönyi 1931). Out of the 150 millet landraces preserved in the gene bank of Tápiószele, 100 landraces were morphologically characterized (Bányai 1972), one third of which were Hungarian varieties or landraces. The following landraces were found to have the best traits: brown-grain millet of Debrecen, red millet of Mezőhegyes, white millet of Bánkút, Császárréti 2, Fertődi 2D, Fertődi 6 and 24, white and red millet of Fertőd and Püski.

At the end of the nineteenth century, millet was already grown on a relatively huge area as a main crop; however, due to the fact that its yield was not competitive enough and that intensive farming became more and more widespread. In the twentieth century it was increasingly used only as a secondary crop to replace the plants that died off after the autumn sowing. Nowadays, thanks to good export opportunities, millet's production areas are between 9000 and 12,000 ha (Matuz et al. 2003).

In Hungary, 8 millet cultivars have been registered so far: 'Lovászpatonai pirosmagvú' (1936, Centre for Agricultural Sciences, University of Debrecen, Karcag), 'Fertődi 2' (1959, Cereal Research Non-Profit Ltd., Szeged), 'Maxi' and 'Gyöngyszem'(1991, Centre for Agricultural Sciences, University of Debrecen, Karcag and Nyíregyháza), 'Biserka' and 'Rumenka' (1998, Institute of Field and Vegetable Crops, Novi Sad, Serbia), 'GKT Piroska' (2000) and 'GK Alba' (2007, Cereal Research Non-Profit Ltd., Szeged).

1.6 Buckwheat

Buckwheat (*Fagopyrum esculentum*) was carried to Europe by the Mongolian and Turkish tribes in the fourteenth to fifteenth centuries. It originates from the region of the Himalayas. Buckwheat cultivation reached its peak in the seventeenth century, potatos gradually replaced it later. It is still an important secondary crop in Southern Europe. In Hungary, significant production areas are in the country's Western and Northern parts, where the climate is cooler and wetter. Buckwheat was mentioned in the literature for the first time in 1888 and in 1906 (Balás and Hensch 1888; Cserháti 1906), and buckwheat breeding in 1947 (Villax 1947). Thereafter, Soviet cultivars were grown for a long time until the first Hungarian cultivar – 'Hajnalka' – gained state recognition in 1991 (Agricultural Research Centre, University of Debrecen, Nyíregyháza). The German cultivar 'Rutina' and the French cultivar 'La Harpe' were acclimatized in 1994 and 1999, respectively. 'Oberon' cultivar gained state recognition in 2018 (Cereal Research Non-Profit Ltd., Szeged).

2 Excerpts from the History of the Hungarian Milling Industry

A particularly close connection, arising from history and living traditions, connects the Hungarians with cereals and its products, especially wheat and bread. As a result, from the settlemetnt of the Hungarian population to the present day, the cultivation and processing of grain and wheat, not only one of the pillars of our livelihood determining our economic development for centuries, but also a part of our culture.

It can be proved that our ancestors, during the conquest, already knew the grains and the basics of milling processes. It appears that during and after the conquest (ninth to tenth centuries A.D.), the seeds were ground with small and portable hand mills (Fig. 8.1a). Of course, wholemeal flours were made in this time, which was later supplemented by the simple fractionation of coarse bran with hand sieves. At that time, the fermentation and sourdough bread-making processes did not appear – at least provably – the consumption of flat breads and pies was presumably more typical. This simple milling process survived until the early twentieth century in smaller family farms (Fig. 8.1b) (Kovacs 2005). The modernized, hand or electronic kitchen versions of this mill have been still experiencing their "renaissance" in the households of some conscious consumers.

In the centuries following the conquest, in parallel with the settlement, the formation of village communities and the development of crop production, watermills using hydropower played the main role in the milling processes of the grain crops. Authentic sources prove that in the decades following the founding of the state (eleventh century A.D.) watermills were already in operation throughout the country. Since we are talking about wooden structures that are less resistant to elemental disasters and war operations, many watermills disappeared after a few decades of operation. Many of them have been rebuilt on the same site several times over the centuries, but many have disappeared forever. Therefore, the number and capacity of mills operating at one time are difficult to determine. A seemingly authentic data, which also well reflects the economic role of watermills, that even in the middle of the nineteenth century, nearly 16,000 flour-milling water-powered milling

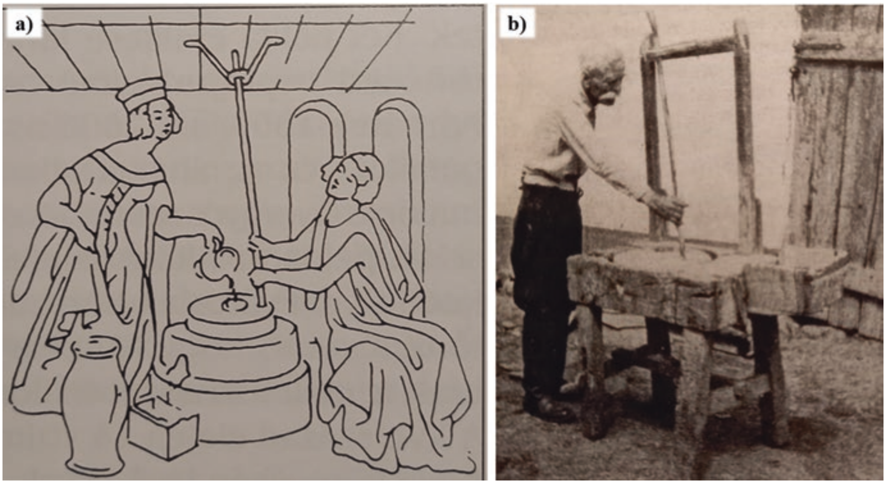

Fig. 8.1 Handmill from the fourteenth (**a**) and the early twentieth century (**b**). (Kovács 2005, 2012)

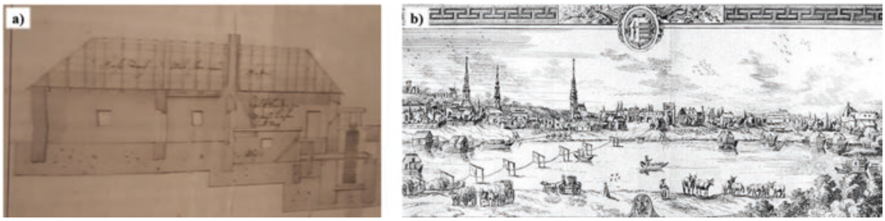

Fig. 8.2 Original blueprint of a stream mill from 1795 (drawing of Tumler, Henrik), Balatonfüred, Hungary (**a**) and ship mill on Danube Ráckeve, Hungary (**b**). (Rózsa 1995)

technologies operated in the territory of historical Hungary. Most of them were simple two-stone mills with low-capacity (50–150 kg/h), producing wholemeal flours. Roller mills and separation technologies at watermills did not appear until the nineteenth century. Their capacity is characterized by the fact that even in small villages that provide a livelihood for a few families in the Middle Ages, up to 8–10 mills was working simultaneously. Basically, two types of watermills were used. One of them was installed on streams or smaller watercourses and was working with vertical or horizontal axes (Fig. 8.2a), while the other type was a ship mill utilizing river drift (Fig. 8.2b). It is an interesting fact that in the flat regions and lowlands characteristic of a significant part of Hungary, windmills and so-called animal or human-powered "dry mills", were used in smaller numbers (Kovács 2012; Frisnyák 2011; Vajkai 1983).

Vertical axis wind driven solutions in the east (Persia, China, etc.) were already in use in the first millennium A.D. In Hungary, the so-called European-type version with a horizontal axis, later installed in a tower-like structure, spread in the eighteenth to nineteenth century, probably through Dutch mediation (Kovács 2005).

Hungary has been a major exporter of grain and wheat since the Middle Ages. The good quality grain yields have reached the western and southern countries by land or water. Unfortunately, exports of processed, milled products were not typical at that time yet, partly due to the fragmented processing capacities described above, and partly due to the demands arising from the socio-economic and historical situation. The operation of processing technologies based mainly on watermills became unsustainable by the nineteenth century. Ship mills operating on rivers were a major obstacle to the development of waterborne transport, and small-capacity mills were unable to meet the quantitative and qualitative needs of increasingly populous, bourgeois cities (Pongrácz 1967; Kelement 2012). Roller mills appeared that time.

The technological development of the seventeenth to nineteenth centuries, the appearance and application of steam mills, roller mills, abrasion and fractionation technologies and sieving systems made the leaping improvement of capacity and quality possible. From the second half of the nineteenth century, a rapidly developing and growing machinery industry developed for the traditionally reputable and high-quality Hungarian agricultural production. Perhaps it is less well-known that during the Austro-Hungarian Monarchy period, referred to as dualism, Budapest was the second most sought-after milling centre in the world after Minneapolis (USA). Hungarian technological superiority developed with the further development of the cylinder chair. The porcelain-topped rollers that replaced the grindstones were a Swiss invention from the 1830s. András Mechwart, the director of the Ganz Works, bought the right to manufacture the porcelain roller. Subsequently, he developed a wear-resistant, hard cast, obliquely grooved grinding rolls that provided better grinding quality and efficiency (Fig. 8.3a). These products of the Ganz Works were produced in a large series; the Hungarian technology reached the overseas (America, Australia) in addition to the European countries. We can also say thanks to an other Hungarian inventor, Károly Haggenmacher, for the elaboration of the flat sieving system and its inclusion in the milling separation operations. Modern, high-performance milling technologies have made it possible to produce flour fractions in different quality and for different purposes and made it available to an ever-widening section of the population. This socio-economic process led to the transformation of the traditional fermentation (sourdough) procedure commonly used in the peasant self-sufficient way of life, to the production of home-made and industrial yeast, and to the emergence of the baking industry. (Vajkai 1983; Kelement 2012; Halkovics 1997, see also in Chap. 4). In addition to the intensive and successful cereal breeding and the development of the milling technology, Hungarian experts also played a pioneering role in the determination of the cereal and especially wheat quality. One of these pioneers was Professor Jenö von Hankóczy, who developed some dough-testing machines, early in the twentieth century in Hungary. Among other instruments, Hankóczy developed the principles and the prototypes of the Farinometer, Farinograph (Fig. 8.3b) and Extensograph, which were improved and produced later by Brabender in Duisburg, Germany (Kenyeres 2006).

This is how we arrived to the today's practice. As in most countries, the vast majority of mill products are produced in modern, high-capacity mills in Hungary. The primary products are white flours produced from the endosperm. Of course,

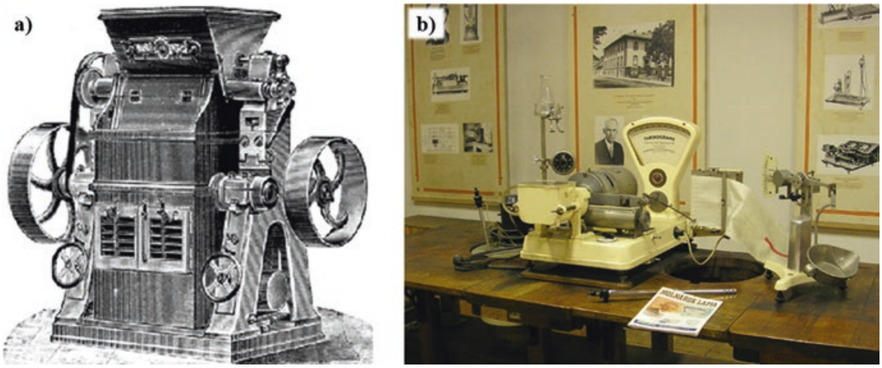

Fig. 8.3 András Mechwart's roller mill produced by Ganz Works in the last quarter of the nineteenth century (**a**) (Bokor and Gerő (1998) and Hankóczy's Farinograph (**b**) with permission of Mill Industry Museum, Budapest)

with the development of the nutrition science, the views on white flours are changing, and demand for wholemeal and dietary fiber-rich flours and products made of them is growing. Accordingly, the milling industry practice is constantly changing and evolving, as well. Today, the more specialized, healthier products are typically produced by small mills, often with traditional operations and more simple fractionation steps. Fortunately, the survival of the traditional milling technologies is also helped by the preservation of the traditions and the growing interest for natural nutrition.

3 The Traditional Hungarian Sourdough Bread and Other Sourdough-Based Meals

3.1 Brief History of Breadmaking in the Hungarian Regions

Observing the spontaneous fermentation of cereal meals led people to recognize the possibility of sourdough making. It can be considered historically proven that the fermentation of dough and breadmaking are not of monogenetic origin. Bread finds found north of the Alps, from 800 B.C. onwards, contradict the earlier interpretation that all European breadmaking derives from Egypt. In the early Middle Ages, only the top social stratum ate some bread across Europe. From the end of middle age in northern and eastern Europe, as well as in smaller peripheral, high-mountainous and extensive maize-producing areas (including the Carpathians, the eastern third of the Carpathian Basin and the Romanian lowlands) a bread-based diet became more common and replaced porridge-based dishes. From the fourteenth century onwards the baking industry in Hungary started to develop in larger cities and in industrial and mining centers, while the spreading of regular home-made bread baking can be dated from the middle of the fourteenth century based on serf services. Until the twentieth century, villagers and some urban families made the bread themselves, but with the development of the milling and baking industry, this activity steadily declined. In the nineteenth and twentieth century, there were many variations in the raw materials and methods of breadmaking. In Eastern Transdanubia, in the majority of the Great Hungarian Plain and Transylvania, bread was baked from wheat flour, while in the rest of Transdanubia, in Danube–Tisza Interfluve, in Nyírség, in the north and in some part of Transylvania, bread was made mainly from rye flour. In the transition zones, bread usually was baked from a mixture of the two flours. Barley was used as independent raw material by the Hungarian population of the Eastern Carpathians. Corn bread was baked regularly on the north-eastern edge of the Hungarian Great Plain (along the Kraszna-Szamos-Tisza). In Somogy, the mixture of rye and corn was typical. In case of weaker grain yield, supplementing the raw material with other types of flour was an established custom; e.g. wheat bread often contained potatoes as well (Szabó 2017; Ortutay 2006).

3.2 Technological Steps of Homemade Sourdough Bread

Breadmaking used to be a woman's task and was considered as an issue of prestige. Elderly people, who were not able to knead dough anymore, were mainly involved in heating up the oven and baking. The ingredients of bread were only flour, water, salt and sourdough. The whole breadmaking process (Fig. 8.4) was quite long and needed around 18–20 h.

The preparation of the flour already started in the evening, a day before baking. First of all, flour was sifted and poured into a wooden (beech, later aspen or willow) kneading trough (Fig. 8.4a). Then a smaller portion of flour was separated and mixed with sourdough, covered with a cloth and let mature for several hours. To prevent dough sticking to the cloth a wooden tool, so called "kovászfa" (Sauerteig Holz in German) was put on the trough. – In general, sourdough was made of bran for a longer period (half a year or even a whole year) and it was flavored with several ingredients such as hops, acacia flowers or the foam of fermented grape juice. The simpler way to get sourdough was to set aside dough after breadmaking, which was enough for the next baking. Sourdough was torn into small pieces and dried out completely on the sun or on the walls of the warm oven. In a cloth bag it could be stored also for a year. – After ripening, warm water or bran water was filtered to sourdough, and the remaining flour was also added (Fig. 8.4b). Then the kneading process was begun, which required special hand technique and stamina (Fig. 8.4c). It lasted around two hours and was performed until the dough became smooth, separated from the trough wall easily and tiny blisters were formed in it. The dough was folded, put to one end of the kneading trough and covered by a cloth. During bulk fermentation the oven was heated up and prepared for baking (Fig. 8.4d). When it was hot enough, dough was divided into pieces of a size to fill out the cloth-lined and floured baskets or wooden vessels (Fig. 8.4e, f). The shaped dough pieces were

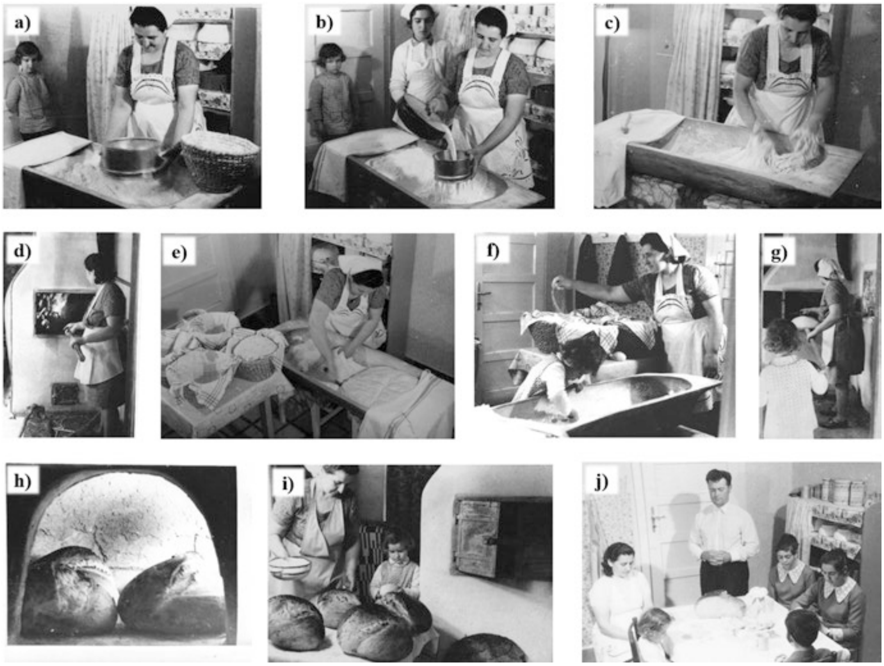

Fig. 8.4 Steps of the traditional sourdough bread making process typical of the Hungarian Great Plain: Sifting of flour (**a**). Filtering bran water to the sourdough and the remaining flour (**b**). Kneading of the dough (**c**). Heating up the oven (**d**). Dough division and shaping (**e**). Sprinkling bread with flour (**f**). Putting bread into the oven (**g**). Baking breads (**h**). Washing breads with lukewarm water (**i**). Praying and bread slicing (**j**). (The photos were taken by Márton, László in 1980. The process was presented by Mrs. Gyaraki, Istvánné)

let rest a while and then were put into the oven with the help of a baker's shovel (Fig. 8.4g). Baking of the large and round breads usually took three hours in the ovens of the Great Plain (Fig. 8.4h), while the smaller breads typical for other regions needed less time for baking. In the Great Plain the bottom of breads were cleaned with a goose feather brush and their top part was washed with lukewarm water to get a nice shiny reddish-brownish colour (Fig. 8.4i). Breads taken from the oven were let to cool down, then they were stored on a bread rack. In Transylvania, the top of the bread was usually burned to black during baking, and in the case of wheat bread, this burnt crust was removed immediately after baking, while still warm (Balassa and Ortutay 1980; Ortutay 2006).

Bread was generally made once a week on Saturday so always fresh bread was on the Sunday table. To cut the first slice of bread was the task of the head of the family (Fig. 8.4j), who in Catholic areas drew a cross on the bottom of it. The average weight of a homemade bread was 5–6 kg, it was larger only in Transdanubia and smaller in Transylvania. Their basic diameter was 20–25 cm in Transylvania, and 35–40 cm elsewhere. The height of rye and ryeish breads was 10–12 cm, that of wheat bread in the Great Plain was 20–25 cm, while at the Southern Trans Tisza it could have been even 30 cm from the highest gluten content flour. Wheat breads were cut in a semicircle with a knife (in the central part of the country) before baking, while in the Southern Great Plain it was folded (Balassa and Ortutay 1980; Ortutay 2006).

3.3 Other Foods Made with Sourdough

In addition to bread, sourdough was an important ingredient in other dishes as well. From small pieces of bread dough or dough scraped off the kneading trough walls, fist sized buns so called “vakaró” were often made, which was a favorite early morning delight of children. On bread-baking day, round flatbreads were also made from the ripe dough throughout the Hungarian-speaking area, which was baked in the last stage of oven heating, by placing on the cleaned center of the oven bottom. Since it was made from bread dough, its raw material could be both wheat and rye. The family smeared with lard and garlic or with sour cream (Balassa and Ortutay 1980) and immediately consumed flatbreads which had a diameter of 30–35 cm.

A very special pulp was the sour, gelatinous “kiszij” or “zabkiszi” made from oats, which was customary in the Hungarian-speaking area only in Székely Land (Csík, Háromszék, Udvarhely) in the twentieth century. Oats were dried well in an oven and ground in a mill for this purpose. Unsorted flour was mixed with warm water in a large wooden jar and allowed to ferment; fermentation was sometimes started with sourdough. The filtered, whitish juice of the acidified mixture itself was the raw material for making the food. The required amount was put on fire and cooked until thickening. When cooled, it gave a yellowish-white, jelly-like gelatinous paste with a sour taste. This was eaten cold, with milk, honey or later sugary water and cooked prune juice (Balassa and Ortutay 1980).

The Szeklers of Bukovina made fermented flatbread from raw grated potatoes, which was baked in an oven on cabbage leaves. It was eaten as bread, and it was called “leppalacsinta”, so a sort of pancake (Ortutay 2006).

Until the turn of the last century, the soup made of filtered, sour juice of fermented bran was common throughout the Hungarian language area. Its name was “keszőce”, “kiszi” or “cibere” which names from the early modern period onwards, however, also indicated other sour soups. From the Middle Ages onwards, it was a specific fasting dish, especially sour bran juice prepared during the Lent period of the year (Ortutay 2006).

3.4 Traditions, Customs and Beliefs Connected to Bread

Bread is an important Christian symbol and has been the most important food in our region for centuries. Accordingly, its preparation, handling and role were surrounded by many beliefs. Among them it should be mentioned that the New Year, a new phase of life, had to be started with an uncut bread. The bread placed on the Christmas table was cut at New Year's Eve, people moved into the new house only with uncut bread, and the new wife was received only with uncut bread. If a beggar or poor begged for bread, they were never denied. Bread was held in high esteem, and its reverence was alive even in the twentieth century. It was not allowed to be trodden on, or to throw it away. If it fell to the ground, it had to be kissed, or at least had to be blown on. The regulations and prohibitions governing the consumption of bread also partly reflect this respect. Before cutting, a cross should be drawn on the bottom of the bread and the whole first slice should be eaten. Some of the prohibitions regulated the time of the baking. The nationwide general Friday (especially Good Friday) ban has been upheld even recently. Beliefs about the punishment of offenders against the bans played a major role in this (Friday's bread will be bloody, it will become stone or it will cry in the oven). Tuesday and among the notable days of the year, Luca's Day and Barbara's Day were also forbidden days. The other part of the prohibitions applies to the person performing the baking (men and menstruating women may not bake) or to the making itself (to prevent spoilage sourdough could not be seen by a stranger, the dough was not to be praised and the leavening material was generally not allowed to be lent). Due to its importance, bread and breadmaking tools were often applied also for magical and healing purposes and was used as a medicine for many diseases. The chewed bread crust was used for healing wounds. Breaking bread over the patient's head and drinking breadwash water were thought to cause healing. For the prevention of storm and hail, the charcoal scraper and the frying paddle were thrown out into the yard. Each phase of baking was associated with some habits and gestures, which were needed to the success of the work (e.g. "speaking" to bread after kneading (giving out squelchy sound with mouth)) (Ortutay 2006).

There were several feast days connected somehow to bread. On All Saints' Day, according to folklore, the dead visit home, so it was customary in many places to wait for them with a set-table placed bread, salt, and water on it. The celebration of the new bread, held on July 15 at the Feast of the Apostles, dates back to the Middle Ages. The bread was taken to the church, where it was blessed. The harvest parade can also be linked to this day. Today the celebration of the new bread is held on August 20, which is Hungary's national holiday and official state holiday in memory of the founding of the state and the founder of the state, King Stephen I (Nardai 2012).

With the development of baking technology, the production of time-consuming and labor-intensive sourdough bread has become increasingly relegated to the background and the technology has mainly shifted to the easily automated and faster straight-dough method using yeast as leavening agent. With the stable production and commercialization of baker's yeast, its use (in addition to or instead of sourdough) became widespread in the households as well due to its better leavening ability. There were a number of reasons (social, political, economic and lifestyle changes) for the steady decline of homemade bread making as well, which mostly occurred simultaneously and became prominent from the 1950s. About the current trends of sourdough bread can be read in more detail in our final chapter.

4 Sourdough Trends in Hungary – Nowadays

The consumption of sourdough breads (or similar products) has a long tradition in Hungary. If we are taking a deeper insight into the current state of the Hungarian baking industry, we can detect that the trends have changed a lot compared to the domestic traditions. In 2019, 63.85% from all the cereals consumed by the Hungarians were bakery products (Hungarian Central Statistical Office 2019). Most of the Hungarians buy bread from supermarkets or bakeries and baking bread at home is not very common. Consumers want to buy perfectly fresh and tasty bakery products and the bigger the assortment is the more they appreciate it. They also tend to be very sensitive to the prices. These demands have been pushing bakery industry towards bigger production in lesser time, and using additives, which can support the above mentioned needs (Válenti, B 2020).

The Hungarian legislation contains precise requirements for the common bakery products (Codex Alimentarius Hungaricus 2017). The Codex specifies the definition of bread, what types of breads can be called bread, and what criteria these products have to meet. It also regulates whether a product has to be made with sourdough technology. The sourdough is defined as the mixture of flour, yeast, starter culture and water, which differs from the traditional production way of sourdough. Also, sourdough equivalents can be used triggering sourdough. Using yeast and sourdough substitutes has many technological and economical and partly sensory advantages. These can significantly shorten the production time of breads compared to the traditional sourdough techniques. Organic acids, like lactic acid can be found also in them, which is crucial for the evolving of taste and aroma, and the aciditiy of the bread. The dough can be handled better and warmer with machines (Werli 2001). These facts have the main affect on the developing trends of the baking industry, according to these, there are three main streams nowadays in Hungary:

Most industrial bakeries make products in a big capacity, mainly by direct method, offer a wider product assortment, and use sourdough equivalents because of the reasons mentioned before. They use mainly mechanised production lines, and the hand work on each product is tried to be minimalized in favour of maximizing the profit and the efficiency of production. Using sourdough is typical only in those products for which regulations are in force. Information can be found how industrial bakeries use their sourdoughs, the most common statement is that they use longer fermented sourdoughs, at least for 8 h. This method is the indirect bread baking method, in which a proper part of the flour is mixed with yeast, starter culture and water, and after a given maturing time, the rest of the flour and other ingredients are kneaded. However, because of the Hungarian legislation, these sourdoughs are made with yeast, which practice differs from the traditional indirect bread baking and can be a little bit confusing.

There are also some smaller, but still industrial scale bakeries, which have a more traditional assortment, and for example they have their own stone mills, and make freshly milled wholemeal flours, and with these flours they are making a special product group. In these bakeries, the indirect sourdough technique has a bigger role, and their products are for a wider range of customer base.

The other stream in Hungary is that there are more and more small bakeries, especially called themselves 'craft bakeries' and they started propagating the original and traditional sourdough bread baking. They mainly sell bakery products made with their own, sometimes many years old, sourdough process. They call their sourdoughs wild or ancient and also refers their technology like that, because they never use baker's yeast during making sourdough and baking. They use only flour, water and their starter to make the sourdough for each batch of dough. This is happening because of the incompletion of the Hungarian legislation as earlier mentioned, and they want to differentiate themselves and their products from the industrial and yeast-based bakeries and their sourdough breads. In these craft bakeries handwork needs to be used, and the production time of each bread is longer, so they have to sell their product more expensive compared to the industrial ones. They produce wheat and rye bread, both white and wholemeal types. The use of some ancient cereal types, like spelt and einkorn wheat are getting popular, too. In case of white wheat breads, there are some favourite seeds or dried fruits used onto or in the bread, like pumpkin, sunflower seeds. They can add walnut, or walnut with raisins, or also cranberries, which they call the Women's bread, which are characteristic of these craft bakeries. Sprinkling onto the surface or covering with poppy seeds the whole surface of the breads is also popular.

Altered regional distribution of the craft bakeries can be observed. Several of them can be found in the capital, Budapest, and the region around it. Also, there are more craft bakeries in the western region of the country, in bigger cities and mainly in turistical centers, where such customer demand arises, but in smaller towns and villages significantly less can be found. Unfortunately, in the eastern and the south-eastern part of Hungary only in some bigger cities, one or two craft bakeries can be found yet.

On behalf of customers, more and more people want to know about the company from which they are buying their purchases and want to be a conscious consumer. There is also a growing demand of the traditional bakery products. The respect of culture also evokes the interest of using traditional materials and techniques, and the customers often connect this to the health propagating effect and are willing to buy these products at a higher price, too (Szabó 2017). Thanks to this, the traditional way of sourdough bread making seems to be experiencing a renaissance from both customers and bakers.

Last but not least, baking bread at home is also starting to take up space again typically in middle class, but not as the goal and means of self-sufficiency, like thousands years ago, rather the part of healthy and additive-free nutrition partly consciously, partly out of fashion or hobby.

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Chapter 9
Traditional Italian Bread

Giulia Selvolini and Giovanna Marrazza

1 Introduction

Bread is one of the most popular and consumed foods in Italy. The Italian legislation indicates bread as the edible product obtained by baking in the oven a suitably leavened dough, prepared with cereal flour, water and yeast with or without the addition of common salt (LEGGE 4 luglio 1967 1967). Each Italian region has preserved an immense variety of breads linked to the gastronomic traditions of its territory; they are distinctive in ingredients, preparation processes and shapes.

Bread history is very ancient and intertwined, and it is associated with the emergence of agriculture and the domestication of grains during the Neolithic in Southwest Asia. The oldest known bread dates back to around 14,000 BC and was found in Jordan (Arranz-Otaegui et al. 2018). Archaeological and archaeobotanical discoveries indicate that stones were used for grinding grains of cereals in the caves. A kind of dark and grainy flour was obtained, which was mixed with water. The final mixture was consumed, raw or cooked on a red-hot stone (Cozzolino et al. 2015). The Egyptians can be considered the first true bakers in history because of the use they made of yeast and, therefore, of leavening around 2600 BC; we can consider yeasts as the greatest discovery for bread production. In fact, they observed that the mixture of flour and water if left to rest in the air began to swell and the resulting bread, after being baked, was softer and more fragrant. Refined cooking techniques, with respect to the initial one, were also developed on red-hot stones, such as the covering with overturned pots, and the creation of holes dug in the ground and covered with stones. The first real ovens were made of clay, in the shape of a cone, so as to house the fire inside and, on the outer wall, the bread. Later, the secrets of bread making were passed on to the Greeks, who attributed important

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religious meanings to it. From Greece, the art of baking arrived in the Roman Empire by the Greek prisoners captured in Macedonia. The Romans refined the grinding techniques and, for the first time, the category of millers appeared. They began a convenient production of bread, setting up public ovens where the bakers could work.

In ancient Rome, since the first century BC, bread entered in the daily use for a large part of the population. The demand for wheat was sometimes so great that, when it was lacking in Italy, it was imported from Egypt and North Africa. A specific legislation, the Roman edict, was enacted, establishing quality and cost of bread: for example, wheat bread was considered healthier and preferable to "*polenta*" bread and other cereal mixes in use; therefore, wheat had a lower price in public granaries than the market price.

Roman bread was generally prepared with poor quality flours (which absorbed less water than the best ones) and with a small amount of yeasts, which are the reasons of its hardness. The yeasts were prepared once a year at harvest time, with grape must and bread dough. However, many types of bread were prepared, according to different uses, with various doughs and baking methods; the *panis ador* was used in sacrificial offerings, *panis palatius* at the imperial tables, *panis siligineus* at the tables of the rich people, black *panis plebeius* was intended for the canteen of the poor, *panis canfusaneus* was for gladiators and athletes, *panis castrensis* for the soldiers, *panis nauticus* for the sailors; finally, *panis gradilis* was distributed during the games in the amphitheaters to give bread and entertainment to the people attending the scenes, and it is from this practice that the expression "*panem et circenses*" comes from.

During the Middle Age, the skill of bread preparation achieved by the Romans was lost. Cereal growing stopped due to continuous wars and the consequent abandonment of the fields; the farmers produced poor bread without yeast and salt, made with ground oats and bran. On the contrary, the feudal lords, who controlled the territory and the population through the possession of ovens and mills, were used to eat white wheat bread.

In the Renaissance, bread was still different according to the social category to which people belonged. Therefore, different breads were prepared and their names identified the category for which they were prepared, *e.g.*, pope's bread, king's bread, knight's bread, squire's bread, *etc*. Bread was the basis of the people's diet, while the upper classes had instead a varied diet, based primarily on meat and on some ingredients that for the time were considered delicious. The best bakers worked at the papal court and the courts of the kings and nobles of the time. It is told that the cooks at the court of the Medici in Florence were the first to use brewer's yeast to improve bread leavening, and that this custom was then spread in France by Maria de' Medici (1573–1642), who got married to King Henry IV.

In the modern era, bread has become a public service, with a taxed and fixed price. In 1600 in Italy, bread underwent many different taxes, starting from the "gabelle" for flour to the "duty" for baking in private ovens. The increase in the price of bread during the famine in 1628 in Milan led to the rebellion of the people, as told by the Italian writer Alessandro Manzoni in the book "*I Promessi Sposi*".

Bread was generally produced at home or in small ovens until 1800; its production began to be on an industrial scale only from 1900 onwards.

Over the centuries, the hard working of cooks, bakers and housewives made possible to obtain a gradually pleasant, fragrant and "typical" bread for each region and locality, which are different in shape, ingredients and packaging methods. Today, the surveyed Italian breads are 250, with over a thousand variations to which at least another 150 types must be added, including *focaccia, pizza, pitte, calzoni* (Pani Regionali Italiani n.d.).

The most purchased bread in Italy is fresh and artisanal still now, as shown by a recent research by the Italian Bakery Ingredients Association (AIBI) (AssoPanificatori Pasticceri n.d.). Furthermore, the results document that 1.5 million tons on average are produced per year, for a *per capita* daily consumption of 80 g (Ansa.it 2020). Bread consumption over the years had noticed a progressive containment of consumption starting from 1861, when Italy was unified; the decreasing of sales has been particularly noticeable during crisis periods (Fig. 9.1) (Coldiretti 2013; Mocarelli and Piñeiro 2013).

However, during the Covid-19 pandemic in 2020, bread has gained a great visibility, being the symbolic food of lockdown period (Assitol 2020).

2 The Italian Bread

2.1 Bread in the Italian Legislation

In the years of the economic boom following the Second World War, the Italian Parliament promulgated the law no. 580 of 4th July 1967, which regulated the processing and trade of cereals, flours, bread and pasta. The law established the different types of bread, the maximum water content to be used in the various bread recipes, and their sales denominations. About 30 years later, Presidential Decree (DPR) of 30th November 1998 no. 502, contained rules for the revision of the legislation on bread processing and trading. Another type of bread, namely special bread, was identified and the permitted ingredients were established: malted cereal flour, malt extracts, alpha and beta amylase, dried sourdough, pregelatinized wheat flours, gluten, food starches and sugars. The use of fats (butter, olive oil, lard), milk, figs, olives, *etc*. was also allowed. When food ingredients other than those provided by law are used in the production of bread, the sales denomination must be completed by the mention of the ingredients used and, in the case of several ingredients, of that or those characterizing. This kind of bread, when sold in bulk, must be kept in separate shelves in the sales premises. For breads obtained with flours of other cereals than wheat or mixed with the latter, as well as to breads obtained with the addition of other food ingredients (lard, oil, *etc*.), the percentages of moisture increased by 10% (w/w) with respect to nonspecial breads. It is also possible to put on sale partially baked bread, frozen bread or bread obtained by completing the

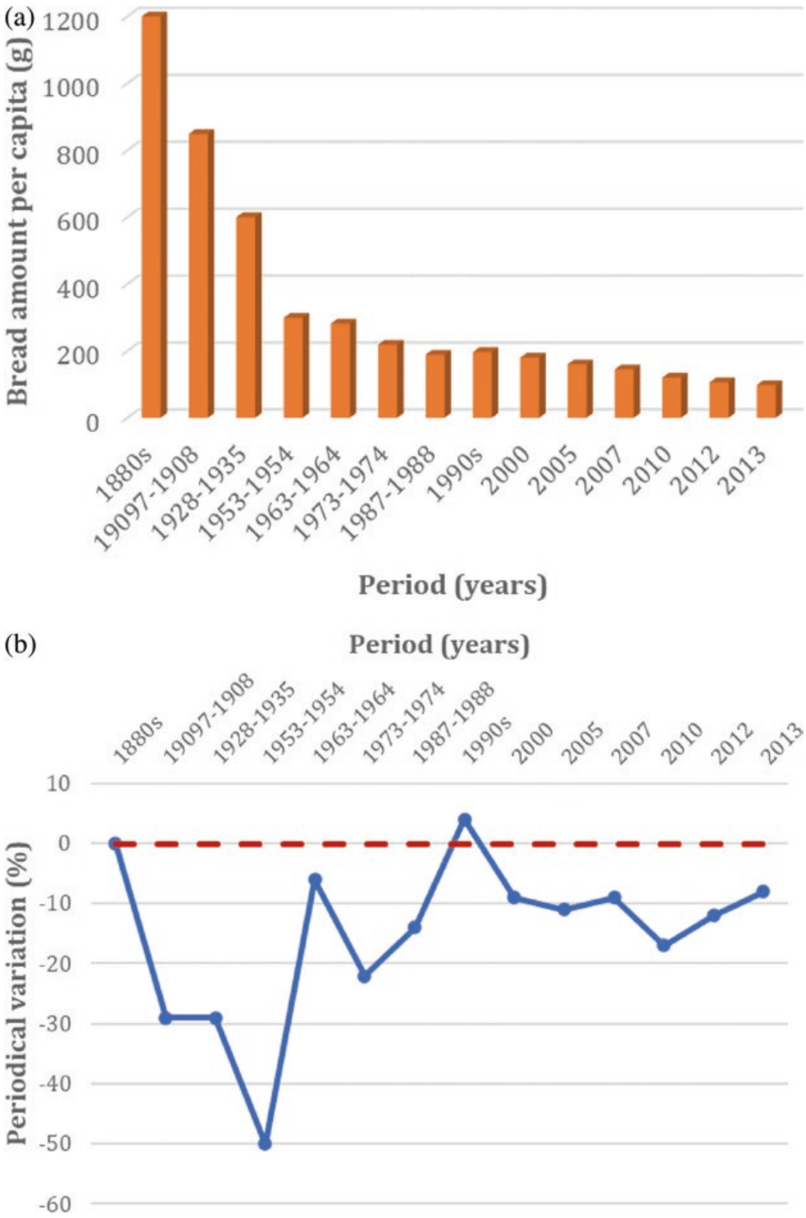

Fig. 9.1 Daily consumption of bread *per capita* in Italy (**a**) and percentage variation in the consumption with respect to the previous periods (**b**)

baking of partially baked bread, whether frozen or not. Finally, it should be taken into account that in 2018 the Italian Minister of Economic Development, in agreement with the Minister of Agricultural, Food, Forestry and Tourism Policies and the

Minister of Health, issued the Interministerial Decree of 1 October 2018, no. 131 (1998) concerning the Regulations governing the denomination of "bakery", "fresh bread" and the adoption of the term "preserved bread". The text of the Ministerial Decree provides that "bakery" includes the companies that have facilities for the production of bread, but also other bakeries and similar which carry out the entire production cycle from the processing of raw materials to the final baking.

2.2 The Baking Technique

The quality of the bread is strongly correlated to the ingredients and the used technologies during the baking process. As for the ingredients, the quality and the type of the used flour are very important, the characteristics of the water and salt.

Cereal production in Italy mainly regards wheat (soft and hard), maize, barley and rice. Different types of bread are often named according to the type of flour used. Bread made from soft wheat flour (*Triticum aestivum*), also called "white bread", which is the most widespread (even if especially found in Northern Italy) with a variety of shapes and can also be mixed with other cereal flours (*e.g.*, rye, oat, rice, corn bread, *etc*.). Durum wheat (*Triticum durum*) bread, which can be preserved for a long time and is typical of the regions of Southern Italy. Another type of bread produced in this area of Italy is durum wheat semolina bread. This type of flour is also used to make other typical bakery products such as *taralli* and *friselle*. Another type of bread is wholemeal bread made with flour rich in bran, which comes from the outer coating of the grain of wheat and gives a darker color with respect to that of white bread and has higher fiber content.

From a technological point of view, the mixing, rest, leavening and baking are the multiple operations, which represent important parts of the baking process. These steps are adapted to produce all the different types of bread. The dough is the phase in which the basic ingredients (flour, water, yeast and salt) are assembled and mixed through mechanical energy: a physicochemical process then begins, by which the wheat cereal proteins, gliadin and glutenin, become hydrated and form the gluten – whose amount in the wheat flour is a measure of its strength and which constitutes the supporting structure of the dough and gives it elasticity and cohesion.

Salt is not added in some dough, such as in the regions of Tuscany, Umbria and Lazio. The dough is left to rest for a time that varies depending on the recipe and the strength of the flour. During dividing and forming phase, the dough is divided into pieces of the desired weight: this phase is carried out by hand or with machines called dividers or with automatic groups which, in addition to dividing the dough, create the bread shapes.

In the wheat leavening phase, the loaves of bread double or triple their volume. The bread is placed on wooden boards or trays for a time that varies according to the quantity and type of yeast used. The production of most of the typical Italian breads involves the use ofsourdough, thus falling within the group of artisanal production. In this phase, various chemical reactions take place which, starting from sugars,

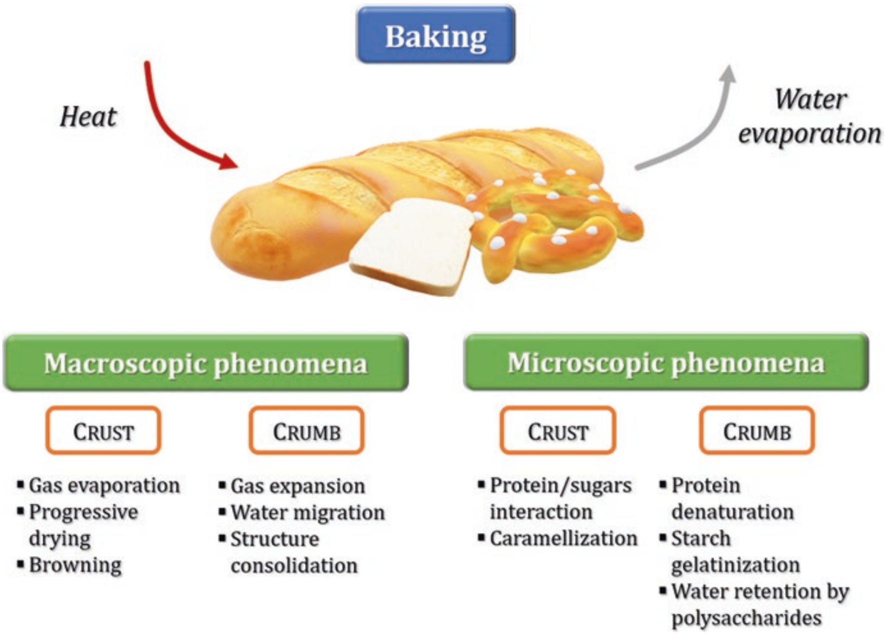

Fig. 9.2 Macroscopic and microscopic phenomena occurring to crust and crumb during baking procedure

producing alcohol and carbon dioxide, which is retained by gluten. During this phase, bread can be covered with sheets (in linen or plastic) to avoid the formation of a crust caused by the evaporation of water from the surface. Adjusting the temperature and moisture of the air can be done through the use of leavening cells.

The last phase for the production of bread is its baking which, by a series of chemical, biological and physical transformations, allows to obtain an edible product, which can be easily digested. The action of heat, at a temperature usually between 180 and 200 °C, works to stiffen the gluten network, thus stopping the volume and shape given to the dough. A porous crumb is formed as water and gas evaporate, while the sugars on the surface caramelize and, consequently, coloring the bread crust. The involved processes are shown in Fig. 9.2.

2.3 *Breads with Protected Status*

Italy has obtained the highest number of bakery products protected by the European Protected Designation of Origin (PDO) and the Protected Geographical Indication (PGI) brands (European Commission n.d.; Ministero delle politiche agricole alimentari e forestali n.d.). In particular, *Altamura* bread, the *Pagnotta del Dittaino*, and Tuscan bread, that belong to the tradition of the different Italian regions, have

Fig. 9.3 Map of the regional distribution of protected breads, retaining the PDO or PGI status

obtained the recognition of the PDO status, while the breads called *Casareccio di Genzano*, *Coppie di Ferrara* and *Matera* bread have obtained the recognition of the PGI status, instead (Fig. 9.3) (Camera di Commercio di Roma n.d.).

Altamura bread was the first bread granted with PDO status in Europe (European Commission 2003). It is a type of naturally leavened bread made from remilled durum wheat semolina from the Altamura area, in the Apulia region. By law, it must be produced according to a range of stricted conditions, including the use of particular varieties of durum wheat (all locally produced) of 80% (w/w) and above in the recipe, a certain specification of water, a consistent production method, and a final crust of at least 3 mm in thickness. The shape of the bread is not an essential characteristic for a loaf to be certified, but there are some traditional shapes.

The processing technology is based on the use of sourdough after at least three refreshments, to increase the fermented mass by adding water and durum wheat semolina, in the percentage of 20% (w/w) compared to the quantity of re-milled semolina durum wheat to knead. In addition to semolina, water, sourdough and sea salt (2% w/w) is added to the mixture. The kneading operation is completed in about 20 min thanks to the use of a kneading machine that homogeneously and energetically mixes the various ingredients. The dough mixture obtained is left to rest for at least 90 min at room temperature, covered with a cotton cloth. Then, the dough is divided into pieces weighing 0.5, 1 or 2 kg, and the first shaping is carried out, strictly by hand, followed by a second resting phase of 30 min. The various loaves therefore require further remodeling, which will give the final shape, followed by a rest period of at least 15 min to complete the leavening. Before being baked, cuts are made on the loaves to avoid the breaking of the crust during baking. The dough is then baked at 250 °C for 15 min in an open oven, for 45 min in a closed oven and, finally, for 5 min in an open oven to allow the formation of a dry and crunchy crust (Ministero delle politiche agricole alimentari e forestali 2000). The oven is preferably powered by wood or gas, indirectly heated, and must reach a temperature of 250 °C. The direct heating of the ovens used for baking *Altamura* bread must be fueled with oak type wood, which guarantees the excellent baking of the product, by burning slowly and gradually while increasing the heat. The final product is characterized by a crust with a minimum thickness of 3 mm, a straw-yellow crumb with a homogeneous honeycomb, a characteristic aroma and a maximum moisture content of 33% (w/w).

Altamura bread, in addition to its characteristic aroma, is also highly appreciated for its shelf-life, which was necessary to satisfy the dietary needs of farmers and shepherds of the past. The custom of baking in public ovens was based on the prohibition placed on citizens “of any state or condition” to bake any type of bread or focaccia in their homes. The milling activity was also to be concentrated entirely in Altamura, considering that at the beginning of the 1600s there were as many as 26 processing plants in full operation (Ministero delle politiche agricole alimentari e forestali 2000).

Another bread that has the PDO status is the *Pagnotta del Dittaino*, a typical product of the *Valle del Dittaino* (central Sicily island) (QualiGEO n.d.) obtained from a dough prepared with re-milled durum wheat semolina from varieties produced within the production area to which water, sourdough and salt are added. The origin of *Pagnotta del Dittaino* can be traced in the historical and cultural tradition of using durum wheat for the processing of bakery products in its production area. It is characterized by a crust of medium toughness and a thickness of between 3 and 4 mm, a highly elastic and soft yellow crumb with a fine, compact and uniform alveolation, and moisture not exceeding 38% (w/w). Thanks to the use of re-milled durum wheat semolina and sourdough, *Pagnotta del Dittaino* maintains unaltered its sensory characteristics for about 5 days. The production area involves the provinces of Enna and of Catania (European Commission 2008). According to the discipline of production, the remilled durum wheat semolina to be used to produce *Pagnotta del Dittaino* must come for at least 70% (w/w) from grains belonging to the *Simeto*, *Duilio*, *Arcangelo*, *Mongibello*, *Ciccio* and *Colosseo* cultivars. The remaining 30% (w/w) must be represented by durum wheat belonging to other 16 varieties and, in any case, all the cereal grains must come from local crops. Semolina is mixed with water, salt and sourdough, which is refreshed daily using 25% (w/w) of the sourdough produced the previous day. After the dough has risen, it is divided into pieces weighing about 0.5 or 1 kg, which are shaped into a round shape and baked in the oven (European Commission 2008). The regulation does not mention either the type of oven or the baking conditions (temperature and duration), but, traditionally, baking takes place in wood-burning ovens. After baking, the loaves are immediately packaged with micro-perforated plastic film or in a modified atmosphere composed of a mixture of carbon dioxide and nitrogen (Gobbetti and Corsetti 2010).

Pane Toscano is a type of bread typical from the Tuscany region, recognized with the protected designation of origin label. With the European directive 2016/58, published in the Official Journal of the European Union on 4 March of the same year (European Commission 2016), Tuscan bread obtained the PDO recognition. What sets it apart most is the fact that it is completely salt-free and with a slightly acidic crumb taste (Consorzio di Tutela Pane Toscano DOP n.d.). Tradition tells that the lack of salt is due to a dispute occurred in the twelfth century between the Pisans and the Florentines. On the other hand, the legend of a similar clash between the Pope and the Perugians is widespread in the Umbrian area, even if a research on saltless bread in Perugia seems to disprove these legends (Nowak 2011). In the seventeenth *canto* of the Paradise of Dante Alighieri's "*Divina Commedia*", Messer Cacciaguida prophesied the future exile of the Tuscan poet, describing the anguish of those who will have to eat the bread of others made with salt. A first written testimony on the production of "insipid" bread, that is without salt, is already provided in the sixteenth century by Pierandrea Mattioli (Pane Toscano n.d.). A text of 1765 by Saverio Manetti reports news about the Tuscan custom of not using salt during the preparation of this particular type of bread, in addition to the use of sourdough, called in Tuscany "*formento*", consisting of sour dough that was stored in the so-called cupboard in the middle of the flour; there is also no lack of evidence regarding the centrality of bread prepared without salt in the diet of nineteenth-century Tuscan sharecroppers. This choice was the natural consequence of using salt, mainly for the preservation of pork meat, given its high price. In the twentieth century, Giuseppe Negri praised the labors of the baker, referring to "the insipid Tuscan loaf" (Pane Toscano n.d.). Some later writers have narrated the goodness and peculiarity of this unsalted bread, with a crunchy crust and soft but consistent crumb.

The "0" type soft wheat, being cultivated in different areas of Tuscany, has different qualitative characteristics. By mixing different batches of wheat, it is possible to obtain a balanced raw material with characteristics suitable for bread making and the right amount of gluten. *Pane Toscano* has various shapes, mainly rectangular, round or ovoid. The weight is usually 500 g, while the shape has a thickness ranging from 5 to 10 cm. The crust is crumbly and crunchy with a golden color, while the crumb is soft, irregularly alveolated and characterized by a white and ivory-white color. The primary scent of *Pane Toscano* PDO is that of toasted hazelnut and the flavor is saltless but not bland since the types of wheat used, together with the sourdough, give it a unique flavor despite the lack of salt. Naturally leavened *Pane*

Toscano means the product obtained from the bread making of the following ingredients: type "0" Tuscan soft wheat flour, sourdough and water.

During the grinding of the wheat, a complex process of crushing the cereal grain and subsequent sieving of the cereal flour is carried out. During processing, the germ remains an integral part of the ground flours exclusively for the production of this bread (commonly, however, the germ is eliminated, depriving the flours from vitamin E, an essential antioxidant with a high nutritional value). In order to have a good PDO Tuscan bread only with water and wheat flour, without the addition of additives of any kind, it is necessary to start with sourdough coming from a previous processing, which stored in an environment suitable undergoes a gradual processes of fermentation and acidification. This portion of sourdough, suitably refreshed, placed in new dough is able to cause it to rise. At the end of the refreshments it "comes off" a portion of dough to guarantee the sourdough for the following day.

Casareccio di Genzano is a homemade bread from Genzano and is the first PGI in Europe; it is produced with soft wheat flour, water, sourdough and salt; owes its goodness to the quality of the basic ingredients used, in particular to cereals, water and, according to the inhabitants, to the air of the town that has been producing it for over than 300 years (Comune di Genzano di Roma n.d.).

The cereal flour is mixed with sourdough dissolved in warm water (approximately 37 °C) and salt in the mixer. The dough is left to rise for about an hour and then the bread, transformed into loaves with a weight varying from 0.5 to 2.5 kg, is left to rest in wooden crates with hemp cloths and sprinkled with bran or mince. At this point the bread is placed in a warm environment where it will undergo another growth; then, it is baked in the oven, which can be heated with wood or indirectly, at a temperature between 300 and 320 °C, giving to the bread a consistent crust of at least 3 mm.

Crunchy on the outside and very light on the inside, it has a savory flavor and a scent that recalls that of granaries and can be attributed to the use of sourdough and the quality/variety of the cereals used. The dark brown rind is very important because it protects the crumb and keeps it soft and spongy for a long time. Sourdough, that is, the dough from the previous process made acidic, rich in active enzymes, retains the fragrance of the bread even for several days after baking. Precisely because this bread contains a huge amount of live ferments, it does not tolerate vacuum packing or, even less, plastic (Comune di Genzano di Roma n.d.). It is packaged in the shape of a loaf with "kissing at the hips" or round and long strands weighing from 0.5 to 2.5 kg. It cannot be marketed with additional qualifications such as "extra", "fine", "top" or "selected".

Coppie di Ferrara is the bread traditionally linked to the city of Ferrara (Coppia Ferrarese n.d.). It consists of two pieces of dough attached to each other that form a pair, joined in the central part and forming four arms, called *crostini*. Type "0" soft wheat flour is used, to which water, pure pork lard, extra virgin olive oil, salt, malt and sourdough are added. Sourdough is obtained by mixing type "0" soft wheat flour with a strength (W) of 220 and with a protein content (P/L) of 0.45–0.50 with water (water/flour ratio of 45% w/w) and possibly adding red wine vinegar, hops or grape must. The sourdough is then fermented for 24 h at room temperature.

Sourdough must be refreshed every 12 h, by adding water and wheat flour, for five consecutive days, while the day before use it is wrapped in a cotton cloth. The dough is processed in a fork mixer and, subsequently, after the refining phase inside laminating machines, it is cut into strips of 20 cm long and 4 cm thick. There are two techniques for the preparation of the "couple": the strips of dough can be finely worked between the fingers and the palms of the hands, until they take on the particular spiral appearance, or they can be placed in the die that forms half pairs, which are then joined manually. After forming, the bread is left to rise covered with a cloth on wooden boards. Baking allows obtaining crunchy and fragrant bread with a savory flavor, characterized by a hard, smooth and golden crust. This bread is characterized by compact structure inside with small and uniform alveolation at the ends, while a more uneven one can be found in the central part where the two arms join. There is a conservation regulation according to which the Ferrara couple must be marketed within 24 h of its production without being deep-frozen or frozen.

Matera bread is obtained through an ancient processing system, typically used by bakers in the province of Matera (Associazione per la Promozione e la Valorizzazione del Pane di Matera n.d.). This system provides for the exclusive use of durum wheat semolina. It has a very long tradition dating back to the Kingdom of Naples and beyond, as confirmed by numerous and verified historical sources. It has always been a typical food of the Matera region, a traditional area of cereal cultivation, as it is also evident from various artistic and literary testimonies that attest to the importance and worship of bread in the life and economy of the whole territory. Particularly suggestive is the rite of the three cuts impressed with a knife on the dough, which represented the Holy Trinity, a gesture of deep devotion with which the families thanked God for the opportunity to take advantage of this primary good. *Matera* bread must have the following characteristics: croissant or high bread shape; 1 or 2 kg size; crust thickness of at least 3 mm; crumb of straw yellow color with characteristic alveolation; moisture not higher than 33% (w/w).

The choice of old varieties of wheat, which retain in their genetic heritage some characteristics which are not present in others, gives rise to flours that transfer the unique taste and flavor that make this bread to be distinguished from others, without mentioning the manufacturing process and, specifically, the creation of the sourdough produced with fresh fruit, which adds further and particular taste sensations. The product is obtained through the ancient production process, which involves the use of sourdough, durum wheat semolina, salt and water. It can be baked both in wood and in a gas oven. The obtained product, thanks to the ingredients used and the specificity of the manufacturing process, is characterized by a yellow color, a typical and very uneven porosity (with pores, inside the bread, ranging in diameter from 2–3 mm up to 60 mm), an extremely characteristic taste and smell. Its shelf life can reach 7 days for 1 kg pieces and 9 days for 2 kg pieces (Consorzio di Tutela del Pane di Matera n.d.).

2.4 *The Most Famous Traditional Breads of Italian Regions*

In Italy, every region has kept an immense variety of breads, different for ingredients, processes, forms and traditions, which have survived over time. In this section, the most famous traditional types of bread of each Italian region are reported (Ubaldi 2019). Some of these typical breads are shown in Fig. 9.4.

Friuli Venezia Giulia

The ancient *Pan di Sorc*, today a Slow Food Presidium, takes its name from the corn flour present (*sorc*), combined with rye flour, wheat, dried figs, raisins and fennel seeds. It's about bread that is a little sweet and a little spicy, widespread above all in the Gemonese area. In Trieste, sandwiches, prepared with oil or lard, are often eaten with hot cooked ham from Trieste and Kren, while brown bread is widespread throughout the region, which, with a mix of dark flours, replaced the white one for years.

Valle d'Aosta

The main breads in this region are three: rye bread; one with dried figs, walnuts and chestnuts; and *Micòoula*, a sweet loaf of rye and wheat with chestnuts, dried figs and raisins which is prepared traditionally in the Christmas period. In 2001 *Micòoula*, which in patois means "smaller and special bread", was included in the national list of traditional agro-food products of this region.

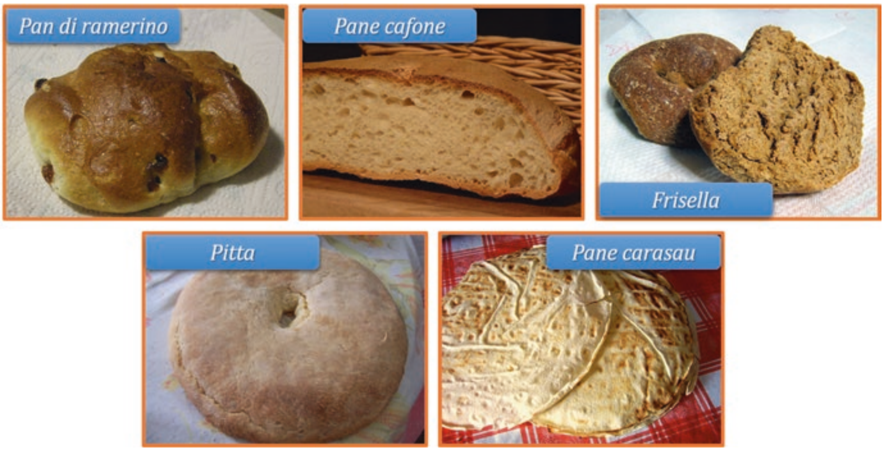

Fig. 9.4 Some of the most typical Italian breads. (Reproduced from Wikipedia.it under Creative Commons licence)

Piedmont

The most popular bread is the classic *mica*, which is widespread not only in Piedmontbut in all of Northern Italy and whose name comes from crumb, with a dough of flour of soft wheat, yeast and salt. There are numerous variants depending on the area and shape. Standing out completely from the others, the Carlo Alberto's bread with eggs, butter, walnuts and anchovies.

Veneto

In this region, breads of corn, rice, di rye, buckwheat and figs are very widespread.

Lombardy

Milanese bread for excellence, but widespread throughout Lombardy, is the *michetta*. From the same family of blown breads typical of the North Italy, with low moisture and hard dough, we can find other types such as *rosetta*, *ciabatta*, *miccone pavese*, *ricciolina*, *busella* (in the area of Bergamo), Mantuan trunk, semolina banana, *luvadel*, *al panon*, beetle, *chisolina* (the Mantuan *schiacciata*) and various oil sandwiches that change name according to their shape and to the place they come from.

Trentino

The bread of this region almost stands out from the others because of the presence of rye flour, that can be found in the following specialties: *the breatl* sourdough with fennel seeds, cumin and coriander; *Fela Struzn* and *Vinschgauer Struzn,* two loaves in the shape of a horseshoe; the loaf with 4 *tritelli*, also containing barley and oats; the *pindl,* which with the addition of dried apples, cinnamon and lemon becomes the *apfelbrot*, while with pears and grapes sultanas becomes the *palabirabrot*; then, the known *Schuttelbrot,* which is thin and crispy and can be found often in accompaniment to speck.

Liguria

In the area of *Valle Argentina*, Italy, there are very interesting breads: the black bread of *Pigna* and the *Carpasina*, or *Carpasio's Pan d'ordiu*, with ground barley, sourdough and spring water. Being very tough, it gets wet with water and vinegar, usually topped with tomato, anchovies, oil and basil, food base of shepherds. Moving towards the capital, Genoa, on find the *libretto*, the classic sandwich soft white of the Genoese, with crumb soft and well alveolate. Finally, a bread that tastes of Liguria more than any other can also be mentioned: it is the bread of Chiavari, with soft wheat flour and pulp of black olives preserved in extra virgin olive oil olive.

Emilia Romagna

Bread from this region is mostly known for wraps, watercresses, fresh and stuffed pasta; but despite everything, it also owns an outstanding position in breadmaking, with types such as hard dough bread from Pavullo with various flours and lard, in different forms such as micca, loaf and *michetta*; or *Pane del Bollo*, from the name of the stamp that in the fifteenth century was used to make loaves for pilgrims on the *Via Francigena*. Finally, there is *Miseria*, a great loaf similar to the original michetta from the city of the musician Verdi, Busseto.

Tuscany

In addition to unsalted bread *Pane Toscano* described earlier, there are many other interesting types, less known and tastier, such as spelled or potato bread, in Garfagnana; or the *Marocca di Casola* in Lunigiana, which is also protected, prepared with chestnut flour that abounds in the area. *Neccio* is also prepared with chestnut flour, in particular in the surroundings of Pistoia. Other noteworthy breads are the *Pan di Ramerino*, with leaves of rosemary and raisins; *Bozza Pratese* which it also has a consortium that takes care of its own promotion and enhancement; *Pane di Marocco* of Montignoso with chilli and black fresh olives (in fact, it is prepared during the period of olives collection); and *Pane di Vinca*, in Lunigiana, with soft wheat flour and bran, made after a long leavening of at least 12 h.

Umbria

Pan nociato is really a specialty: it is prepared with seared, peeled and crushed walnut kernels, Norcia pecorino, oil, salt and pepper. Like most of the most valuable recipes, it varies from country to country, where it can also be found in a similar form under the name of *pan caciato*; for example, some varieties have red wine, raisins or cloves inside the dough.

Marche

There are many focaccias, which are similar to wraps, and there are the classics homemade, wholemeal, spelled loaves. To stand out, the bread with the must, which is prepared during the harvest period, and the loaf of Chiaserna, in the province of Pesaro, with soft wheat flour and sourdough.

Abruzzo

Very large loaves are typical of this region, like spike bread, from the name of the small cuts on the surface that resemble the thorn of wheat; or the chapel bread, prepared with the *Senatore Cappelli* grain. It is not uncommon to find also corn bread.

Lazio

In addition to *Casareccio di Genzano,* we can find other kind of breads: the *ciriola romana*, the classic white soft wheat bread which is always present on the table; the *Falia of Priverno*, with an elongated shape, which is closer to one flat bread; the *Velletri bread*, made according to the ancient technique of shelling; *the bread of Salisano*, a classic strand with three incisions on the profile.

Basilicata

Here we can find, in addition to very known *Matera* bread, the *Rivello bread* with three flours from Pollino and sourdough; then various donut-shaped loaves are widespread, such as *Bread of Cuddura, u ficcilatìdd,* the *mescuotte,* the *varone* and the *pizzatolo.*

Molise

The typical bread of this region is the *parrozzo*, which indicates a type of bread prepared with potatoes, corn and maize flours.

Campania

The entire region produces bread with greaves or crumbled pork *cicoli*, or with fat of this animal. In Naples city, the so-called *Pane Cafone* is produced, because of the raw flour used for its preparation. It can be found in various formats such as loaf, cocchia, palatone, etc.

Apulia

Friselle, taralli and *pucce* are the specialities of this region. In Salento area, there is a real one specialty: the *scéblasti*, the characteristic bread seasoned with yellow pumpkin, olives, onion, courgettes, oil, chilli, salt and capers, baked on stone in wood-burning ovens and celebrated every year on 2nd and 3rd August.

Calabria

Here, various *pitte* breads from the Arbëreshë cuisine are produced. There are also other excellent products, like the bread with sesame (the *Giuggiulena*), that of *Mangone* and the bread of *Cutro*, containing grains and with a thick, crunchy crust. An actual speciality is the *pane pizzata*, which is widespread above all on the Ionic side and that distinguish itself from the others by the use of cabbage. In fact, before baking, the dough is wrapped in cabbage leaves that give it that typical "collected" form. Another special loaf is that of *Grano di Pellegrina*, one fraction of Bagnara Calabra, in the province of Reggio Calabria.

Sicily

Here, bread changes a lot from one area to the other. In the Western part we find the *muffulettu* in Licata and surroundings, or the *muffoletta* in Palermo, a round loaf that is prepared with spices such as anise, cinnamon, fennel, pepper or cumin. There is also the well-known black bread of Castelvetrano, with a mix of durum wheat wholemeal and tumminìa, baked for about 1 h in stone ovens fueled with olive wood; the *Cuccidatu di Carrozza,* a donut bread that is prepared for the feast of the Crucifix, so beautiful that it is also used for decorating the floats during the event; the bread of Monreale, with milk and lemon juice; and wonderful *Salemi breads*, prepared for the holidays in various forms that recall baroque elements.

On the Eastern side of the region, there is the *Vastedda* di Enna, which would be the classic homemade bread; *Pè*, with durum wheat semolina flours passed through a sieve and sourdough; the *Cicciddatu,* also with a shape of a donut; and homemade bread from Lentini, in the Syracuse area, covered with the classic sesame seeds that always characterize the Sicilian bread, and which reminds us of the importance of the Arab presence. Throughout Sicily, *Pupu cu l'ovu* is prepared for Easter, that is a kind of bread with egg inside.

Sardinia

Sardinia is one of the regions with the most variety of bread ever. In addition to the most famous *carasau* and *guttiau* (soaked in oil, salted and toasted in the oven) or *pistoccu*, there are some really interesting breads, such as *tunda*. Known for its particular shape with seven points or "lace", it was prepared only on Saturdays to be consumed all week. Other types are the *pintau* bread, prepared in various forms depending on the holidays and the *coccoi a pitzus*, a typical decorated bread of durum wheat semolina, which in the past was prepared for weddings and Easter.

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Chapter 10
Traditional Latvian Sourdough Rye Bread

Dace Klava, Daiga Kunkulberga, Gunta Duka, and Ruta Murniece

1 Introduction to Latvian Bread Making History

Republic of Latvia is a State of North Europe (sometimes regarded as Eastern-European country) located on Eastern coast of the Baltic sea. It is one of the three Baltic states, member of European Union (EU) since May 1st, 2004. Latvia is a country with moderate climate and natural environment (forests, bogs, natural meadows, lakes and rivers) favorable for agriculture. Traditional food has been used in Latvia's territory for centuries, and many of these traditions are alive today. Different conquerors (Germans, Swedes, Poles and Russians), as well as 50 years of the "soviet time" with dishes from Russia, Caucasus and Middle Asia have left the influence on food habits, and some of these foods are used till now.

Riga was a member of Hanseatic League since thirteenth century, and it was a platform for successful international trade arousing conditions for availability of exotic products and spices in Riga and all Latvian territory like to top society in other places in Europe. Imported products mostly were herrings, salt, wines and spices. On the table of German population, the quantity of imported products could exceed amount of local products (Bleiere et al. 2005).

Essential changes in the food of Latvian inhabitants were caused by transition from natural to industrial economy at the end of eighteenth century and in the nineteenth century, as well as abolition of serfdom, acquisition of land property and development of agriculture, industry and trade in general (Dumpe 2009). In the

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twenty-first century, by maintaining and improving traditional food products, the food industry is developing and Latvia has become an economically sustainable and export-capable country.

Bread has a special place in the Latvian consciousness. Rye (*Secale cereale* L.) is a widely cultivated crop in Latvia. Rye has been grown since VIII–IX century thanks to the suitable climatic conditions in Latvia. In addition to its freeze-resistance, rye is not as demanding crop as wheat. Over the centuries, it has been adapted to variable Latvia's climatic conditions. Rye sourdough bread is a Latvian national treasure – our historical and cultural heritage, the national symbol and pride. The value of rye sourdough bread is known and it is appreciated in each Latvian family.

Latvian traditions state that the day, when bread is baked is a sacred day. Therefore everything was prepared in advance, cleaning and washing the rooms; the hostess also prepared herself for the day – she tied a white kerchief and apron. Baking Day was a high day, typically bread was baked every or every other Saturday.

Bread was baked at home until the twentieth century. In the 1940s, the baking of traditional sourdough rye bread and the development of technology were completely stopped. Around year 1987–1989 sourdough rye bread baking according to traditional technology was resumed. In the twenty-first century, home-baked bread became a new trend, which was being addressed by more and more housewives, using both recipes from grandmothers' heritage and new hitherto little-used, but being nutritionally very valuable recipes. Home-baked bread is healthy and delicious, a testament to the hostess's skills. Baking good sourdough rye bread requires quality rye flour, warmth, a good hearth oven, knowledge, strength and love! Among Latvian folk songs (*dainas*) – short poems usually four lines long, which describe ordinary but essential things of living there are songs highlighting the importance of bread:

No rītiņa malt iedama, [Going to mill in the morning,]
Satiek Dievu celiņā. [I met God on the road.]
Kur tu teci malējiņa, [Where are you hurrying to, miller,]
Tev rociņas nemazgātas? [Are your hands unwashed?]
Ej pa priekšu mazgā rokas, [Go, first wash your hands,]
Tad nāc mali ritināt. [Then go and turn the millstone.] (Cekstere 2004)

In Latvia, Bread Day or Jacob's Day was celebrated on July 25th, when the harvesting of rye and barley began. In ancient times, each farmer tried to be the first to sow, reap, thresh and mill grains, to bring a new loaf of bread or – *karaša* (bread baked from barley flour) to the table for his family and neighbors. On Anna's Day, July 26th, which is called the day of the bakers, they baked the first loaf of bread from the newest harvest. Again, it is described in a folk song:

Jaunu rudzu maizi cepu, [I bake a new rye bread,]
Cepu Laimes kukulīti, [I bake a loaf for Happiness,]
Lai Laimiņa gausi deva, [To Happiness slowly gave]
Jaunai rudzu maizītei. [For a new rye bread.] (Cekstere 2004)

Bread was a blessing for home and family, therefore much attention was paid to the beliefs associated with it. Another folk song is dedicated to bread baking:

Kas vecā vārda klausa, [Who obeys the old's word]
Pilnu cepli maizes cepa,… [Bakes a full oven of bread…] (Rode 2013).

In Latvia, there are some customs about bread to follow.

- Do not give the other bread through the window, then you give blessing out of home too.
- If one drops a piece of bread, one must picked it up gently blow off the dust of it and kiss it.
- One should be angry when kneading the dough, then the dough will better ferment.

Knowledge of the value of sourdough rye bread is inherited from generation to generation. In the research work "Our Daily Bread" (*Mūsu maize*), the ethnographer Indra Čekstere (2004) explains that in Kurzeme (historical and cultural region in Western Latvia), the sourdough rye bread (*rupjmaize*) is known as "*salinātā*". Part of the rye flour has been scalded with hot water. A piece of dough from a previous batch of bread is dissolved in warm water and added as a sourdough. The runny dough is mixed in the wooden pail and left overnight to ferment. It is beaten with a long wooden spatula. In the morning, the kneading process starts. The kneading takes a long time, with caraway seeds (*Carum carvi*) and more rye flour being added. When the dough no longer sticks to the hands, it is ready. The tub with the fermenting dough is placed next to the oven and long small loaves are shaped on the peel, which is covered with a dusting of rye flour or maple leaves and quickly placed in the oven (Cekstere 2004). Also the publication Latvian traditional dishes (*Latviešu tradicionālie ēdieni*) notes that right up until the early twentieth century the main activities among Latvians and Livonians were farming and fishing, and so the staple of their diet consisted of homemade sourdough rye bread and various boiled dishes. The publication provides a description of '*salinātā rudzu rupjmaize*', noting that rye flour was used in the production of the bread and that this rye flour was partially scalded (Heinola and Stinkule 2006). The dough was prepared in a wooden tub (Fig. 10.1) and its fermentation was ensured by sourdough left from the previous batch of dough bread and microorganisms preserved on the sides of the tub. Long loaves were formed from the dough and further baked in a wood-fired oven.

In the book "Diverse bread" (*Daudzveidīgā maizīte*), bread making expert Zigrīda Liepiņa (1993) also gives a description of the production of traditional "*Salinātā* rye bread" (*Salinātā rudzu rupjmaize*) as it was still made at the beginning of the twentieth century. The description emphasizes the uniqueness of the rye flour scalding and the duration of its fermentation in wooden pails, which create the distinct and pleasant aroma of the bread and its porous and elastic crumb. The housekeeping and handicrafts teacher Marija Leiše (1931) described the way of preparation and the recipe for "*Salinātā* rye bread". She noted that it was the best to use a vessel made from deciduous wood to prepare the bread, and that a certain amount of hot water should be poured over a part of the rye flour and that this should then be

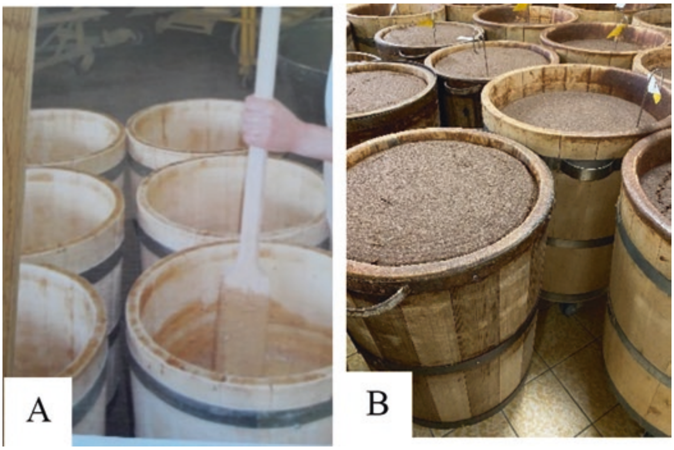

Fig. 10.1 The scald preparation process (**a**) scald is mixed with a wooden spatula, (**b**) ready scald. (Photo R. Murniece)

mixed with a wooden spatula until the dough attains a homogenous consistency. Around 12 h later, when the scalded rye flour has cooled, sourdough is added and the mixture is allowed to ferment and, afterwards, the dough is kneaded. The fermented dough is then divided into pieces and baked in a hot hearth oven. Linda Dumpe (2006) described the way in which "*Salinātā* rye bread" was baked around 1915 in her publication "Latvian national dishes" (*Latviešu tautas ēdieni*), based on the material gathered during ethnographic expeditions. She noticed that 'normal' bread was fermented using warm water at 45–65 °C, while "*salinātā*" bread was first scalded using hot water at 95 °C. It was mixed until the dough no longer stuck to the hands and a white stripe remained when it was pulled at with a finger. The kneaded dough was covered with linen towel and fermented again in a warm place. Similar to other authors, she noted that the fermented dough was divided into pieces, formed into elongated loaves and baked on a hearth oven. Water or starch paste (water and potatoes starch) were then applied to the hot loaves. This made the crust soft and glossy. Nowadays, sourdough rye bread is one of the Latvian National treasures and cultural heritage – a treat for guests who want to get to know Latvian culture, a souvenir that we take abroad and take on a trip ourselves, so that we have the feeling of home!

2 Characteristics of Latvian Sourdough Rye Bread

Bread has always been the main product of Latvian cuisine, which provides a feeling of satiety. In this respect, Latvia is very rich country with unique and well-developed baking traditions, especially in sourdough rye bread. Special rituals of honor and blessing are dedicated to Latvian bread! Numerous Latvian folk songs and beliefs are known to address bread, and ethnographic and historical expositions are created in museums. The power of Mother Nature in the loaf accompanies human's life, and it has also been included in the prayer … "Give us this day our daily bread …". However, it is a bread with a great cultural and historical added-value, knowledge and skills. It requires hard handwork and considerable time to bake. In order to promote the traditions and national value of sourdough rye bread, scalded rye bread baked according to the oldest traditions was awarded in 2014 with a certificate of traditional character guaranteed by the European Commission [Commission Implementing Regulation (EU) N° 12/2014 from January 8th] entering the name in the register of traditional specialty guaranteed (TSG) [Salinātā rudzu rupjmaize (TSG)]).

Figure 10.2 shows an image of "*Salinātā* Rye bread" from a medium-size industrial bakery. Bakery LTD "Lāči" has always appreciated the traditions, and strived to cultivate and popularize them. Several small and medium-size bakeries throughout Latvia try to maintain baking traditions and choose to produce "*Salinātā* Rye bread". In recent years, there has also been an increase in individual bakers, who often use the European Commission certificate [Commission Implementing Regulation (EU) N° 12/2014] as the accepted recipe for sourdough rye bread baking.

Sourdough rye bread (*Rudzu rupjmaize*) is a naturally fermented bread, baked in Latvia from rye flour, with scalded rye flour and sourdough being used in the fermentation process. This type of sourdough bread is baked in a hearth oven and loaf weighs about one or more kilograms, with a smooth and glossy crust, to which starch paste or water is applied after baking.

The external appearance and shape of this traditional Latvian sourdough rye bread may be described as an elongated loaf with rounded ends, at least twice as long as it is wide. Moreover, a mark may be made on the top of the crust, and imprints may be made on the sides.

Fig. 10.2 LTD "Laci" "*Salinātā* rye bread" as product in supermarket. (Photo from LTD Laci) and traditional sourdough rye bread. (Photo G. Duka)

Fig. 10.3 The map of Latvian blessing-bearing bread signs in different regions of Latvia, and examples of sourdough rye bread with Latvian blessing-bearing signs in bread. (Photo R. Murniece)

When baking traditional Latvian sourdough rye bread, each baker marks it with the Latvian blessing-bearing signs, which vary according to the ethnographic regions (Fig. 10.3). Mara's cross, the sign of Sun, and the cross are often used, as depicted in Fig. 10.3.

Latvian sourdough rye bread is baked on a hot hearth oven, not on the recurrent baking trays or in the molds. This ensures an intensive transmission of heat, preserving the hand-shaped form of the bread and creating a larger loaf with a stronger crust.

The value of sourdough rye bread lies on its texture, taste and aroma. The crust is typically dark, smooth and glossy. It may be sprinkled with caraway seeds or marked with Latvian blessing-bearing signs, and there may be bran, flour or maple leaves on the underside of the crust. Regarding the crumb, it can be described as dark, with larger or smaller pores, elastic and may be slightly moist. Finally, the taste and aroma can be defined as a pleasant aroma of baked bread and caraway seeds, with a sweet-and-sour sourdough rye bread taste.

3 National Sourdough Rye Bread from Recipe to Bread

The rye flour in this traditional Latvian bread is scalded in order to make '*Rudzu rupjmaize*,' Traditionally, the scalded rye flour or scald is prepared in the wood tubs made from planks of deciduous wood from aspen or lime trees, with a volume of approximately 30 L. The scald is mixed with a wooden spatula. After dough preparation process the tub is not washed but is carefully scraped out and kept in a dry place. Therefore the microbiota being present in the wood pores of the tub from previously fermented dough stimulates fermentation. Each baker had his own special rye bread recipe, some are sweeter other are more sour. The main ingredients used for "*Salinātā* rye bread" recipe is summarized in Table 10.1.

The basic ingredients in Latvian sourdough rye bread baking are rye flour, caraway seeds and unfermented malt (Fig. 10.4).

Table 10.1 Recipe of "*Salinātā* rye bread"

Ingredients	Amount of ingredients	Temperature
Scald		
Rye flour (wholegrain)	3 kg	
Caraway seeds	0.08–0.1 kg	
Hot water	6–8 L	85–95 °C
Unfermented malt	0.2–0.3 kg	
Fermented scald		
Cooled scald	7–10 kg	37 °C
Sourdough	0.4–0.6 kg	
Dough		
Fermented scald	7–10 kg	30 °C
Rye flour (wholegrain)	7 kg	
Sugar	0.4–0.8 kg	
Salt	0.15–0.2 kg	
Total	~18 kg	

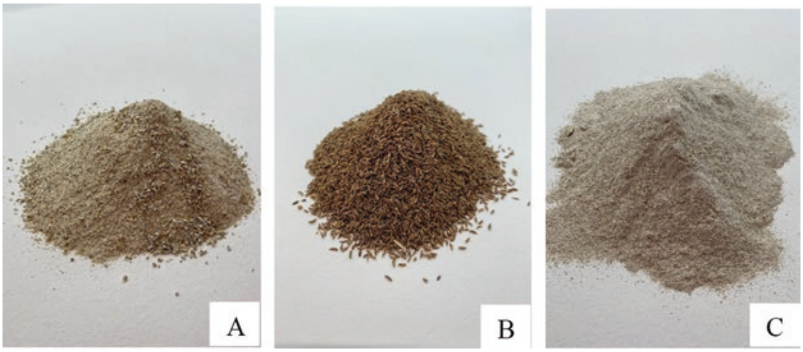

Fig. 10.4 Basic ingredients for rye bread preparation: (**a**) wholegrain rye flour; (**b**) caraway seeds; (**c**) unfermented malt. (Photo R. Murniece)

Whole grain rye flour (*type 1740*), *i.e*. 98% (w/w) of a grain is milled. From the nutritional standpoint, this type of rye flour is the most complete but in bread making its use is very challenging. Often wholegrain rye flour has coarse particles, which slowly swell in the dough. According to Straumite (2006) it is important to have rye flour with good baking properties, namely, – Falling number of 160–190 s, starch gelatinization temperature of 65–68 °C and starch gelatinization maximum of 350–650 AU When baking traditional sourdough rye bread, it is recommended to use traditional rye varieties that have been inherited from our ancestors. In Latvia, it is the rye variety "Kaupo".

Caraway seeds come from an herbaceous plant and they contain 1–6% (w/w) essential oils and 95% (w/w) of weight is composed by carvone and limonene – known to possess antibacterial properties (Sedlakova et al. 2003). Consequently, when caraway seeds are added in sourdough rye bread, it gives a special taste and adds antibacterial properties.

Unfermented malt is the germinated and dried cereal grains used in food as a natural colorant, flavoring and sweetener. Unfermented rye malt in Latvia is traditionally used in bread making as a source of enzymes (in particular, the α-amylase). The enzymes α- and β-amylases are fundamental in helping to hydrolyze starch into reduced sugars and dextrans – which are fundamental for the fermentation process.

3.1 Preparation of Scald

Around 30% (w/w) (3 kg) of the total amount of rye flour (10 kg) used to produce the sourdough rye bread is used to make the scalded rye flour. The rye flour set aside for scalding and together with the caraway seeds it is combined with water having temperature around 95 °C. Following this process of approximately 2–4 h, the temperature of the scalded rye flour should be around 63–68 °C. The temperature of the scalded rye flour is continuously decreasing during its cooling process, reaching approximately 24 °C after 12–24 h.

Usually 2–2.5 fold more tap water than rye flour is required. Water is added gradually so that the rye flour and water can be mixed more easily into a homogeneous dough with a consistency similar to that of thick cream (Fig. 10.1). When the scalded rye flour is at a temperature of 63–65 °C, approximately 200–300 g of unfermented rye malt is added, and should be well mixed. The enzymes α- and β-amylases from unfermented rye malt actively hydrolyze starch from rye flours and form dextrans and maltose. In the further process of scalding, the enzyme maltase hydrolyzes maltose into simple sugars – glucose and sucrose, which gives a sweet or "*Salinātā*" taste. Caraway seeds and malt provide to the scalded rye flour with the caraway-seed aroma and specific sweet-and-sour taste of the product.

The lactic and other organic acids, resulting from the lactic acid fermentation, gives the sour taste. When prepared correctly, after scalding and cooling processes the scalded rye flour dough has a homogeneous texture, but it is more liquid and with a light brown color.

3.2 Fermentation of Scalded Rye Flour

The cooling and fermentation of the scalded rye flour takes place in the same wooden tub over approximately 12–24 h. When the temperature is around 36 °C, approximately 0.2 kg of sourdough from the previous batch of bread is added to the scalded rye flour to stimulate the lactic acid fermentation.

Sourdough produced from rye flour and water, contains important microorganisms, mainly lactic acid bacteria and yeasts, which activity results in a steady increase of the dough acidity and the formation of carbon dioxide. Microorganisms are in an active form and undergo active fermentation processes in the bread dough. Sourdough can be prepared using the three-phase method or resorting to microbial starter cultures, but often bakers use the dough from previous batch as the source of microorganisms. In the past, such piece of dough was called the "*abrkasis*". This name comes from the fact that after cleaning or scraping the wooden tub, called "*abra*", they get a piece of dough, which is later used as a sourdough. Every baker kept and cared for it, because this piece of dough was the main secret of bread since the microbiota present therein influences substantially the taste and aroma of the final sourdough rye bread. Today, small and medium-sized industrial bakeries also use the previous dough, but it is renewed every week by adding rye flour and starter cultures of microorganisms. High-quality sourdough must have a pH of 3.6–4.0, total titratable acidity of 12–17 mL NaOH/10 g, concentration of lactic acid bacteria not less than 10^8–10^{10} CFU/g and of yeasts not less10^5–10^7 CFU/g.

The sourdough should first be added only to the upper part of the tub, then after a couple of hours later it should be spread deeper, halfway down through the scalded rye flour and, finally, right to the bottom.

Scald temperature is of the greatest importance, when adding the sourdough to the scald. It must not exceed 37 °C, otherwise microorganisms would lose their activity or even their viability. The temperature of the scald can be measured using a thermometer or by putting a hand in the scald. If it is not too hot, the sourdough can be added. During the scald fermentation, lactic acid bacteria actively produce a variety of metabolites. Sourdough often contains three types of lactic acid bacteria (LAB), which form different metabolic pathways: the homofermentative lactic acid bacteria (*e.g*. *Lactobacillus plantarum*) mainly form lactic acid; and the heterofermentative lactic acid bacteria like *Leuconostock* spp., which form lactic and acetic acids, and other heterofermentative like *Lactobacillus brevis*, which form acetic, lactic, malic and succinic acids and CO_2 (Gobetti and Gänzle 2013). Yeasts from the spontaneous sourdough also play an important role in sourdough microbiota. *Saccharomyces cerevisiae* isolate from sourdough is more tolerant against acetic acid compared to baker's yeast. Symbiosis between LAB and yeasts is significant for the community dynamics and stability of the sourdough microbiota (Brandt et al. 2004). Acids produced by the fermentation process have different roles in the taste and aroma in the dough and final bread.

3.3 Dough Kneading

When the scalded rye flour is fermented, the dough is kneaded in a wooden kneading tub or a kneading bowl. According to recipe of "*Salinātā* rye bread" Table 10.1 rye flour (~70%), sugar (~5%) and salt (~1,5%) are added to the scalded rye flour dough after it has fermented, and up to 10% wheat flour may be added as well. The dough is kneaded until it no longer sticks to the hands and all the ingredients are evenly mixed together. The upper surface of the dough is evened out with wet hands, and the dough is covered with wooden cover or linen towel and kept in a warm place (T ≈ 30 °C) to continue fermenting. Moreover, bread signs are often marked on the surface. Splitting in the upper surface of the dough and a doubling in size shows that the dough is already fermented. Now, it can then be divided and baked in the oven.

3.4 Dividing Dough

The fermented dough is divided into pieces, sized from 1 till 5 kg. Sourdough rye bread pieces are formed into elongated loaves which are then smoothed over with the wet hands. On the larger loaf sides are formed dents and the surface is marked with the special blessing signs, thus preventing cracking loaf. Loaves of dough can be placed onto surfaces covered with cloth, on the boards or peels, which have been previously sprinkled with bran or covered with maple leaves, and are then placed into the oven.

3.5 Sourdough Rye Bread Baking

The loaves are baked on the hot hearth, not on baking trays or in molds. The oven is heated to a high temperatures (280–350 °C) at the start of baking, so that a stronger crust is formed and will not split (Fig. 10.5). Afterwards, baking continues at a

Fig. 10.5 Top left fermented dough, top right and bottom left dividing and shaping of rye loaves, bottom right rye sourdough bread baking. (Photo G. Duka and R. Murniece)

lower temperature (200–250 °C). Baking takes place for approximately 1–2 h, depending on the loaf size. When removed from the oven, starch paste or water is applied to the hot loaves, giving a softer and glossier crust.

After being baked, the hot bread is left to cool down and then placed in a cool, well-ventilated room or covered with linen cloth. After cooled, the bread can be sold as an uncut loaf or cut into smaller pieces or slices. The bread can also be packed in a cloth, paper or plastic bag. It can be kept at room temperature (15–25 °C) or frozen (−18 °C) instead. Sourdough rye bread stays fresh for a long time, and can be kept for at least 5–10 days.

Enjoy your meal!

4 Nutrition Aspects of Sourdough Rye Bread

For centuries, northern nations, including Latvians, have grown rye that is modest for soil quality and weather conditions and used sourdough rye bread in their daily diet, thus the human body has learned to receive the necessary nutrients from it. Rye is the most energetically rich cereal (Ozolina 2012), which in a long technological process is transformed into delicious sourdough rye bread, able to retain the power of nature. The summer sun, rain cools and fertile land have given them an immeasurable amount of energy, so the power of grain baked in bread is a source of human health, which gives joy to both mental and physical workers.

It is assumed that sourdough rye bread, which is fermented and baked according to the traditional recipes, produces flavors and aromas that stimulate appetite. The nutritional value is so high that one slice is enough to reach satiety, and one of the most important reasons is because the long fermentation process improves the digestibility of rye flour nutrients. Additionally, due to the long-term fermentation process with sourdough, which contains natural microorganisms (bacteria and yeasts), sourdough rye bread retains and makes available the valuable rye flour vitamins, fiber, minerals and compounds that act as antioxidants among other health benefits. According to the nutrition specialist Dr. Laila Meija (2014), food, movements and thoughts that heal are relevant in solving health problems in today's world. Sourdough rye bread, especially baked from wholegrain rye flour, not only gives strength but improves health and can be called a functional food (Meija 2014). Nutritional value of sourdough rye bread depends on the rye flour used for bread making. Bread contains 45–55% carbohydrates, 6–10% proteins and 1–2% fat (Kunkulberga and Segliņš 2015). Traditional Latvian sourdough rye bread is made from wholegrain rye flour, using the long-term sourdough fermentation, therefore the bread has more available nutrients and is healthier. Latvians often say that sourdough rye bread is our super product (Fig. 10.6).

Carbohydrates provide strength and energy to the body (Fig. 10.6). The most important polysaccharide in sourdough rye bread is starch. On average, 60% (w/w) of the starch in bread is completely digestible and assimilated by the human body. Sourdough rye bread contains also small amounts of monosaccharides (arabinose

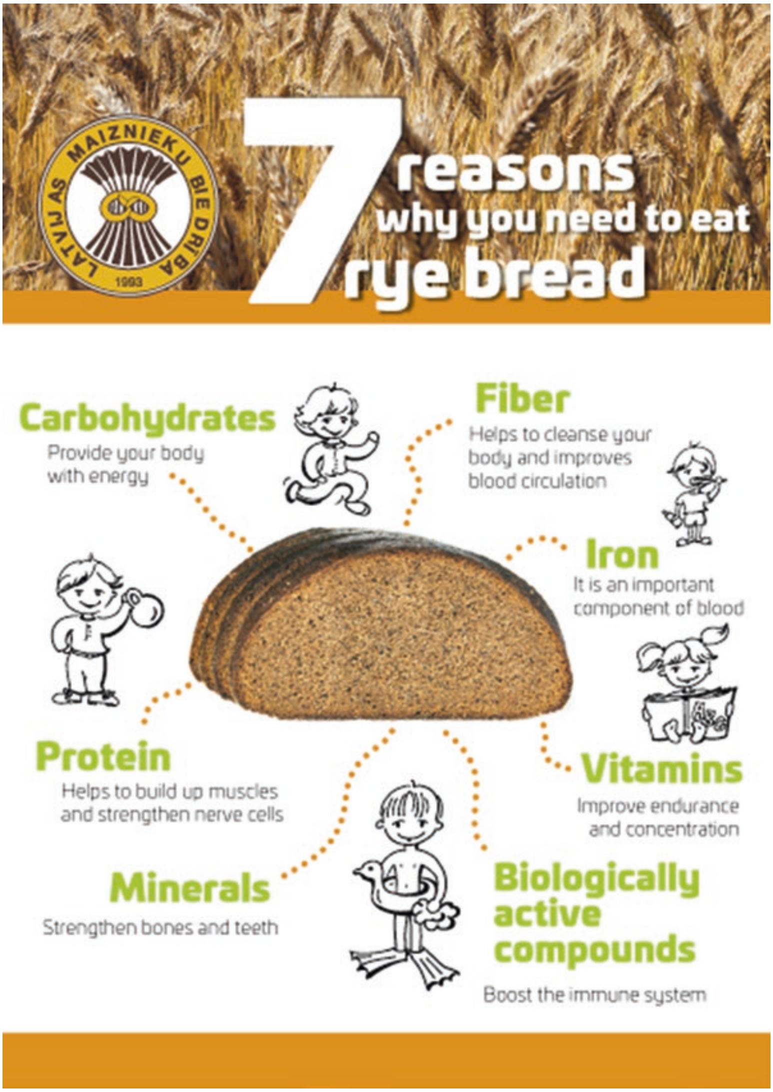

Fig. 10.6 Leaflet of Latvian Bakers' Association explaining the "7 reasons, why you need to eat rye bread". (Author G. Duka and Latvian Bakers' Association)

and xylose) and oligosaccharides (sucrose and maltose), which give color, taste and aroma to the bread.

Proteins provide the body's plastic function – strengthens muscles and nerve cells (Fig. 10.6). Proteins are organic compounds composed of amino acids and play an important role in life processes. Grain proteins contain 20 amino acids, including 10 essential, which are not synthesized in the body. Protein biological value shows how many grams of protein in the body is formed from 100 g of dietary proteins. The amino acid composition of sourdough rye bread is different from the most commonly used wheat bread. Rye wholegrain products contain more essential amino acids lysine, threonine and phenylalanine because they are present in the outer layer of the grains. The ratio of essential amino acids in sourdough rye bread indicate their biological value higher than that of wheat bread.

Dietary fiber participates in the regulation of the digestive tract, normalizes blood cholesterol and sugar levels (Fig. 10.6). Fiber in whole grain products is combined with various biologically active compounds that have a functional role in the human health and prevention of diseases. Fiber is divided into water-soluble and water-insoluble. In rye, the soluble fibers – arabinoxylan, β-glucan, and the soluble fibers – cellulose and lignin, are of the particular importance (Kunkulberga and Ruža 2008).

The scientist Vija Ozoliņa from the Latvia University of Life Sciences and Technologies found that the total dietary fiber content of the Latvian traditional sourdough rye bread is 13.0 g per 100 g (Ozolina 2012). The obtained results suggest that wholegrain rye bread is a rich source of dietary fiber, containing more than 6 g of dietary fiber per 100 g (EC Regulations No 1924/2006).

Sourdough rye bread is high in fibers associated with biologically active substances, including alkylresorcinols (AR) and lignans, which have antioxidant activity. Phytoestrogens are subdivided into three major classes: isoflavones, lignans and coumestans (Cornwell et al. 2004). Predominantly, lignans are the most important sources of phytoestrogens in western diet (Carmichael et al. 2011; Zamora-Ros et al. 2012). This is collectively referred to as the so-called protective 'fiber complex'. The results of the Dr. Laila Meija research showed that the amount of AR and lignans in Latvian rye bread is high compared to wheat bread. The total AR content varied from 560 to 840 μg/g (in dry matter) and the amount of lignans in rye bread is approximately 800–1400 μg/100 g of product, but in wheat bread 80–100 μg/100 g (Meija 2014, Meija et al. 2012). Meija (2014) in her scientific study concluded that lignans and alkylresorcinol sourdough rye bread might delay the progression of prostate cancer.

Biologically active compounds provide the immune system boost (Fig. 10.6). Wholegrain rye products, which are rich in phenolic compounds, especially phenolic acids, are important for health benefits, and their consumption reduces the risk of chronic diseases. The scientist Vija Ozolina (2012) in her research about bioactive compounds in sourdough rye bread proved that total phenolic compounds content of the crust at any stage of baking is higher than the total phenolic compounds content in the crumb. The content of total phenolic compounds in the crust of traditional sourdough rye bread was determined to be 1344 and for crumb 1170 μg/g. Phenolic compounds are characterized by unique antioxidant capacity in sourdough rye bread.

B group and E vitamins strengthen the human immune system and increase concentration (Fig. 10.6). Vitamins play an important role in the human body, so they should be included in the diet every day. The outer layer of cereals is rich in B vitamins. Sourdough rye bread is an important source of B1 (thiamine), B2 (riboflavin), B3 (niacin), B5 (pantothenic acid) and B6 (pyridoxal), as well as carotenoids and vitamin E. The research of Ozoliņa (2012) has shown that total amount of thiamine

(B1) in sourdough rye bread is 0.32 mg/100 g dry matter (DM). Yeasts and lactic acid bacteria synthesize water-soluble vitamins during fermentation, so the content of riboflavin (B2) in bread increases up to 0.58 mg/100 g DM compared to rye flour. Niacin (B3) content decreases in sourdough rye bread when compared with the respective rye flour and dough to a total amount of 5.93 mg/100 g DM. Comparing the results obtained in the study of Ozoliņa (2012) with literature data on vitamin content in similar bread samples, as well as the recommended daily allowance (RDA), it can be seen that the highest coverage of RDA in sourdough rye bread refers to the riboflavin, niacin and thiamine. Sourdough rye bread is an important source of vitamins in the diet of the population, because 100 g of whole grain rye bread contains 21% (w/w) thiamine, 29% (w/w) riboflavin, 27% (w/w) niacin and 13% (w/w) a tocopherol of the RDA (Ozolina 2012).

In a research work from V. Ozolina, the analysis of α-tocopherol (vitamin E) content and its change during fermentation and sourdough rye bread baking showed similar tendency. During rye dough fermentation its content increased but during baking a 30% (w/w) decrease was observed. The total content of vitamin E in sourdough rye bread reached 2.17 mg per 100 g DM, according to researcher V. Ozolina (2012).

Minerals (zinc, calcium, phosphorus, sodium, potassium and magnesium) strengthen bones, and improve dental, oral health and blood composition (Fig. 10.6). The availability of minerals in the cereal components differs. Their distribution in rye grains outer layer is ten-fold greater than in endosperm. The amount of minerals or ash determines the quality of the rye flour and the possible presence of the outer skin of the cereals and the germ. This means that sourdough rye bread is rich in calcium (56 mg/100 g), sodium (424 mg/100 g) and magnesium (40 mg/100 g). Minerals are necessary for all life processes in the body because they are a kind of building blocks, a component of colloidal solutions that regulate the reaction of osmotic pressure enzymes and the transmission of nerve impulses (Kunkulberga and Seglins 2015).

Furthermore, iron is an important component of blood. The amount of iron in sourdough rye bread is 3.0 mg/100 g (w/w). In the sourdough rye bread the phytate content has to be considered due to its large impact on iron bioavailability, and absorption of iron in the body (Hallberg et al. 1987). The long time sourdough fermentation processleads to a considerable reduction of phytate content, which makes sourdough rye bread a significant source of iron.

Scientific investigations prove that regular consumption of sourdough rye bread has a positive impact on health: sourdough rye bread reduces the risk of cardiovascular diseases, prevents breast and bowel tumor formation, improves digestion, inhibits cholesterol absorption and reduces the risk of type-2 diabetes (Golikova 2021).

5 Concluding Remarks

The national value of sourdough rye bread in Latvia has been saved through the different centuries, social, political and cultural times. Its value has also been saved with the development of industry and science in Latvia.

Normunds Skauģis, the owner of the bakery "Lāči" Ltd. and a master of bakery, has said:

> Latvians have the most excellent sourdough rye bread, which we bake according to the ancestral recipes. It is the highest pilotage in the bakery business world. No one has come up with anything better. We have reason to be proud that we know how to ferment it, bake it and get the product with the highest added value.

Valters Kanopa, production manager of N.Bomja bakery Ltd. "Lielezers", master of bakery also expressed his opinion:

> Bread is one of the warmest symbols in our language. The word "bread" in its "value" is in part equated with both a mother and a hearth, essentially a small micro space around which one's own gather.

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Chapter 11
Malta's Sourdough Breads

Noel Buttigieg, Christopher Magro, Arianne Muscat, Stephen Decelis, and Vasilis Valdramidis

1 Introduction

Maltese scientist Sir Temi Zammit (1902) admitted that in the case of Malta, 'There is nothing else that is eaten more than bread … it's the first need for human beings and I don't know what we would have done without it'. One hundred and twenty years later, Zammit's scientific treatise *Chelmtein fuk il hobz* still resonates, albeit for different reasons, with Malta's sourdough bread culture.

Similar to other Mediterranean countries, bread dominated every aspect of life of the inhabitants of the Maltese archipelago. Since medieval times, Malta's grain production output did not suffice to feed the entire population. Consequently, as the centuries progressed, Maltese governments strived to acquire large quantities of grain imports for its daily sustenance (Bellizi 1993). The direct dependence on foreign sources, coupled to the omnipresent fear of hunger, propelled the nation to develop a highly articulate bread culture.

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Today, the spiritual and temporal meanings of Maltese bread have changed significantly. In a globalised world, the consumer is spoilt for choice. The Maltese bread-eaters have developed a taste for other types of bread. Amid such developments, sourdough bread is still a popular fare. This is best shown through the recent recognition of *ftira*, a sourdough flat bread that was recently registered as part of UNESCO's World Intangible Heritage for Humanity.

2 Reminders of Malta's Bread Culture

Bread was more then a vector of life. Not only was it essential in the diet, but also intrinsically ingrained in historical consciousness and culture of Maltese citizens. As a symbol of daily survival, bread was loaded with temporal and spiritual charge. The disparate value of grain in the local market influenced the grading of bread. The quality of the product was aggregated according to its colour which invariably became a symbol of social and economic distinction. Bread also symbolised Divine prosperity, as charity was best represented through the giving of bread. It formed a part of the religious calendar and village festivals (the *festa*) celebrating local patron saints. As an essential means of survival, raw and processed grain penetrated the Maltese way of parlance, with numerous idioms and metaphors describing various life situations and meanings (Cassar 1994; Cassar-Pullicino 1961; Gambin and Buttigieg 2003).

For the local populace, these reflections state the obvious. Nevertheless, the symbolic meaning of bread underwent significant changes through time. Until 50 years ago, much of the relationship between Maltese society and bread was strongly pragmatic. The Maltese wanted to eat their bread, they did not want to waste any of it, they were anxious on acquiring their supply, they organized a good part of their day around getting it and making it ready for eating. They were also very interested in creating strong intellectual and emotional bonds with bread. In fact, they talked a lot about their bread, as remarked by a nineteenth century Arab visitor (Gambin and Buttigieg 2003). Within this framework, the Maltese developed an elaborate set of symbolic concepts revolving around bread – symbols of human activities and relationships.

The association of bread and religion, and its holy nature, pushed humans to translate the supernatural into more temporal meanings. Several festive breads, such as those of St. Nicholas, St. Anthony or St. Basle are but few of the occasions which defined Maltese hospitality. Until recently, rituals associated with bread were commonly found among several European Mediterranean countries, such as Sicily, France, Spain and Malta. These include the tracing of the symbol of the cross on each piece of bread before consumption as a sign for Divine prosperity. When a piece of bread was dropped on the ground, this was immediately picked up, kissed and disposed appropriately. Bread consumers preferred to break into their bread using their hands rather than cutting it using a knife. Wasting bread was a taboo, to an extent that even crumbs were saved for later use.

Malta was no exception to the general understanding related to bread as a denominator of socio-economic distinctions (Montanari and Fochi 1992). Writing about dietary practices during the early modern period, Ken Albala (2002) locates bread as the focus around which the most interesting and subtle malleable food prejudices revolve. Similarly, Piero Camporesi (1989) refers to bread as 'a dietary metaphor of the two different cultural systems that find their focal point in bread'. The social significance of bread in Malta reinforced an already well established bi-polar perception of bread symbolism.

Bread was generally categorized into two standards, arranged hierarchically according to colour and texture. Bread made of white flour was considered to be of a fine quality for the higher echelons of society. The poor had to contend with a less expensive product. Wholemeal bread, sometimes even referred to as black bread, had a rough texture. A cursory look into the language employed in local documents immediately emphasises the above reflections. White bread was always referred to as *pane*, breads of an inferior quality as *misturato* or in local parlance *tal-mahlut*, bread made from a mixture of grains, normally with a concentration of barely.

When included in Maltese idiomatic expressions, bread becomes an expression in metaphorical terms. A cursory look at some local idioms directly referring to the word *ħobż* (bread) or any of its variations are enough testimony of some socio-cultural constructs. The inquisitive type would ask *x'ħobż jiekol dan*? (lit. what type of bread does he consume?), if wanting to know about the socio, economic, or political status of a person. If interested in employing the services of an individual, the last thing the inquirer would want to hear is *dak ma jiswiex il-ħobż li jiekol* (lit. he is not worth the bread he eats) or *mhux ħobż għal snienu* (lit. this bread is no good for his teeth). If a person could live up to an expectation the Maltese say *jikolha mal-ħobż* (lit. he eats it with bread) (Aquilina 1975; Fenech 1970). The inferences made through bread generate a number of emotional parallels. The transaction, in other words the idiom, is sandwiched between the transmitter and the receiver. Here a number of socio-cultural norms are given a new understanding which is not easily deciphered by the outsider. The edible, that is bread, is given a non-edible understanding which could imply several psycho-emotional meanings such as frustration, recognition, honour, shame and degradation. In general, these idioms evaluate human behaviour against the ability of those same humans in expressing responsibility and control over bread on both a human and spiritual level.

Today, most of these practices have faded away. Amid such transitioning, the heritage of Maltese sourdough bread across the Maltese archipelago is still extremely vibrant. The culture of different types of sourdough breads illustrates well the interlinkage between tools (such as ovens), sites (such as bakeries or old windmills) and intangible heritage practices (such as bread-making and consumption).

3 Sourdough Bread Production from the Baker's Perspective

At face value, bread confection appears as a casual and straightforward process. The real experience, however, is remarkably different and the outcome can be quite unpredictable. The preparation of sourdough bread is made from a series of separate, yet interdependent, processes. Perceived as rather easy to the untrained eye, a mistake during any step of the preparation process could seriously jeopardize the quality of an entire batch. The skilled artisan has to read and understand all the chemical mutations taking place just before his eyes. In the case of Malta, artisanal bakers often go through the entire bread making process, generally unaware of the bio-chemical transformations which alter four simple ingredients into the most sought out food since time immemorial (Agius 1994). Zammit (1902) explains how, '*… ma ssibx wihed f'elf li jaf il ghala ighamel hecc u m'hux xorta ohra'* [lit. maybe one in a thousand might know of why to adopt this method rather than any other]. The 1994 research commissioned by Medigrain Malta (Agius 1994) holds the same opinion. From a positive standpoint, the conservative mindset made it possible for the Maltese baker to remain more faithful to a bread making process which has developed significantly over the past 50 years, and especially with the turn of the millennium. Although, these developments were generally perceived as positive ones, time also brought to light several unintended consequences, including an increased concern on the quality of Maltese sourdough bread.

To this day, most bakers use recipes passed onto them from their mentors or families. This was also communicated verbally through our research on the subject by various bakers who were willing to divulge information about the recipes and methodologies currently being adopted. Generally, Maltese bakers use the same dough to produce the two main types of bread, which are the Maltese Bread (Fig. 11.1) and the Maltese *Ftira* (Fig. 11.2).

Fig. 11.1 The Maltese Bread. (Own Image of authors)

Fig. 11.2 The Maltese *Ftira.* (Own Image of authors)

4 Leavening Agents

Until relatively recent time, Maltese bakers remained faithful to the long fermentation process using mainly natural leavening agents. When Temi Zammit published his research, the twentieth century Maltese bakers still employed an 'old' method of fermentation. He also remarked how local bakers still avoided using other leavening agents, which accelerated the fermentation process. Nine decades later, the French Hubert Chiron, a researcher within the *Institut National de la Recherche Agronomique* [INRA] of Nantes, noticed how such practices have been gradually introduced by many Maltese bakers (Agius 1994). Within a generation since Chiron's study, the use of accelerators and other additives among sourdough bread bakers became the norm rather than the exception.

The change in the bread making process, triggered by various developments within the industry itself, affected one of the most important key processes that defines sourdough bread from any other breads. Parmentier elevates the subscribes of the fermentation process to 'the soul of the bread-making process'. The mother dough is alive, reflects Temi Zammit, *'il hmira ticber fil ghagina ghax tcun tgheix'* [lit. the mother dough grows in the confection because of its living nature]. According to Parmentier and Zammit, the leavening agent was stored in such a way that the fermentation process was not tempered by any environmental conditions such as cold air, direct sun light, and odours (Kaplan 2006). Each batch had to be kept sheltered from any drafts and ideally stored in a warm place with a relatively constant temperature – *'ghalec il hmira biex tigi il koddiem ma tridx chesha izda diefa. Collox igheix ahjar fis-shana.'* [the starter leaven improves only if not stored in a cold environment. Anything lives better in warm environments] (Zammit 1902).

In recent years, many Maltese bakers became increasingly convinced that the preparation of a fermentation agent shackled the workplace, reducing any possibility of recovering between each day of work. The only way of how to reduce the time of producing a batch of bread was to introduce leavening agents that could accelerate the rising of the dough. Especially in countries with a history of beer production, bakers introduced barm or brewer's yeast with natural leavening agents to further reduce the rather prolong bread dough resting periods.

4.1 Kneading

The rheological nature of the kneaded dough depends on a number of variables including the quantity of ingredients, the type of water, the flour used during the kneading process, the quality of the fermenting agent, the machinery engaged in the kneading, and the ambient temperature of the bakery.

The process starts with the mixing of the fermenting agent with water and an amount of flour. More flour is added to the mix, employing electric mixers to sustain a lively dough. This process continues until all the ingredients [including salt and improvers] are well incorporated into a mass of dough.

The bulk fermentation process, otherwise known as the first rise or primary fermentation, is an important step during the bread confection process. As soon as the baker completes the mixing of the four main ingredients then the dough is allowed to rest. The process of fermentation depends on various factors including: the type of flour, the flour extraction rate, flour nutrients such as damaged starch and natural sugars, the flour's ability to absorb water, fermentation temperature, relative humidity of the fermentation environment, the quality of the starter leaven or refreshed leaven or the industrial yeast, the use of improvers and the duration of the fermentation process. During the first resting period, the fermentation process creates organic acids and carbon dioxide gasses. The bio-chemical process influences the flavour and strength of the dough while the gaseous build-up provides the dough with volume and lightness.

When the baker recognizes the moment when the dough reaches its ideal fermented stage, the dough is introduced to the next stage of cutting and shaping the dough before the second resting period.

4.2 The Bread Takes Shape

Moments after the full incorporation of the ingredients, the dough starts to rise. As the dough transitions from a rather rapid kneading process into a gentler one, the baker would occasionally fold the dough as it slowly continues to rise in the kneading trough. The kneading trough is normally covered with flour sacks to trap the heat emitted from the fermenting dough especially during winter. This stage is usually the longest period which allows the dough to develop its flavour. A reduction in the first fermentation period is precisely the most significant change [apart from the use of electric dough mixers] that the Maltese small-scale bakeries experienced in the past three decades. Such developments, were the result of the post-war modernization process that many Maltese artisanal bakers were completely powerless to resist. Amid such changes, only the experienced baker knows exactly what to look for before deciding when to break the waiting.

As soon as the proofed dough reached its optimal stage, the baker starts to cut the dough into smaller pieces. This manual process requires a dose of fine handling skills and a good sense of weight. The elastic nature of the confection is immediately introduced to the dough cutter to portion enough dough to form a loaf. In one swing the baker would grab a small amount of dough, cut a small lump, and then release it with a snapping effect of the wrist onto the weighing scale. Due to the repetitive nature of the process, bakers get an intuitive feel of the required weight. The expert baker does not even allow the scales to fully set in balance. The rapid motion of the fingers and the hands fold the elastic dough, then gently model it into its final rounded shape. Each shaped dough is then softly placed in a wooden tray for a short second resting period. During this period, some of the gasses lost during the scaling and shaping process will be partially replaced as the rounded loaves rest between 10 and 30 min before inserted into the oven for baking.

The handling of the dough during the scaling and shaping process involves a series of articulate physical actions. Consequently, poor handling could easily ruin the skin of the dough, allowing excessive release of important gasses. Inconsistent handling could result in different quality outcomes from the same batch. Afterall, the shaping of the elastic dough remains to be one of the most persistent markers of artisanal bread making in Malta.

4.3 Baking

Successful baking is the result of a synchronised timely exercise between oven heating, bread proofing and the insertion of the shaped loaves into the oven. The baking of the kneaded dough and its transformation into bread is widely held among researchers as the key stage throughout the bread confection process. Bread experts Steven L. Kaplan (2006) and Raymond Calvel (2001) emphasise how good baking qualities produce good tasting bread.

Prior to the final proofing session, the baker would have already prepared the oven for baking. Until the 1930s, in the absence of accurate temperature measuring equipment, the baker employed his skill and experience to judge the oven's temperature level. After an approximate feel of the oven temperature from the previous baking cycle, the baker inserted enough firewood to regenerate an optimal temperature without delaying the initiation of the baking process. The baker constantly watched the temperature by opening the mouth of the oven from time to time. Until the 1930s, bakers used their senses to decide on that moment when the oven was ready for baking. '*Mita il ħatab jinħarak collu*', Zammit explains, '*il ħabbież jiftaħ il forn u mil fewġa sħuna li toħroġ għal wiċċu jinduna jec il forn saħanx bizzeied*' [lit. once the firewood is burnt, the baker opens the oven door and depending on the heat that meets his face, he decides whether the oven has reached the right baking temperature] (Zammit 1902). Once convinced of optimal oven temperature, the baker carries out the final stage of the bread production process.

With the final proofing stage nearing its completion the baker transfers the shaped dough into the oven. Now the baker handles the live dough for the very last time. The skilled artisan uses the fingers to pick up each loaf from the tray using enough force not to break the outer skin of the shaped dough. The pickup is immediately followed by a flick of the wrist allowing the dough to land on the baker's hands. The baker then places the dough on the *palun* [lit. paddle] to start the strategic laying of the loaves on the oven floor. Kaplan (1996) refers to this short transitional phase as the baker's most anxious moment. The insertion of the shaped dough, argues Kaplan (2006), '… requires deftness, dexterity and speed …'. Each calculated stroke needs to deposit the shaped loaf in an exact location premeditated in the mental map of the artisan's oven. The laying of bread follows a specific pattern, both to accommodate all the shaped dough and also knowing the different types of baking required to produce different bread consistencies.

5 Sourdough Maltese Bread Production from Technological Point of View

5.1 Consumption and Local Practices

In 2018, the National Statistics Office (NSO) published data that indicated that the most popular commodity consumed is 'bread and cereals' (27.5%), both with regards to individual consumption as well as average household intake. Figure 11.3 depicts the food purchases for an average person on a daily basis in terms of energy values. Bread and cereals are the most bought food per person or household when compared to other food commodities, like meat and fish. This provides proof or understanding that bread is still one of the most popular foods consumed within the Maltese population balanced diet (NSO 2018). Different lifestyle factors might affect such results since the Maltese individuals, similar to most inhabitants of the Western countries, prefer a quick, relatively cheap snack for lunch at their respective workplace or home.

Wheat flour (*Triticum aestivum*) used by local bakers for Maltese bread baking is composed of a mixture of soft and hard wheat in the ratio of 40:60, respectively. The majority of wheat is imported from international countries mainly by two local companies, Federated Mills Plc. and Vernons Limited. Wheat is then milled locally at their respective facilities (Magri 2022). As a result, the variation seen in Maltese bread types in appearance, taste and quality is mostly dependent on the different recipes and methodologies used during the kneading process rather than because of different flour types and quality.

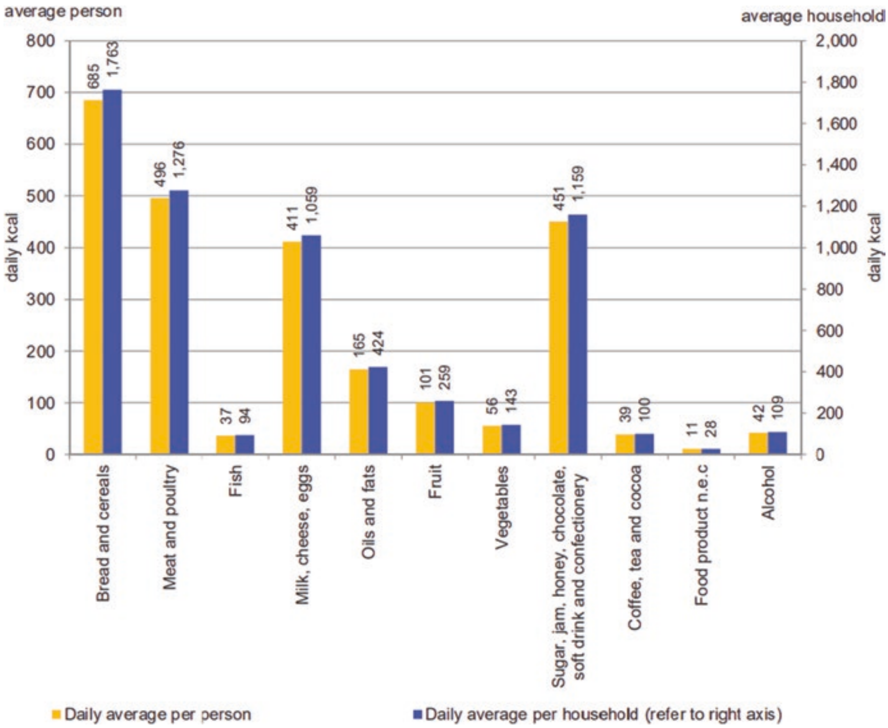

Fig. 11.3 Food purchases in terms of calories by the average person and by the average household. (NSO 2018)

5.2 Production Steps of the Maltese Bread

Maltese artisan bakers consistently use the same raw materials for the making of local bread. Water, dry yeast, salt and wheat flour are used to formulate the dough of the Maltese traditional bread, which essentially makes such food staple so simplistic and pure (Fig. 11.4). Most bakers use dry yeast while very few still adopt the traditional use of the mother dough, known in Maltese as "*tinsila*" (Aguis 1994, M. Tanti, personal communication, April 25, 2022). The conventional method that is being used to make bread involves the addition of salt (~0.1% w/w) to the water (~32.5% w/w). During the summer months cold water is added to the mixture, while during the winter months lukewarm water is used. Once the salt is dissolved, wheat flour (~64.75% w/w) is added intermittently during mechanical kneading of the mixture. During this ongoing process, dry yeast (1.5% w/w) is added. Table 11.1 details the common formulation used for Maltese breadmaking (Agius 1994).

The ingredients are allowed to mix slowly for 20 min to ensure complete homogenisation. This step is of utmost importance to determine the quality of bread, as is also the quality of the raw materials one use, which should work cohesively and complement each other to interact in order to reach a certain level of dough/

Fig. 11.4 Flowchart showing the process if Maltese Bread making

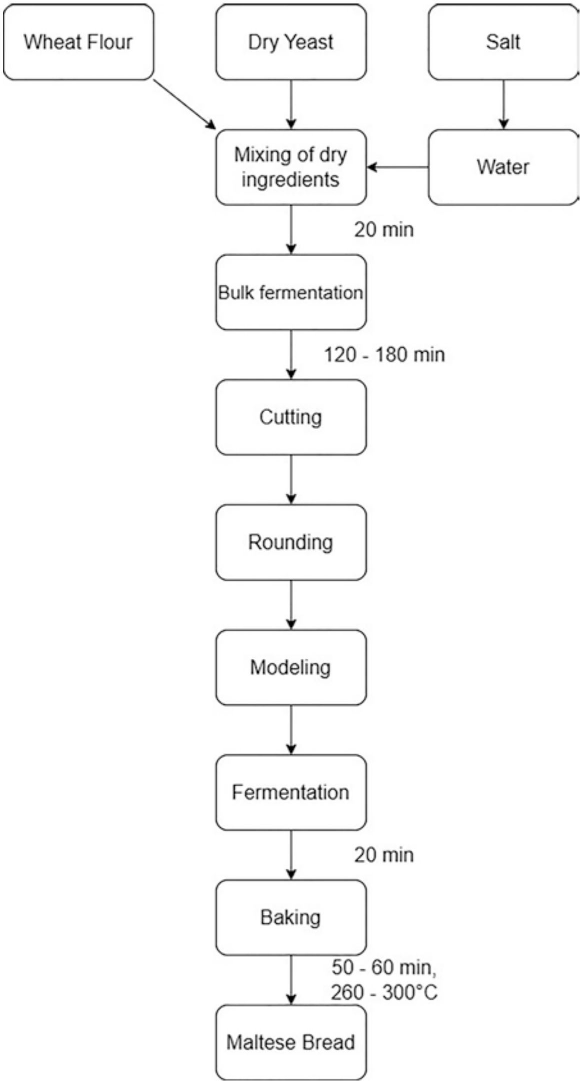

Table 11.1 Maltese bread recipe containing ratio for the dough

Ingredients	3–5 h
Flour	100%
Salt	0.5–1%
Yeast	2–2.5%
Water	50–60%

bread quality. The flour used for Maltese bread has a substantially high protein content. In turn the latter and with the introduction of mechanical energy and oxygen (air), oxidation and the formation of a robust gluten matrix is facilitated during the kneading phase, which allows carbon dioxide (CO_2) to be produced, trapped and retained. CO_2 is a natural by-product of yeast fermentation, which when retained, contributes to increased bread volume (Cauvain 2012; Cauvain 2016a, b). Artisan bakers probably do not know that such quality control testing exists, but such practices are more commonly found and used within bakery enterprises as a standard operating procedure for internal quality control testing and standardisation of the product.

Traditional bakers used to use wood dough mixers (Figs. 11.5 and 11.6) during the kneading of dough. Nowadays, bakers have invested in mechanical stainless-steel mixers which are more hygienic and reduce microbial cross-contamination, as one way to reduce and control bread spoilage in bakery products (Saranraj and Sivasakthivelan 2015). Then, the baker allows the dough to undergo bulk fermentation for 120 to 180 min at room temperature. The time taken for the bulk fermentation process depends solely on the ambient temperature. Hot ambient air will quicken the process of fermentation, while cold air will do the opposite. A damp cloth is usually placed on the tray to cover the container where the dough is placed. During the fermentation process, the baker performs manual folding of the dough from 2 to 5 times every 20 to 30 min of the resting process. This step is frequently referred to as 'knock-back' or punching down of the dough (Cauvain 2016a, b).

There is no available literature about quality or rheological assessments of dough used by Maltese bakers. Hence, we cannot compare physiochemical properties of the Maltese product with other European and non-European countries. Rheology testing aims to describe dough's physical properties and its mechanical

Fig. 11.5 Traditional wooden dough mixer. (Own Image of authors)

Fig. 11.6 Steel rotating hooks. (Own Image of authors)

properties, to characterise and compile what-if models on the dough's performance during processing and to provide detailed information on the molecular structure and conformation (Rosell 2011). Methods used to determine dough quality are mainly based on extensional deformations such as compression, shearing, bending or pulling apart. As a result, different parameters can then be determined namely stress, strain, stiffness, viscosity, consistency, extensibility, firmness and texture (Dobraszczyk 2016).

The dough is then cut into portions equivalent to one loaf of the bread. This is done manually by skilled bakers who mastered the art of baking, knowing exactly the amount of weight each portion should be cut into just by holding it into their hands. Dough portions would then be rounded and modelled by hand to form the loaf. Each dough ball is then placed onto a rectangular wooden tray covered in flour. These are then left to proof for approximately 20 min. The time taken for the second fermentation process depends on the size of the batch of bread dough initially produced. The aim behind this proofing step is to allow the yeast to produce CO_2 gas. During this step the level of yeast activation would have been reduced and a lower degree of gas is expected to be produced. Open cell structures are also formed which facilitate the final shape of the bread, when baked. It is important to avoid drying of the dough's surface, as this would lead to repercussions during baking since the dough would not be able to expand freely (Cauvain 2016a, b).

By using the same dough prepared, the baker would then proceed to create the Maltese *ftira*. The baker would manually shape the Maltese *ftira* by flattening the dough balls by hand, giving it an oval shape. The baker would then punch a hole in the middle of the flattened dough, so that during baking the bread could "breathe", allowing the *ftira* to adhere to its nickname as a double-layered flat bread. Most bakers typically fire their wood or gas ovens up to 300–400 °C. Once this temperature is reached, the baker proceeds to bake the *ftira* first, with the oven door remaining open throughout the short-baking time which is of roughly 15–20 min. During the baking time of the *ftira*, the baker is already putting the Maltese dough balls inside the oven for them to also start baking. Maltese bread generally takes 50–60 min to bake, since the temperature would then have been lowered to around 260 °C (M. Tanti, personal communication, April 25, 2022). Prior to baking the traditional Maltese bread, the dough is inverted such that the surface previously touching the wooden tray would then be the face of the bread. This step gives the traditional Maltese bread its unique, characteristic appearance. Skilled bakers also systematically position the dough inside the oven, which would allow the bread to rise and conjoin with the neighbouring loaves which brings about the Maltese bread sides as also seen in Fig. 11.1. In Maltese terms this is known as "*il-bewsa*" (Agius 1994). On one hand, artisan bakers do not pack any of their bread, except when they perform deliveries by using their own vans for the locals within the bakeries vicinities. On the other hand, industrial baking companies do pack their gluten free bread products, but the majority of such companies pack their normal wheat bread in simple plastic bags. The shelf-life of the Maltese bread is between 1–2 days when left at room temperature while the Maltese *ftira* has a shelf-life of around 1 day.

5.3 Dry Yeast Dough Identification Assessment

As limited information is available about the microbiota present in the dough for the Maltese *ftira*, some preliminary tests were applied. Dough was obtained from two different bakeries, one in Had-Dingli (West of Malta) and one in Haz-Zebbug (centre of Malta), in total, 500 g of dough was obtained. To homogenize the dough prior to plating, 10 g of each dough sample were placed in a stomacher bag together with 90 mL of saline Ringer solution. Homogenization was performed using a Stomacher apparatus (BagMixer® 200P, Interscience, Paris) for 2 min. MRS (de Man, Rogosa, Sharpe) (Oxoid Code: CM0361; Oxoid Limited, ThermoFisher Scientific Inc., Hants, UK), Dichloran Rose-Bengal Chloramphenicol (DRBC) (Oxoid Code: CM1148; HiMedia Laboratories GmbH, Einhausen, Germany) and Potato Dextrose Agar (PDA) (Oxoid Code: CM0139; Carl Roth Gmbh & Co. Kg, Karlsruhe, Germany) culture media were used for the microbial assessments in triplicates. The DRBC and PDA plates for yeast were incubated at 27 °C for 3–5 days while the MRS plates for lactobacilli were incubated for 1 day at 37 °C in 5% CO_2 (Gordún et al. 2018). After incubation the yeast plates were observed for different types of growth. Colonies where selected based on differences in their morphology and subcultured on Candida Chromogenic Agar (CCA) (Oxoid Code: CM1002; ThermoFisher Scientific Inc., Hants, UK) medium for analysis and identification by Matrix assisted laser desorption ionization-time of flight mass spectrometry (MALDI-TOF MS). The identified organism was *Saccharomyces cerevisiae*, which is in line with the yeast that most bakers use for bread making (Calvert et al. 2021; De Vuyst Neysens 2005; Lau et al. 2021; Nuobariene et al. 2012; Gordún et al. 2018). No *Lactobacilli* were identified which could be an indication the specific bakers did not follow the traditional sourdough starter production.

5.4 Sourdough Production

Before artificial and technological leavening agents were introduced to the producer, sourdough was the conventional leavening agent for *Maltese* bakers, especially when it comes to the production of the flat bread, *ftira* (Gänzle and Zheng 2019). Nowadays, only a few still use such an ancient method (Lau et al. 2021). The mother dough is a small batch of dough (flour and water), which is usually taken every day from the freshly prepared dough to be used for the following day, as a sourdough starter. Moreover, through this method, the baker uses the mother dough as a source of natural yeast and lactobacilli for bread leavening. There are four types of sourdough starters. Type I sourdough is the one explained above hence the most commonly used by artisan bakers (Calvert et al. 2021). Bakers, who obviously had no scientific background, determine the sourdough level of maturity on its visual appearance and flavour, while in research, sourdough qualities and stability are determined through assessing the pH, rise and detecting which microorganisms are present (Gänzle 2014). Type II sourdough requires technological interventions as bakers intentionally inoculate the dough with lactic acid bacteria (LAB). The latter starter is fermented at a higher temperature than the Type I starter, for a quicker rise (Siepmann et al. 2019), which in turn would result in different flavour (Type II taste is more sour), crumb texture and volume (Calvert et al. 2021; Sterr et al. 2009). Type III and IV starters are variations of the two previously described starters. Moreover, Type III starters are usually dried starters used to maintain the microflora present, while type IV has unconventional ingredients added to it such as honey or fruit (Calvert et al. 2021).

The sourdough method differs to the one explained in the previous sub-heading, as this method which is shown in Fig. 11.7, is lengthier and more delicate, but tends to produce a richer and better-quality bread. The baker uses the same ingredients to make the sourdough bread, the only difference is the addition of small pieces of the mother dough starter during the slow mixing process. This step is known as back-slopping, while the term mixing refers to the homogenisation and hydration of the raw ingredients used within this recipe (Parenti et al. 2021). Endogenous fermenting microorganisms are being added to the fresh mix, which improve the properties of the bread dough, while also amplify the bread texture and flavour giving its typical sour flavour. Stable LAB and yeast present in the starter dough, produce metabolites such as acetic acid and carbon dioxide (CO_2), respectively. The latter also contribute to delay bread staling (increase the shelf-life) and spoilage, benefit the nutritional and aroma profiles while also increasing the general quality of the bread (Catzeddu 2011; Vrancken et al. 2011). This slow mixing and kneading process takes around 20–40 min, while the bulk fermentation takes around 240 min. It is important that during the kneading process, the development of the gluten network is fully recognised by the baker as to not to under or over work the dough. This is because when the wheat flour biopolymers are hydrated, physical and chemical changes occur. Semi-crystalline polymers also known as starch and other wheat gluten proteins namely gliadins and glutenins interact to form disulphide bonds forming a mesh network through the addition of mechanical energy (Bonilla et al. 2019; Cappelli

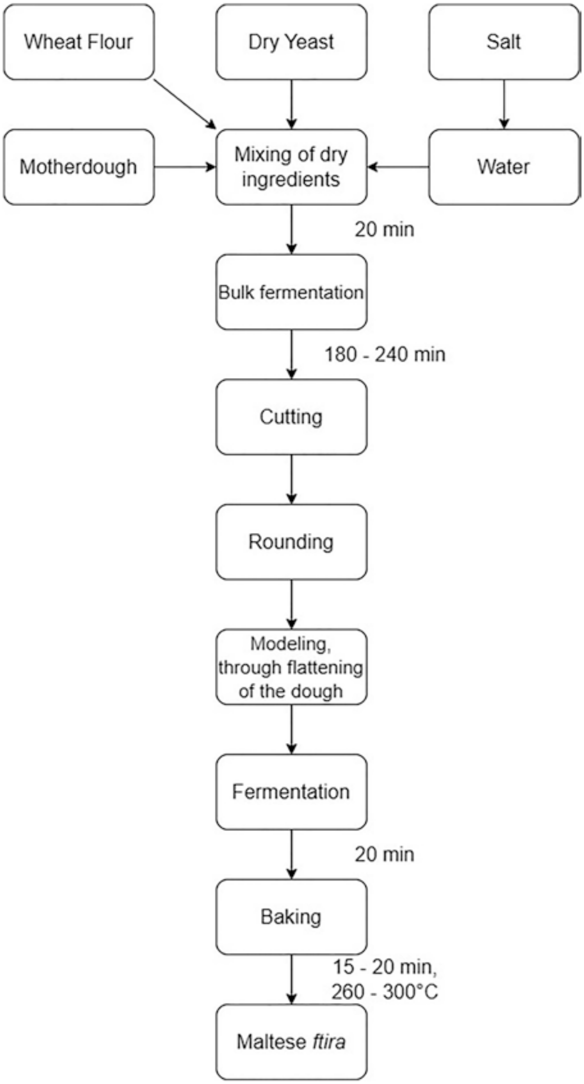

Fig. 11.7 Sourdough bread method used to make the Maltese *ftira*

et al. 2020). Excessive energy input leads to protein depolymerization which ends up ruining the dough development (Parenti et al. 2021). Other processes such as cutting, rounding, modelling, proofing, baking and packaging are the same as explained in the dry yeast method. Thus, the shelf-life of sourdough bread such as for the Maltese *ftira* is greatly increased to 2–3 days.

Sourdough microbiota is mainly composed of different genera which are namely heterofermentative *Lactobacilli*, *Saccharomyces*, *Candida*, *Weissella* and *Leuconostoc* spp. Within these genera more than 50 and 20 species are found in sourdough only from *Lactobacillus* and *Saccharomyces* (Catzeddu 2011; De Vuyst and Neysens 2005; Vrancken et al. 2011).

Most of Maltese bakers have adapted to using lyophilized yeast, which is much simpler and more rapid, provides less production costs and involves less risk when compared the more laborious, time-consuming, and delicate sourdough starter leavening method (Catzeddu 2011; Gänzle and Zheng 2019). To this day, very few artisan bakers still put to practice such method, although very recently, through the promotion of eating healthy food with less additives, healthier properties and better quality, sourdough bread has somewhat increased in consumer popularity.

6 Conclusion

The Maltese are still interested in their bread. Although the general local and visitors' perception often hails the quality of sourdough bread, the quality of the product changed signifcantly, whether intentionally or unintentionally.

A close reading of Chiron's reflection on the kneading process immediately communicates a cautionary message intended to safeguard the quality of sourdough bread. Beyond the political correctness of the author, the research communicates an already worrying situation in 1994. The evidence collated indicated how bakers started to increase the number of ingredients intended to manage the kneading process. The use of industrial yeast and improvers had already become a common practise among the majority of bakers, reducing the amount of time necessary for the first fermentation. A concomitant effect of such practices came to substitute the long-standing tradition of using a starter dough or a levain. These trends, anticipated Chiron, will have a negative effect on the identity of Maltese sourdough breads (Agius 1994).

Today, nostalgia towards a romantacised past glorifies the wood-fired oven. Although the method falls short of any form of convenience, wood burning ovens continue to embody a general understanding among some artisinal bakers and customers of authentic and traditional maltese sourdough bread. This subject remains the subject of ongoing debate. However, research informs how odors released from wood burning has no effect on the taste of bread. On the contrary, we ought to be focussing on the products, the recipe and the baking method. These same concerns provide enough stimulus for the study of Malta's sourdough bread to ensure its quality and propagation into the future.

An integrated approach to heritage management for sourdough bread production and consumption may encourage greater national awareness of the importance of tangible and intangible heritage and those markers of Maltese identity.The inscription of the art and culture of *ftira* on the UNESCO Representative List should encourage both a broader recognition among the Maltese of quality culinary heritage as well as a growing awareness of the rediscovery of sourdough bread preparation techniques that have lost favor with artisinal bakers competing with the forces of the market. Furthermore, the inscription should act as a catalyst to encourage the Maltese authorities to invest the necessary resources to sustain one of the most important markers of Maltese ethnic consciousness.

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Chapter 12
Traditional Polish Breads

Anna Diowksz

1 Introduction

Since the establishment of Poland as a state in 966 AD, bread has been a staple food for both rich and poor. The Slavic tribes that inhabited the area between the Bug and Odra rivers intuitively developed a product that met their nutritional requirements. Bread not only provides energy, but is also a source of valuable nutrients, such as proteins, minerals, vitamin B complex, vitamin E, dietary fiber, and many other bioactive compounds. Bread also has some advantages not found in other food products. Bread gives satiety and remains fresh for quite a long time. It is easy to divide, and can be made into sandwiches containing other ingredients. Polish traditional bread is particularly notable for its fragrant and crispy crust, its moist, elastic crumb, and its unique taste and aroma. The outstanding quality and authenticity of the Polish bread is due to the fact that it is mostly based on rye sourdough—a fermented mixture of flour and water. Even today, with all the changes in lifestyle, it is estimated that over 96% of Polish households buy bread on a daily basis. Bread is commonly eaten for breakfast and with the evening meal. Furthermore, in Poland it is also more common to have sandwiches for lunch at work or school, than to have a regular meal at midday (Ceborska-Scheiterbauer 2013; Diowksz 2011; Jankiewicz 2006; Szafulera 2017).

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2 History of Polish Bread

The first breads in Poland were flat, similar to those popular in African countries and the Middle East. Gradually, it was discovered that using a mixture of flour and water that had been left in a warm place changed the taste and texture of the bread dough, which when baked turned into a raised loaf. In central and northern Europe, in areas of rye cultivation, bread produced using sourdough appeared in the late Bronze Age. For many centuries, sourdough was the only factor used to leaven the bread. A real revolution in breadmaking technology was the introduction of baker's yeast in the second half of the nineteenth century. This enabled time-consuming sourdough technology to be replaced by the much faster method of using yeast for leavening. However, rye dough does not form the elastic gluten network characteristic of wheat dough. Instead, its structure is made up of partially degraded carbohydrates and proteins, together with swollen starch grains. Therefore, simple yeast fermentation does not work in the case of rye flour. This transformation can be achieved only in the slightly acidified dough that results from sourdough fermentation (Diowksz 2011).

Rye and wheat have traditionally been the two most commonly used grains for breadmaking in Poland, with rye flour being a more frequently used ingredient. This is related to the soil and climate in the region, as rye is a very hardy cereal. Although originating in the Middle East, this grass perfectly matches the environmental conditions of Central and Northern European region. There are winter and spring varieties of rye. Rye is not only the most frost-resistant type of grain, but also tolerates both cool summers and humid weather. Rye has few habitat requirements and can be grown even on poor, infertile, sandy, or acid soils, and on the land where other cereal grains may fail. Furthermore, due to the fact that it is a well-rooted plant, it can withstand drought better than other cereals Gąsiorowski 1994; Jankiewicz 2006).

Grain production is one of the most crucial branches of Polish agriculture. In the sixteenth and seventeenth centuries, rye constituted the country's main export product. Nowadays, Poland is the second largest producer of grain in the European Union in terms of total agricultural land use, and its grain harvest is the third largest after France and Germany. However, the total area cultivated with rye has diminished over the course of the last century, as wheat farming has advanced northward at an accelerating pace, thanks to the development of new varieties of wheat and new farming techniques. Wheat is replacing rye and other types of grain, largely because wheat farmers can expect higher yields and better prices. Nonetheless, regional traditions still have an influence on production. Along with soil and climate conditions, culture is the most important factor contributing to the diversity of crops in Poland. In central, northern, and eastern Poland, agricultural production mostly focuses on rye rather than wheat (Institute of Agricultural and Food Economics 2015).

For years, national demand for rye grain has resulted from the consumption of rye bread. In the early 1930s, rye bread constituted 85% of the bread produced, with some 140 kg eaten per person per year. However, in recent decades grain consumption has been declining, as eating habits have changed. The same tendency has been observed for rye bread. Dark, wholemeal bread with dense crumb has started to be treated as a symbol of poverty. At the same time, there has been increasing demand for bakery products containing wheat flour. In the middle of the twentieth century, only half of the bread consumed was rye bread. In the second half of the century, mixed wheat-rye breads began to predominate. By 2000, 85% of the bread consumed was mixed bread, with only a few percent of rye bread. Total consumption had dropped to less than 80 kg per capita per year. The decreasing popularity of rye breads has also had an impact on Polish artisan breads. Today, approximately 70% of locally made breads are wheat-rye. Crucially, however, they are still made using rye sourdough (Jankiewicz 2006; Trajer 2019).

Recently, there has been renewed interest in 100% rye sourdough bread, using ingredients based on traditional natural farming techniques, without mineral fertilization or agricultural chemicals. In the context of climate change, global warming, dwindling water resources, and accelerated land surface drying leaving less water in the near-surface layers of soil, rye crops are better adapted to tough environmental conditions. The health benefits of rye breads are another reason for their growing popularity.

3 Specificity of the Polish Breadmaking Process

Obtaining good quality sourdough bread is no simple matter. In Poland, the most popular wheat-rye bread is produced by a traditional method based on sourdough. Rye flour fermentation is caused by microorganisms occurring naturally in the raw material. Traditionally, a mixture of rye flour and water is left for a suitably long time to initiate the development of the microflora. As more flour and water are added, the microorganisms in the flour are subjected to environmental factors and mutual interactions, which induce natural selection. Matured sourdough provides a stable system of two harmoniously coexisting groups of microorganisms: lactic acid bacteria (LAB) and yeast (Diowksz and Ambroziak 2006).

Sourdough is a complex system that depends on many factors. Apart from the quality and quantity of the microflora, which results directly from the quality of the flour, the process is influenced by temperature and fermentation time. The recipe, type of flour, and dough consistency are also very important. These factors influence the activity and metabolites of the microorganisms in the flour. To some extent, it is therefore possible to control the fermentation process in order to obtain the desired effect. Dough yield, which stands for the flour to water ratio, can strongly influence the development of LAB and yeast. Lactic acid bacteria grow much faster in dense dough, whereas soft dough promotes the development of yeast. Sourdough acidity correlates with the number of lactic acid bacteria. As the dough yield increases, the total acidity of the sourdough decreases (Hammes and Gänzle 1998; Spicher and Stephan 1999).

Bakers have learned to manage the fermentation process by breaking it down into multiple stages. Traditional rye sourdough fermentation is performed in five stages (Diowksz and Ambroziak 2006). The customary names for each stage are associated with the dominant processes that take place:

- initial sour
  enhanced growth of flour microflora; inhibited growth of spoilage bacteria (soft dough – flour to water ratio 1 : 1, temperature 22–24 °C, 48–72 h);
- fresh sour
  intense growth of yeast (soft dough, temperature 24–26 °C, 4–6 h);
- basic sour
  intense growth of LAB (dense dough, temperature 26–29 °C, 6 h);
- full sour
  harmonious growth of LAB and yeast (soft dough, temperature 27–30 °C, 3 h);
- dough
  final stage, all ingredients are present according to the recipe (appropriate consistency for shaping and proofing, temperature 30–32 °C, 20 min).

The process of traditional sourdough bread baking requires great skill, as well as considerable amounts of work and time. Firstly, to obtain the desired consistency of the dough requires further precise portions of flour and water to be added during each stage. Moreover, each stage requires careful observation, in order to control the fermentation process. Optimum temperatures must also be maintained throughout the process. In the past, this was achieved by pushing the fermentation vessel closer and closer to a hot oven. Nowadays, temperature can be controlled by keeping fermentation vessels in proofing chambers, the temperature of which is precisely regulated. However, the whole process still relies on the baker's experience (Decock and Capelle 2005).

The composition of sourdough microflora is highly dependent on the fermentation technology. At the very beginning of the fermentation process, unwanted gas-producing bacteria are dominant. These create bubbles in dough and unpleasant smell. After this fairly long stage, in which preliminary acidification occurs, the number of these bacteria decreases and LAB and yeast start to dominate. Sourdough is characterized by a large variety of LAB. Their common feature is the production of lactic acid from various fermentable sugars. However, depending on the species, some LAB also produce considerable amounts of other acids and volatile compounds. Apart from lactic acid, a wide range of other compounds are produced, which are important for developing the specific flavor, structure, and color of sourdough bread. The most important of these compounds are acetic acid, ethanol, diacetyl, and acetaldehyde. Other volatiles are produced in smaller quantities, namely propionic acid and formic acid (volatile fatty acids), as well as the alcohols - butanol and propanol (Hansen and Schieberle 2005).

Lactic acid bacteria can be divided into two groups, based on the dominant carbohydrate metabolic pathway: homofermentative, mainly producing lactic acid, and heterofermentative, which apart from lactic acid produce significant amounts of ethanol, acetic acid, and carbon dioxide. Homofermentative LAB dominate in spontaneously fermenting sourdoughs and, from the technological point of view, are responsible for the porosity and flexibility of the bread crumb. Heterofermentative LAB contribute to the bread aroma, due to the character of their metabolites. This is why sourdough breads have more distinct and richer flavor than breads produced with yeast only (Gänzle et al. 2007).

The amounts of acids produced during fermentation depend on many factors, such as the composition of the flour, the dough yield, the temperature, and the period of fermentation. However, in terms of the sensory characteristics of the final bread, the ratio of lactic acid to acetic acid is of central importance. Excessive production of acetic acid is unfavorable, as it causes intense acidity and an undesirable acerbic taste. Obtaining sourdough bread with the desired sensory qualities, including rich characteristic aroma, unique taste, and attractive appearance, also depends on the proper ratio of lactic acid bacteria and yeast. The main role of yeast is to expand the dough. As a result of sugar fermentation, yeast produces large quantities of carbon dioxide, which raises the dough and gives the bread the proper volume and porosity. Yeast also produces many aroma compounds, such as alcohols, aldehydes, acids, and esters, which in combination with the other compounds contribute to the specific flavor of the bread. Thus, the final composition of the sourdough microflora strongly influences the sensory characteristics of the final product. Although most aroma compounds are created during baking, fermentation still plays a key role in the development of the unique flavor of the bread. Thus, the flavor of the crumb and the quality of the crust result from the sourdough fermentation process (Hansen and Schieberle 2005).

Most sourdough breads are made in local craft bakeries, and the enormous diversity of sourdoughs used by each producer accounts for the unique flavor of their products. Artisan bakeries with a long tradition and skilled personnel can maintain the quality of sourdough by traditional methods. However, there is no need to start the long process of initial sour fermentation each time. Spontaneous fermentation may be optimized by backslopping, i.e. inoculation of the raw material with a small quantity of sourdough from a previous successful fermentation. Traditionally, to develop the initial sour bakers use a small amount of a mature full sour as an inoculum for the new batch. Thus, selected strains of lactic acid bacteria and yeast are used to trigger, enhance, and control the process of fermentation. The best bakeries possess starters that have been used for several generations. To ensure continuity of production (for example over the weekend), it is enough to prolong fermentation for some 30–40 h and, to prevent excessive sourness after the break, adjust the bread formula by lowering the amount of sourdough in the first batch. The final dough may contain varying percentages of the full sour, but usually not less than 30%. Similarly, housewives in rural areas used to crumble sourdough with excess flour and gently dry it at ambient temperature to keep it ready for baking the next week. The microorganisms then become naturally inactive, due to the lack of water. However, by adding a fresh portion of flour and water they can be reactivated, and serve as a starter for the next fermentation. Women from the countryside used to bake bread once a week, before Sunday. They baked a large batch of loaves at once for the whole family and stored them in a special place to keep them fresh for a whole week (De Vuyst and Neysens 2005; Hammes et al. 2005; Koralewska 2017).

Table 12.1 Scheme of the rye sourdough fermentation process for rye bread production

Stage of fermentation	Preceding stage [kg]	Rye flour [kg]	Water [l]	Salt [kg]	Temperature [°C]	Time [h]
Initial sour[a]	1.5	–	–	–	–	–
Fresh sour	1.5	3	3	–	24–26	5
Basic sour	7.5	17	9	–	26–28	6
Full sour	33.5	30	33	–	28–30	3
Dough	95.0	48+2[b]	25	1.5	29–31	0.3

[a]Taken after completion of full sour fermentation
[b]Flour used for dividing and shaping dough

Table 12.2 Scheme of the rye sourdough fermentation process for wheat-rye bread production

Stage of fermentation	Preceding stage [kg]	Rye flour [kg]	Wheat flour [kg]	Water [l]	Yeast [kg]	Salt [kg]	Temperature [°C]	Time [h]
Initial sour[a]	3	–	–	–	–	–	–	–
Fresh sour	3	4	–	4	–	–	24-26	6
Basic sour	11	10	–	4	–	–	26-28	5
Full sour	25	24	–	30	–	–	28-30	3
Dough	76	2[b]	60	18-22	1	1.7	28-32	0.5

[a]Taken after completion of full sour fermentation
[b]Flour used for dividing and shaping dough

Sourdough was used to produce leavened breads long before baker's yeast was introduced. An example of a traditional Polish recipe for sourdough bread is shown in Table 12.1 (Diowksz and Ambroziak 2006).

Not only has the popularity of 100% rye breads decreased in favor of mixed breads, but wholemeal breads have also been replaced by breads made from refined flours. Currently, breads made with rye flour type 720 (ash content up to 0.78%) and wheat flour type 750 (ash content up to 0.78%) are the most popular. Over time, the share of wheat flour in recipes has increased, reaching 60–70% in recent decades. This has had an impact on the sensory characteristics of breads, as well as on the technology and methods used. In general, a lower percentage of rye flour in the formula requires more of it to be acidified. Rye breads (rye flour share >90%) require at least 50% acidification of the rye flour; mixed rye-wheat (rye flour share 40–90%) breads require at least 60% and mixed wheat-rye breads (rye flour share 15–40%) need at least 70% of the rye flour to be fermented (Ambroziak et al. 2002; Jarosz 2020).

In Poland, traditional everyday bread is prepared in many ways. One typical recipe is presented in Table 12.2 (Woźniakowski 1993).

The disadvantage of this traditional method is that it is extremely labor- and time-consuming. For this reason, it is very often replaced by simplified methods (Table 12.3). Such simplified methods of sourdough breadmaking are applied not only by large-scale industrial plants, but also by many craft bakeries. However, simplified methods cannot be used in dough recipes with a predominant share of rye

Table 12.3 Scheme of the simplified method of rye sourdough fermentation for wheat-rye bread production

Stage of fermentation	Preceding stage [kg]	Rye flour [kg]	Wheat flour [kg]	Water [l]	Yeast [kg]	Salt [kg]	Temperature [°C]	Time [h]
Initial sour[a]	47.5	–	–	–	–	–	–	–
Full sour	47.5	48	–	44	–	–	28–30	3
Dough	95	2[b]	50	ca. 25	1	1.7	29–31	0.3

[a]Taken after completion of full sour fermentation
[b]Flour used for dividing and shaping dough

flour. The quality of the sourdough must also be monitored, as from time to time a return to five-stage fermentation or even re-starting with a new initial sour is needed to enhance LAB growth (Woźniakowski 1993).

Over time, five-stage fermentation has become limited to artisan bakeries that carefully observe traditional manufacturing techniques. Some of these bakers even reject the use of bakers' yeast and patiently wait for the dough to be leavened by yeast from the sourdough only, producing bread according to the methods developed by their ancestors.

3.1 The Science Behind the Breadmaking Process

Our ancestors were not aware of all the reactions behind the transformation of flour and water into bread dough. During sourdough fermentation, several crucial processes take place. The conversion of flour compounds during fermentation is crucial for producing breads of the desired quality, especially in the case of rye-based breads. Rye flour is rich in mucilaginous compounds (pentosans built from xylose and arabinose), which have extremely high capacity for water absorption. This prevents the formation of an elastic gluten network, which is typical for wheat dough. Instead, rye compounds have to be partially hydrolyzed to create a plastic dough, which requires a slightly acidic environment. Lactic acid bacteria are the main agents of this process. Under the impact of acids produced by LAB, the solubility and water-binding capacity of the mucilaginous substances and peptides contained in the rye flour increases. At the same time, changes in the structure of the starch granules occur. This is necessary to create a viscous, homogenous solution of colloidal character, in which the swollen starch granules are suspended. Lowering the dough pH also inhibits the activity of amylotytic enzymes, preventing excessive starch degradation. Otherwise, the bread crumb would be dense and sticky. No less important for determining the final quality of the bread is the pool of LAB and yeast metabolites that emerge in sourdough. Although the unique flavor of the bread is finally created during baking, aroma and aroma precursor compounds originate from the microbial conversion of flour components, and are secreted into the dough during fermentation (Arendt et al. 2007; Gąsiorowski 1994; Hansen 2004; Lönner 1988).

The total amounts of volatiles produced during fermentation depend not only on the types of grain (wheat or rye flour) and flour (refined or unrefined one), but also on the fermentation temperature, water content in the dough, and the quantity and quality of active microorganisms. Flour type and dough consistency significantly influence LAB development, and thus have an impact on the acidification of the dough. The higher the flour type (with a higher ash content), the higher the acidity. Dense dough also promotes acidification, as LAB grow faster in thick dough than yeast does. However, under such conditions yeast, which prefers a slightly acidic medium, intensify alcoholic fermentation and gas (CO_2) production. At the same time, heterofermentative LAB grow better than homofermentative LAB in dense dough, so higher amounts of acetic acid are released. Bread acidity is perceived as pleasant when the molar ratio of lactic acid to acetic acid is in the range between 1.5 and 4.0. To gain a milder taste, the dough yield (the amount of dough produced from 100 kg of flour) should be between 170 and 180. For a more astringent taste, the dough yield should be below 160. In contrast, a loose consistency and higher temperature promote yeast propagation and the secretion of isoalcohols (Decock and Capelle 2005; Hansen 2004).

Yeast grows the most rapid at relatively low temperatures (22–26 °C), but produces the largest amounts of CO_2 and alcohol at temperatures of 28–30 °C. Similarly, homofermentative LAB proliferate best at relatively low temperature, but produce the most lactic acid at temperatures of 30–35 °C. Colder dough fermentation favors the formation of acetic acid. On the other hand, high acidity (around pH 4) is suitable for yeast but hinders the development of LAB. This is why it matters how much fresh flour and water is used to prepare next fermentation phase. Adding larger amounts of raw material (resulting in higher pH) promotes LAB development, whereas with lower batches pH is still low and yeasts grow better. If the pH drops excessively, increased amounts of acetic acid are produced (Lönner 1988; Słowik 2015; Spicher and Stephan 1999).

Each fermentation stage has an influence on the active microflora. A longer period of fermentation (4 h) is better for LAB, whereas a shorter period (2–3 h) is better for yeast. To shorten the fermentation process the temperature should be increased, the dough should be dense, and only a little flour and water should be added (Słowik 2015).

3.2 Shelf-Life of Traditional Breads

Bread has a limited shelf life. During storage, numerous changes diminish its sensory quality. Apart from losing aroma and moisture, the most severe results are staling, which is manifested as increased crumb firmness, and microbial spoilage. Polish traditional bread keeps fresh much longer than its wheat counterparts. Firstly, rye flour is rich in soluble fractions of dietary fiber (arabinoxylans), which bind considerable amounts of water. Secondly, a special baking technique (prebaking) prevents water and volatile aromatic compounds from evaporating too quickly.

Most important, however, is the influence of acids produced during sourdough fermentation. These components stimulate swelling of the starch, pentosans, and peptides, effectively slowing down amylopectin retrogradation, which is responsible for crumb toughening. Moreover, unlike conventionally leavened bread, sourdough bread resists mold, mainly due to its lower pH. This effect can be enhanced by LAB-produced bacteriocins with antibacterial and antifungal activity. Some specialty breads do not become stale even after more than a week. By adding ingredients that increase water binding capacity and stabilize crumb moisture, such as boiled potatoes, or by baking large pieces of dough, the shelf life of sourdough bread can be extended to up to two weeks (Arendt et al. 2007; Gobbetti et al. 2005; Hansen 2004; Jankiewicz 2006; Katina 2005; Schnürer and Magnusson 2005).

3.3 Everyday Polish Bread

Poland has dozens of regional types of breads. In the past, everyday Polish bread was most often in a round shape, whereas nowadays the elongated shape is more common (Marchandt 2013). Scoring the surface of the expanded dough pieces prior to baking is not only decorative, but also prevents deep tears. Each bakery has its own characteristic patterns, applied to different types of bread (Fig. 12.1).

The most popular everyday bread has a characteristic shiny crust. This effect depends largely on the baking conditions and the amount of steam in the oven chamber at the beginning of the baking process. Water is sprayed over the dough pieces or diluted suspension of fermented flour is brushed over them before baking (Fig. 12.2).

Another popular technique for breadmaking is to raise the pieces of dough in floured baskets, which results in a characteristic floury crust (Fig. 12.3). This technique is used more often by artisan bakeries, to differentiate their products from industrially baked breads, as it gives bread a more ‘rustic’ appearance (Marchandt 2013).

Another common practice is to sprinkle breads with poppy seeds, oat flakes, bran, or black caraway seeds, also called black cumin (*Nigella sativa* L.). These additives, as well as crushed grains, sunflower seeds, or dried cranberries, are sometimes added to the dough, giving the bread a distinctive look and flavor (Fig. 12.4). Sourdough breads based on traditional recipes, with authentic Polish ingredients imported directly from Poland to preserve the genuine Polish taste, are popular all over the world, especially among Polish expatriates, for whom a warm slice of sourdough bread spread with melting butter is a taste of home.

Wholemeal breads are commonly baked in molds, as the dough is too loose to be baked on a hearth, i.e. directly on the shelves of an oven (Marchandt 2013). Some bakers continue the tradition of baking pieces of dough on horseradish leaves (Fig. 12.5). In the past, this was done to prevent traces of ash from contaminating loaves baked in ovens heated by burning wood inside a baking chamber (Woicka-Bekas 2011).

Fig. 12.1 Traditional Polish bread with round shape and scoring on the crust. (Photo by Joanna Hrk)

Fig. 12.2 Everyday Polish bread certified with the "Quality Tradition" mark. (**https://asprod.com.pl/kaegoria-aktualności/smak-znany-od-lat**)

3.4 Specialty Breads

In recent years, there has been growing interest among consumers in specialty breads. One of the artisan bakeries in the region of Silesia makes two interesting types of sourdough bread, called *Gryczok* and *Krajcok*, which have been awarded with the 'Discover Great Food' quality label (Woicka-Bekas 2011). Not only do

Fig. 12.3 Floury crust gives bread a more 'rustic' look. (Photo by Joanna Hrk)

Fig. 12.4 Polish bread is often spread with butter. (Photo by Joanna Hrk)

these breads have unusual names, which sound strange even in Polish language, but they also involve unusual ingredients and baking techniques. The formulas for the two breads are based on old home recipes. In the case of *Gryczok*, buckwheat is added to the dough, whereas *Krajcok* contains wholegrain flour. The breads are initially raised in baskets made of beech wood and then baked on cabbage leaves. This baking method was used in ancient times to separate the bottom crust of the bread from the oven bottom and prevent it from burning. During the baking process, the cabbage leaves give the loaf of bread a pleasant aroma, improve the moisture of its crumb, and enhance its freshness. This baking technique is also applied in the case of another specialty bread, known as *Staropolski chleb sanacyjny* (Fig. 12.6). Its recipe also dates back to an old Polish tradition. Raised in wood baskets, the

Fig. 12.5 A variety of artisan breads, including one baked on horseradish leaves. (Image courtesy of Jarosław Gajda, a Radom bakery owner)

Fig. 12.6 *Staropolski chleb sanacyjny* baked on cabbage leaves. (http://piekarniaanmar.pl/)

dough pieces are placed on cabbage leaves put directly onto bricks in an oven heated by burning conifer wood inside. The dough is prepared from coarsely ground rye flour, wheat flour, water, potatoes, buttermilk, salt, and fresh yeast. The vessel used to prepare the dough should be made of pine wood. *Staropolski chleb sanacyjny* has been awarded the ‘Quality Tradition’ label and appears on the ‘List of Traditional Products’ drawn up by the Polish Ministry of Agriculture and Rural Development (Zwoliński 2018).

3.4.1 *Chleb prądnicki*

Recently, a very old traditional recipe for *Chleb prądnicki* (Prądnik bread) was recreated by an artisan baker in Cracow in south Poland. The recipe was reconstructed from old documents and the memories of old people living in the area. It has now been protected by the law referring to geographical indications and designations for the origin of agricultural products and foodstuffs (European Commission 2010). Prądnik bread is a dark rye sourdough bread that had been baked in villages situated by Prądnik river, within the administrative boundaries of the city of Cracow, probably since the fourteenth century. However, the production of Prądnik bread was abandoned at the beginning of the twentieth century. The oldest documents to mention Prądnik bread date back to 1421, when the Bishop of Cracow gave his cook some land and tasked him with baking bread for the bishopric. Some years later, the bakers in that area were given by royal prerogative the right to sell bread in Cracow once a week at the Tuesday market, which was not a common privilege until the eighteenth century. According to the legend, the first loaf manufactured after the harvest each year was handed to the king at Wawel Castle, until the capital of Poland was moved to Warsaw. The bread was renowned for its taste, but was also affordable to the masses. Thus, Prądnik bread was a local specialty eaten by both rulers and subjects. The history of the bread is described in the bishopric documents and old chronicles of Cracow. The special characteristics that distinguish Prądnik bread from most other breads are its huge size, thick crust, unique taste, and long-lasting freshness (Fig. 12.7) (Anonym 2017; Gadocha 2012).

Standard Prądnik bread is baked in 4.5 kg loaves, round or elongated. The round loaves have diameters of 450–500 mm. Oval loaves are 600–650 mm in length, 120–150 mm in height, with a width of 300–350 mm at the center. The width gradually decreases towards the ‘heels’ of the loaf. However, on special occasions giant

Fig. 12.7 *Chleb prądnicki* (Prądnik bread). (http://www.smakizpolski.com.pl/chleb-pradnicki/)

oval loaves were manufactured, weighing up to 14 kg, 950–1000 mm in length, 120–150 mm in height, with a width of 450–500 mm at the center The method of manufacturing Prądnik bread was elaborated over many years by generations of local bakers, and is typified in the newly rediscovered recipe. High-quality rye flour and wheat flour are used, in proportions of three fourths to one fourth. Water, salt, and fresh yeast are added to the formula. Cooked potatoes or potato flakes (used seasonally in spring and early summer) are added to the dough, to keep the bread fresh for longer. The specific flavor is enhanced by the addition of milled cumin. Rye bran is sprinkled over the top. All steps must be performed in the identified geographical area. The process starts with preparing the sourdough according to a traditional five-stage method. After kneading and initial resting, the dough is manually divided into pieces and shaped. Manual shaping gives each loaf a slightly different appearance. Final proofing of the shaped pieces takes place in baskets. Before baking, the dough pieces are moistened with water and sprinkled with rye bran. Finally, the breads are baked and left to cool. Initial prebaking at a higher temperature followed by a longer period of baking at a lower temperature helps keep crumb moisture for longer. This technique is especially important when baking large loaves. In previous times, this was made possible by the two-chamber construction of professional ceramic ovens. During the baking process, the loaves were moved between the chambers at different temperatures (European Commission 2010; Gadocha 2012).

Prądnik bread typically has a 4–6 mm thick crust, brown to dark brown in color, with a homogeneous surface or visible cracks, covered with a thin layer of rye bran. Another distinguishing feature is the fact that Prądnik bread has to mature after baking: it acquires its full flavor on the second day after baking. Stored under normal conditions, it keeps fresh for at least seven days, and perhaps up to two weeks. Even though Prądnik bread is five times more expensive than standard bread, it is highly popular today, particularly on special occasions such as feasts or during the annual Bread Festival.

3.5 Bread-Related Customs

Polish artisan bakers continue the centuries-old baking traditions, once performed in homes. Baking bread used to be a very important, almost ritual activity in the countryside, performed almost exclusively by women. The art of breadmaking was a source of pride. Until a girl was able bake bread, she was not considered ready for marriage. It was very important to take care of all the equipment used for bread manufacturing. The best vessels for the preparation of dough were thought to be those made of wood from a single log, preferably originating from a tree struck by lightning. This was supposed to guarantee that the dough would rise so quickly that it would be ready even before the oven was heated.

In the Slavic tradition, bread is considered as a symbol of wealth and social status. In contrast, lack of bread symbolizes hunger and poverty. Wishes for ‘daily bread' appear in almost all old Polish Christian prayers, first and foremost in the Lord's Prayer. Some bread-related customs are still continued, especially in the countryside. In an old tradition still practiced by some (especially older people), freshly baked or bought bread is marked with the sign of the cross before the first cut, as a kind of blessing. Similarly, if a piece of bread falls accidentally on the floor, it has to be picked up immediately and kissed as a sign of respect and gratefulness. Stale bread is never thrown away, even when it becomes very hard—it should either be eaten to the last crumble, or used as feed for farm animals. Alternatively, it can be used in cooking. Otherwise, the sin of wastage is thought to bring hunger and bad luck (Koralewska 2017; Orłowski and Woźniczko 2018; Szafulera 2017).

Bread is considered one of the most sacred foods in Poland. It forms a key part of many national celebrations and festivals, including Christmas, Easter, and the Dożynki Harvest Festival. Breads baked for rites are often decorated with various symbolic elements, shaped out of dough on top of the crust. During the annual Dożynki Harvest Festival, people wearing regional costumes carry decorated breads during a colorful parade, along with giant wreaths weaved from ears of grain, celebrating good crops. Loaves of bread feature in the majority of old festive rituals. For example, in all Slavic countries it is customary to welcome guests with bread and salt, which in Poland is often associated with hospitality (Fig. 12.8). Nowadays, this tradition is mainly observed on wedding days. The newlywed couple is greeted with bread and salt by their parents when they return from the church, as a welcoming gesture into the family and a promise of prosperity (Koralewska 2014; Orłowski and Woźniczko 2018; Rothkaehl 2017; Staszewska and Janik 2016).

Traditions related to bread are so fundamental to the Polish identity that during the difficult times in the history, it evoked nostalgia and homesickness, especially for those forced to leave the land for various reasons. The famous Polish poet Cyprian Kamil Norwid expressed this sentiment in one of his poems (My Song (II) translated by Walter Whipple):

> For that land where a scrap of bread is picked up
> From the ground out of reverence
> For Heaven's gifts…
> I am homesick, Lord!... (...).

Fig. 12.8 Decorated bread for welcoming guests. (http://www.gajda.pl/produkty)

4 Conclusion

In Poland, the skills necessary to manufacture sourdough bread have been for centuries passed down through generations. Producing bread using rye flour requires acidification, in a time-consuming and labor-intensive process. However, many consider the effort worthwhile. There is an enormous diversity of sourdoughs, making each craft bread a local specialty. Polish bread is unique, and a recognizable brand all over the world, where Polish bakers continue the centuries-old art of breadmaking.

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Chapter 13
Broa – A Portuguese Traditional Sourdough Bread, Made of Maize and Rye Flours

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Abbreviations

AD	*Anno Domini*
BC	Before Christ
CAP	Common Agricultural Policy
DY	Dough Yield
EMP	Embden-Meyerholf-Parnas pathway
COST	European Cooperation in Science and Technology
EEC	European Economic Community
EU	European Union

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EEZ	Exclusive Economic Zone
EPS	Exopolysaccharides
FQ	Fermentation Quotient
FAO	Food and Agriculture Organization of the United Nations
GI	Glycemic index
INE	Instituto Nacional de Estatística [Portuguese National Institute of Statistics]
IS	International System of Units
LAB	Lactic acid bacteria
N	North latitude
PDO	Protected Designation of Origin
UN	United Nations
USD	United States Dollars
USA	United States of America
W	West longitude

1 Introduction

1.1 Bread, Sourdough Bread and Broa

Bread is a staple food on the light of its highly nutritional value, lying on its main constituents – cereal flour or flours (Novotni et al. 2020; Rocha 2011). With the advent of bakery and biotechnological processes, the white or wheat bread fermented with *Saccharomyces cerevisiae* (commonly known as baker's yeast) turned into the most popular bread due to several factors, such as wide appreciation and acceptance by consumers in terms of texture, aroma and flavor, fast digestion and high glycemic index (GI), and suitability for the growing market of fast-food and to the common practice of quick meals particularly in the big cities. From the technological point of view, bakeries found enormous advantages in white bread made with baker's yeast, namely its straightforward manufacture, its fast production, possibility of high loaf volume rates leading to an increase of softness with greater acceptance by consumers at large and more profitable to bakers, and ease to implement at industrial level that has meanwhile undergone substantial technological progresses in terms of equipment. In short, almost a "perfect food good" from a technological standpoint.

In the latest decades, ancestral and natural processes of breadmaking have been rediscovered, chiefly the use of whole grains, alternative cereals and pseudocereals (such as buckwheat, amaranth, and quinoa), biofortified bread recipes with addition of seeds and tubes, and sourdough fermentation. The research on the topic of sourdough biotechnology has received enormous attention among researchers and technologists worldwide, noticeable by the exponential rise of scientific production (*e.g.* research manuscripts and projects, and technical publications) and the number of research groups working in this field. A paradigmatic example is COST Action

SOURDOMICS – *Sourdough biotechnology network towards novel, healthier and sustainable food and bioprocesses*, supported by the funding agency for research and innovation networks, the European Cooperation in Science and Technology (COST) in the quadrennial 2019-05 to 2023-11 (COST Action 18101). It is also visible by the popularity gained among local trade bakeries and industrial bakeries. However, the relatively high activity on social networks is a good meter of the interest for whole meal, fortified and sourdough bread by contemporary consumers and the general public. Sourdough biotechnology became an easily accessible fashion, a culture, a way of life that meets the requirements of contemporary consumers for novel, low-processed, natural, healthy and tasty food, and providing together high standards of food safety and quality, coupled with the growing awareness of our society regarding environmental sustainability, and promotion of healthy life-styles and well-being. Indeed, white bread made with bakers' yeast lacks the taste, aroma, nutritional value and long shelf-life of traditional sourdough wholegrain breads. Bread, especially the whole meal and sourdough bread, promotes health effectively through prevention of cardiovascular diseases, colon cancer, hemorrhoids, constipation, diabetes and arteriosclerosis, among others. Cereal starch is the most appropriate energy source, whereas grain cellulose and other insoluble fibers contribute to key regulatory functions in digestive tract and are associated with low levels of cancer's incidence (Novotni et al. 2020; Rocha 2011).

In Portugal, the most popular sourdough bread is the artisanal *broa* made of regional maize and rye flours, and manufactured at small-farm and household levels using ancient breadmaking protocols transmitted throughout generations (Fig. 13.1).

Bread in Portuguese means "Pão" (*Panis* in Latin). *Broa* (plural *Broas*) – probably with the same etymology of the German "*brot*" and English "bread" words – is produced by local small-farmers in Northern Portugal (Fig. 13.2). It has been subjected to several research studies in the last two decades in the fields of microbiota

Fig. 13.1 Traditional sourdough *broa* – a bread made of regional maize and rye flours – produced by a small-farmer in the Northern Portugal. (Courtesy of author Alda M. Brás)

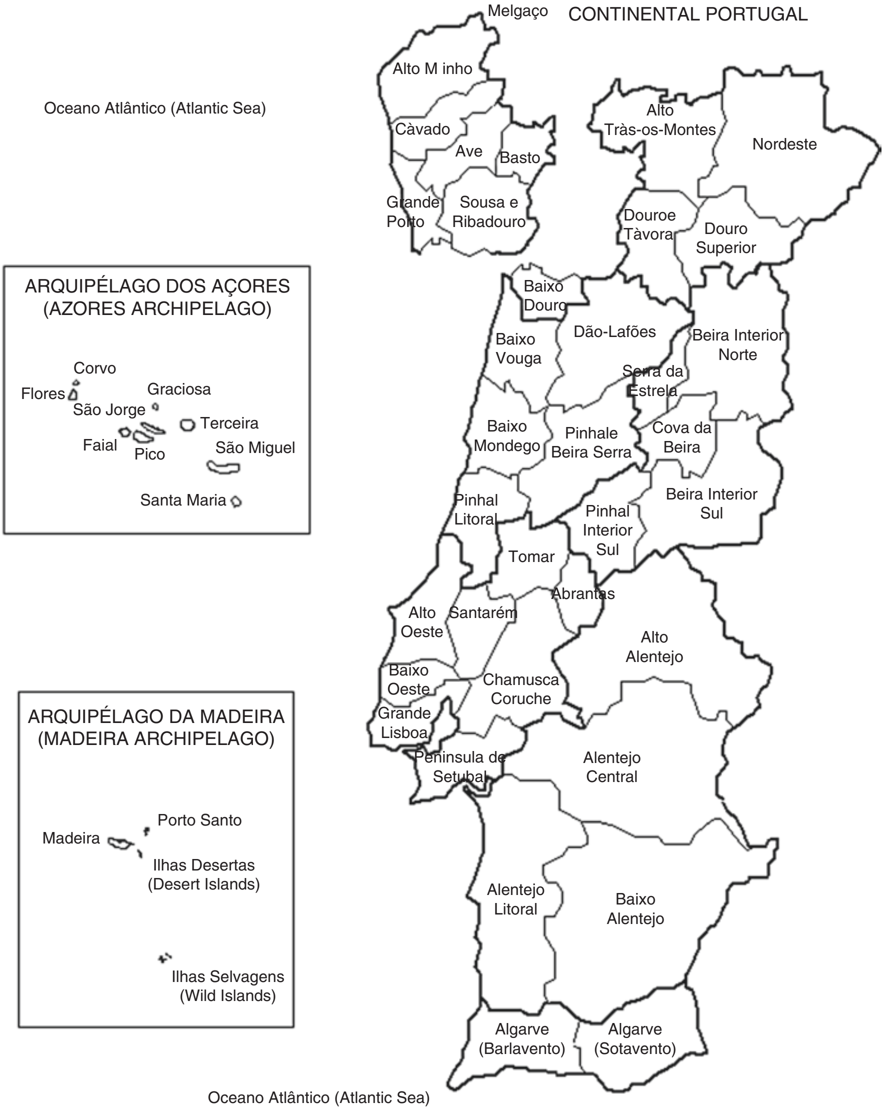


Fig. 13.2 Map without scale of the Continental Portuguese sub-regions with the spotlight to the Northeast (Alto Minho, Basto, Vale do Sousa and Avintes), a typical region where the artisanal *broa* is manufactured by small-farmers and households, and with some frequency in community ovens and water mills of the villages. Portugal is located in the Northeast of the Atlantic Ocean with geographic coordinates of the Continental Portugal between 39° 33′ 25.89″ North latitude (N) and −7° 51′ 13.18″ West longitude (W). According to UNCLOS (1982), Portugal has the 3rd largest exclusive economic zone (EEZ) in the European Union (EU) and the 11th worldwide: 11% of the EU's EEZ belongs to Portugal. Insular Portugal is formed by several islands off the coast, many of them (*e.g*. Berlengas) had an important role in the defense of this National territorial with almost 900 years of existence. It is also formed by the archipelagos of Açores (Azores) and Madeira, two important geostrategic territories for the United Nations (UN) in different times of History.

characterization (bacteria, yeasts and molds) (Almeida and Pais 1996a, b; Rocha and Malcata 1999b, 2012, 2016a, b), physicochemical, rheological, sensory shelf-life and baking studies (Cunha et al. 2019; Rocha 2011; Rocha and Malcata 2003a), and lipid characterization (Kalo et al. 2006; Rocha et al. 2010a, b, 2011, 2012a, b) of regional maize and rye flours, mother-doughs, sourdoughs and/or final *broa*. The research findings on *broa* have also been widely disseminated through scientific and technical communications in the fields of microbiology and fermentation (Rocha and Malcata 1998a, b, 1999a, b, 2000b, 2001c, d, e, 2011b, c; Rocha et al. 2019), lipid composition and nutritional value (Rocha et al. 2002, 2003b, c, d, 2010c, 2012c, d), socioeconomic perspectives (Rocha and Malcata 1997, 1999b, 2000a) and technological studies of breadmaking and storage and concomitant correlation between physicochemical, rheological and sensory parameters (Rocha and Malcata 2001a, b, 2003a, b, c), further to exhibitions in fairs (Brás et al. 1998) and press releases (Freitas 2017; Natal and Luz 1999; Queiroz 1997; TSF 2000).

1.2 Cereal Cultivation in Portugal and Future Strategies

The cereal cultivation in Portugal has undergone sound changes since its joining to the former European Economic Community (EEC) in 12th June of 1985, and concomitant integration into the Common Agricultural Policy (CAP). Apart from a number of advantages, the integration brought also negative impacts upon the country's cereal supply rate and sustainability of its agricultural systems (GPP 2018). Since the end of 1980s–2016, the area cultivated with cereals decreased to less than one third of the original one. The self-provisioning of cereals declined from 60% in 1989 (*ca*. 10% of the territory), 3 years after joining the former EEC, to the actual value of a mere 23%, a singular case in Europe and worldwide. Those controversial and eventually erroneous European policies manifestly resulted in structural imbalance of the Portuguese economy, and in deleterious effects to the sustainability of agricultural systems and territorial cohesion. Among European Union (EU), Portugal has one of the lowest self-provisioning degree of cereals. Unlike the world

Fig. 13.2 (continued) Archipelago of Azores is located between 36–43°N and 25–31°W. Azores archipelago is the most westerly point in Europe (2300 km to the Northwest of Nova Scotia, Canada) and integrates the biogeographic region of Macaronesia. Azores archipelago is composed of nine volcanic islands in three groups: Flores and Corvo, to the west; Graciosa, Terceira, São Jorge, Pico and Faial in the Center; and São Miguel and Santa Maria (and also the Formigas Reef) to the East. Finally, the archipelago of Madeira is located between 33°N and 30°W. It is one of the largest islands in Macaronesia and is located on the Occidental African Plate, 700 km West of the Occidental African coast. Belonging to Madeira archipelago, the Wild Islands are the Southernmost Portuguese territory, located between the latitudes of 30°N and the longitudes of 15–16°W, and the Desert Islands which are a Nature Reserve with coordinates 32°30′N and 16°29′W and often officially visited by the Heads of State of the Portuguese Republic. Wild Islands are the largest marine protected area in Europe and North Atlantic (2677 km^2) since November 2021. (Adapted from Rocha et al. 2011) cereal production which exceeds demand since 2013, the national self-production is lower than either human or animal consumption.

In view of that, the latest National Strategy for the Promotion of Cereal Production (ENPPC) (GPP 2018) establishes that the actions and policies in the national sector of cereals should be focused on reducing external dependence, consolidating and increasing production areas, creating value in the sector, and finally enabling agricultural activity throughout the whole national territory. Therefore, national strategies are required to foster the increase and diversification of cereal production, improvement of production efficiency, enhancement of innovation and knowledge transfer, and business and technical qualification to the small-farmers, and interconnection of players along the value chain, chiefly from farmers to industry and market. This national strategy for agriculture actions is indeed required to mitigate and adapt to the climate change, to stabilize and improve farmers' incomes and resilience, as well as to create an agenda for innovation in the field of cereal production, the valorization of national production and the use of autochthonous cereal seeds – thus preserving the national seed genetic heritage. Such strategies will contribute to promote a fair cereal market, to inclusive growth and to improve rural livelihoods. Investing in smallholder farmers (Fig. 13.3) means investing in a better food, nutrition and agriculture, public health and health of the planet at large. Integrating small farmers in the full agri-food value chain contributes to fair markets, trades and profits, as well as to ensure social and ethical responsibilities by companies and other stakeholders (Bartkiene et al. 2020; Küley et al. 2020; Păcularu-Burada et al. 2020; Skendi et al. 2020; Souza et al. 2020). Under this goal, it is also necessary to effectively contribute to efficient use and protection and preservation of natural resources (soil, water, and biodiversity), and to establish environmentally friendly agricultural practices, namely in tackling climate change and creating discontinuity of agricultural stains in areas with high risk of forest fires. On this regard, Portugal faces great challenges due to its great vulnerability to forest and rural fires – despite the extraordinary public investment in means and prevention over the last decades. The number and intensity of fires are however increasing due to the aforementioned deterioration of agricultural systems and rural exodus, climate change and global warming.

1.3 Market of Breadmaking

Cereals belong to the Gramineae family, and encompasses wheat (*Triticum* spp.), maize (*Zea* spp.), millet (*Pennisetum* spp.), rye (*Secale* spp.) and triticale (x *Triticosecale* Wittmack, a hybrid of wheat and rye seeds), barley (*Hordeum* spp.), oat (*Avena* spp.), rice (*Oryza* spp.) and sorghum (*Sorghum* spp.). Conversely, pseudocereals are non-grasses with similar end-uses as cereals (or true grasses), and comprise buckwheat (*Fagopyrum esculentum*), amaranth (*Amaranthus* spp.), quinoa (*Chenopodium* spp.), chia (*Salvia* spp.), cañihua and pitseed goosefoot (*Chenopodium* spp.), breadnut (*Brosimum alicastrum*), celosia (*Celosia* spp.) and wattleseeds (*Acacia* spp.) (Skendi et al. 2020). Nevertheless, the definition of

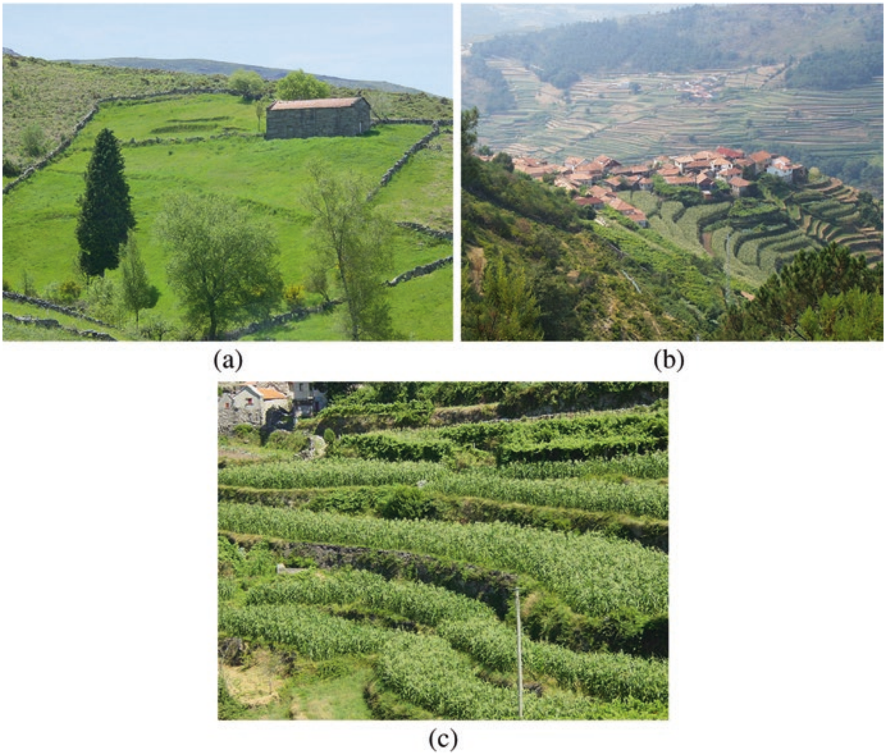


Fig. 13.3 Photograph of (**a**) a smallholder farm typically from the mountainous in Northern Portugal, and (**b**) general and (**c**) approximate perspective of terraced cultivation of maize. (Courtesy of the author Jorge Miranda)

pseudocereals is sometimes controversial. The above mentioned national strategy ENPPC sets as priority the increase of cereal production in the whole territory (GPP 2018); the diversity of cereals is also of the utmost importance from both environmental sustainability and public health standpoints.

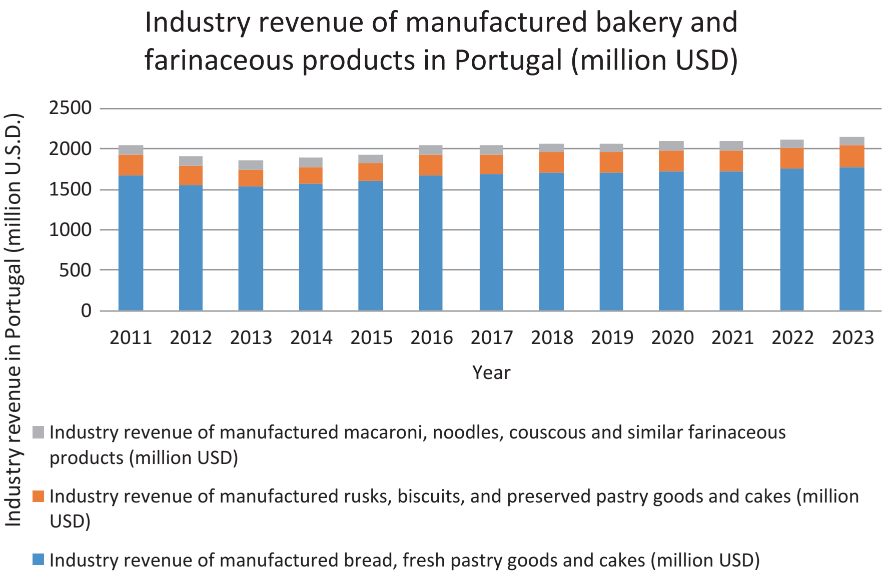
According to the supply balances published by the National Institute of Statistics of Portugal (Instituto Nacional de Estatística, Portugal) (INE 2020) for the 2018–2019 period, the disaggregated values of the national annual human consumption of cereals *per capita* (kg/inhabitant), for a total of 129.9 kg/inhabitant, and the degree (%) of self-provisioning of cereals, for a total of 19.8%, were respectively: wheat (110.9, 4.6%); maize (12.7, 25.0%); rye (3.8, 39.8%); barley (1.2, 19.0%); oat (1.1, 78.9%); and other cereals (0.2, 67.4%). Despite such a low national diversity on cereal consumption (mostly wheat), Portugal had in 2012 the second highest number of bakeries *per capita* among the 25 European countries (LEO 2011), which is certainly a reflection of the Portuguese culture. In Europe, the volume shares of bread making in 2006 was divided between bakery industry (61%), shop bakeries with direct selling to consumers of fresh bread products (34%) and others (e.g. in-store bakeries from supermarkets, restaurants) (5%). The ratio between industrial and local shop bakeries varies substantially among different countries. In Portugal, the local shop-bakeries are very often combined with confectioneries and cafes, and represented in 2006 *ca*. 40% of the volume share (LEO 2011). Comparing the profit margins [(Turnover-Expenses)/Expenses] in 2012, Portugal shares the sixth position with Sweden, with Greece ranking at the top. Among the bakery market goods (bread *versus* pastry), the share of bread consumption in 2011 represented *ca*. 83% in Portugal. Concerning the segmentation of bakery products (fresh, pre-packed baked, and pre-packed partially baked) in 2011, the values ranged between 8% and 91% throughout Europe, from Estonia to Portugal, respectively.

Figure 13.4 illustrates several figures and estimations of bakery and flour products in Portugal (Statista 2020; FAO 2021). According to Fig. 13.4a, the industry revenue of bread, fresh pastry goods and cakes tended to increase since 2014, with an overall yearly average in the period 2011–2023 of 1670 million United States Dollars (USD); whereas rusks, biscuits and preserved pastry goods, as well as the macaroni, noodles and similar flour products tended to remain constant – with overall averages of 244 and 108 million USD, respectively. In terms of European and worldwide market values for estimations as depicted in Fig. 13.4b, bread volume consumption in 2011–2021 tended to slightly decrease in Europe and increase worldwide (yearly average values of 19,969 and 108,814 million kg, respectively); and the same antagonist trends were observed for average bread volume consumption *per capita*, with yearly average values of 31 and 11 kg in Europe and worldwide, respectively. In agreement with these figures, Fig. 13.4c indicates that European countries comprise the highest average volume sales *per capita* in the market of bread and bakery products, with Portugal standing in the middle with 51.7 kg per capita (Statista 2020).

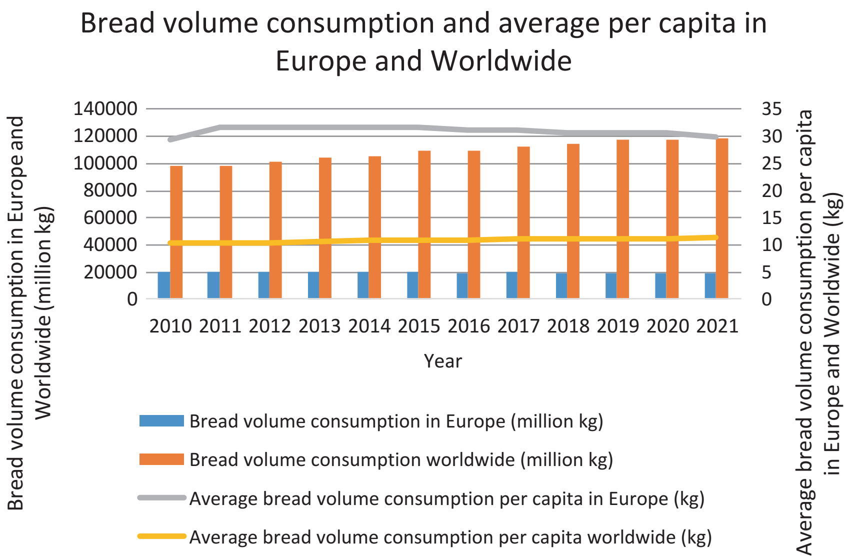
2 Baker's Yeast and Sourdough Fermentation

In fermentation with (dried or fresh) baker's yeast, *Saccharomyces cerevisiae* metabolize simple sugars from cereal flours, yielding (Eq. 13.1) two moles of ethanol (or ethyl alcohol, or simply alcohol) and two moles of carbon dioxide. The odor of alcohol is easily perceptible, owing to its evaporation – which promptly volatilizes under the high temperatures during baking. The overall Eq. 13.1 represents the alcoholic fermentation pathway, but the biochemical reactions undertaken in the absence of oxygen (*i.e.* under anaerobic conditions) by yeasts are quite complex (Novotni et al. 2020; Rocha 1998) (Fig. 13.5).

$$\underset{\text{Glucose}}{\mathrm{C_6H_{12}O_6}(aq)} \rightarrow \underset{\text{Ethanol}}{2CH_3\mathrm{COOH}(aq)} + \underset{\text{Carbon dioxide}}{2CO_2(\mathrm{g})} \quad \underset{\text{Energy}}{(+2ATP)} \tag{13.1}$$

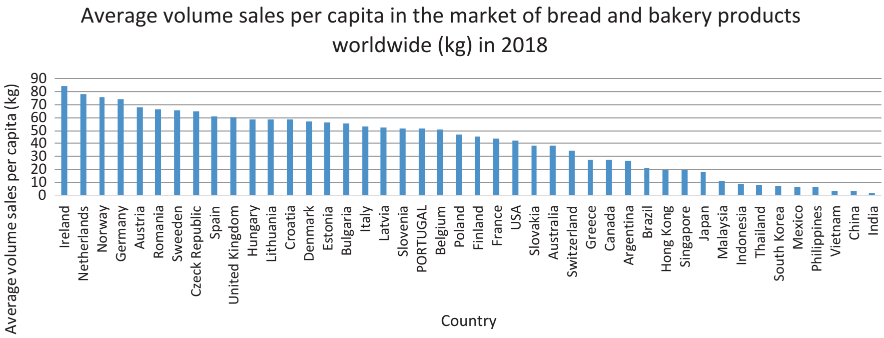


(a)



(b)

Fig. 13.4 Values and estimations of (**a**) Industry revenue (expressed in United States Dollars, USD) of bread and flour products in Portugal in 2011–2023, (**b**) Bread volume (in kg) consumption and average *per capita* in Europe and worldwide in 2010–2021, and (**c**) Average volume sales (in kg) of bread and bakery products worldwide in 2018. (Source: Statista 2020)



(c)

Fig. 13.4 (continued)

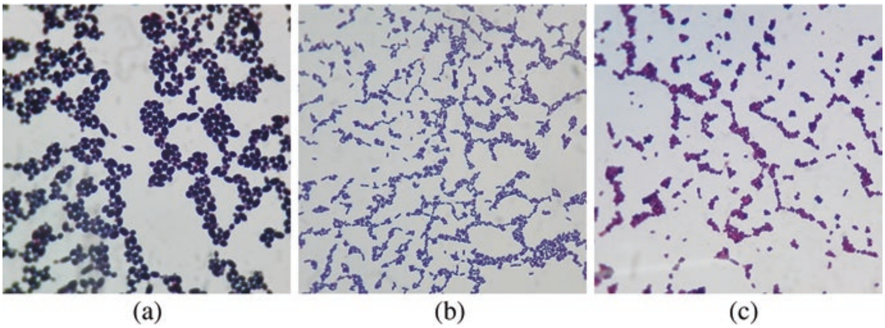


Fig. 13.5 Microscopic images [400× in (**a**), and 1000× in (**b**) and (**c**); with microscope eyepiece 10×] with Gram staining of (**a**) eukaryotic yeasts (not identified to species level), and prokaryotic lactic acid bacteria (LAB) (**b**) *Lactiplantibacillus paraplantarum* (lactobacilli) and (**c**) *Pediococcus* spp. (cocci). Yeasts are eukaryotic microorganisms typically measuring between 3 and 4 μm in diameter, even though some yeasts may reach 40 μm in size. Bacteria are prokaryote microorganisms, typically measuring between 0.5 and 5.0 μm in length. (Courtesy of Dr. Patrícia Reis (LEPABE-FEUP))

Unlike baker's yeast fermentation, lactic acid bacteria (LAB) play major roles in sourdough fermentation (Ağagündüz et al. 2021; Bartkiene et al. 2022; Chochkov et al. 2022; Păcularu-Burada et al. 2021; Rathod et al. 2022; Sharma et al. 2021; Trakselyte-Rupsiene et al. 2022; Yilmaz et al. 2022; Zokaityte et al. 2020). LAB can be classified as homolactic (or homofermentative) and facultative or obligate heterofermentative (or heterolactic). As the names suggest, homolatic fermentation (Eq. 13.2) by homolactic LAB yields only two moles of lactic acid (or its ionized form, lactate) per mole of glucose, whereas heterolatic fermentation (Eq. 13.3) by obligate or facultative LAB yields one mole of lactic acid, one mole of ethanol or acetic acid (or the ionized form, acetate), and one mole of carbon dioxide per mole of glucose. Recall that mole is the base unit of measure of quantity of matter in the International System of Units (SI): one mole of atoms/molecules contains 6.022×10^{23} atoms/molecules. Equation 13.2 describes the hexose fermentation pathway, or Embden-Meyerholf-Parnas (EMP) pathway, whereas Eq. 13.3 reflects the pentose phosphate pathway or pentose phosphoketolase pathway (Novotni et al. 2020; Rocha 2011). When following LAB fermentations (and sourdough fermentations) – and after some practical experience, it is possible to perceive the characteristic odors of lactic and acetic acids, besides ethanol. It is interesting for home bakers to experience the fermentations using only yeasts, LAB and both microorganisms.

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \rightarrow \underset{\text{Lactic acid}}{2CH_3\text{CHOHCOOH}} \quad \underset{\text{Energy}}{(+2ATP)} \tag{13.2}$$

$$\underset{\substack{\text{Glucose or, preferably,}\\ \text{the disaccharides}\\ \text{Maltose and Sucrose}}}{C_6H_{12}O_6} \rightarrow \underset{\text{Lactic acid}}{CH_3\text{CHOHCOOH}} + \underset{\substack{\text{Ethanol}\\ \text{or Acetic acid}}}{\begin{matrix} C_2H_5OH \\ \text{or } CH_3\text{COOH}\end{matrix}} + \underset{\text{Carbon dioxide}}{CO_2} \quad \underset{\text{Energy}}{\begin{pmatrix} +1ATP^1 \\ \text{or } 3ATP^2 \end{pmatrix}} \tag{13.3}$$

A bread dough results when cereal flour (or flours) are kneaded with water and salt,. Afterwards, when the dough is left to rest, the highly complex endogenous microbiota mainly found in the cereal flours (or arising from the environment and water, to a lesser extent) are activated – and spontaneous fermentation starts, leading to a sourdough, characterized by a typical acid flavor and increased volume. This spontaneous fermentation is similar to the most ancestral processes of breadmaking.

The biodiversity of adventitious microorganisms found in sourdough is much lower than those in the flours and unfermented dough, due to synergistic and antagonistic relationships developed among microorganisms throughout fermentation. Therefore, continuous propagation of sourdough from batch to batch promotes natural selection of a synergistic microbiota, mainly comprised of lactic acid bacteria and acid-tolerant yeasts; impressively, most of them are beneficial for humans. Many foodborne pathogens present in the initial dough simply vanish under the conditions created by LAB and yeasts (Rocha 2011; Rocha and Malcata 1999a, 2012, 2016a, b). For example, the production of organic acids (and other compounds) decreases pH to 3.5–4.5, where many harmful microorganisms cannot survive or even grow. Moreover, a piece of this spontaneously fermented dough – called mother-dough, sponge-dough, sour-ferment, mother-sponge, or seed dough – and known as “massa-mãe” (mother-dough), “crescente” (crescent) or “isco” (bait) in Northern Portugal, can be kept aside and added to the dough in a *de novo* fermentation batch, thus serving as a natural ferment (leavening agent) or microbial starter culture. This process, also ancestral, is called back-slopping, and supports the activity of the beneficial microorganisms, also bearing desirable technological implications towards bread quality.

A steady sourdough throughout time is of the utmost importance to produce sourdough breads with constant quality. This requires a great skill, dexterity and experience from the baker, regardless of whether it is produced in household or commercial contexts. Moreover, many other factors may greatly influence such desirable steady quality – namely, the type of cereal or cereals, the level of flour milling and sifting, and the use of refined or whole flours, as well as such characteristics of the cereal flours as the enzymatic activity (chiefly amylolytic, proteolytic and lipolytic activities), buffering capacity (*i.e*. resistance to pH changes), and type of carbohydrates, peptides and amino acids supplied by cereal flours. At the stage of dough preparation and baking, important factors are the use of additional ingredients in the dough recipes – such as addition or not of sodium chloride, glucose, fructose, maltose or citrate, other cereal and pseudocereal seeds, tubers and other vegetable flours–, the level of kneading (and therefore the level of oxygen present), the dough yield (DY, *i.e*. the weight percentage between dough and flour or flours), the maintenance time of the mother-dough and the number of refreshments, the amount of mother-dough used (normally 10–20% in weight), the number and time of propagation steps (back-sloppings), and, very importantly, the time and temperature of fermentation and baking (Rocha 2011; Novotni et al. 2020). Hence, there are numerous factors that can be manipulated in the manufacture of sourdough bread, turning artisanal bakeries or even our own homes into actual scientific laboratories.

The number and frequency of back-sloppings of the mother-dough has a substantial impact on the prevailing microbiota and, therefore, on the final traits of the baking goods. Nevertheless, this process is time-consuming and requires training by the baker. When refreshments are more frequent (*viz*., several times a day), higher amounts of mother-dough and/or higher fermentation temperatures (for instance room temperatures of 20–25 °C, instead of 5–15 °C) for the dough are required (Novotni et al. 2020). Different fermentation temperatures led to development of some microorganisms at the expense of others. In addition, increasing the time of sourdough fermentation will lead to more acidic sourdough and bread. When starter cultures composed by LAB are employed in sourdough fermentation or when using certain fermentation temperatures, the dominance of homolactic or heterolactic LAB strains has a strong effect upon the final level of acidity, odor and flavor, and on the ability to inhibit the growth of fungal spoilage or (bacterial) ropiness during storage. The acidification and anti-fungal capacity of acetic acid (produced by heterofermentative LAB) are higher than those of lactic acid, yet excessive concentrations of the first will decrease sensory acceptance and have detrimental effects on rheological properties. The molar ratio between lactic and acetic acids is called fermentation quotient (FQ); it is generally accepted that values between 2.0 and 2.7 produce a good quality sourdough bread. It is thus apparent that choice of the leavening agent (baker's yeast, different groups of LAB, whether in the presence or not of yeasts, or natural mother-doughs) used as microbial starter cultures represents a key-factor worth testing, toward achievement of the most appreciated sourdough bread in terms of texture, odor, aroma, shelf-life, and nutritional value (Rocha 2011; Novotni et al. 2020).

Sourdough fermentation plays important technological roles in breadmaking. Furthermore, the type of cereals used and the sourdough fermentation also contributes to healthier baking goods. Unique tastes, aromas, nutritional traits and long shelf-life can be attained when using traditional sourdough whole-grain breads. In addition, cereals such as oat, rice, maize, sorghum, millet, teff and ragi, as well as pseudocereals such as buckwheat, amaranth and quinoa, are suitable for celiac patients. Bread may promote health by preventing cardiovascular diseases, colon cancer, hemorrhoids, constipation, diabetes and arteriosclerosis. Starch from cereals is the most suitable type of energy, whereas cellulose and other insoluble fibers play vital regulatory roles in digestive tract. Reduction of salt to decrease the risks of hypertension and cardiovascular diseases brought new challenges to the bakery industry, and sourdough fermentation may decrease the technological handicaps aroused (Rocha 2011; Novotni et al. 2020).

Sourdough fermentation provides several technological advantages, *e.*g. suitable swelling and baking quality, trigger of enzymatic activity, improvement of flavor, loaf volume, texture and structure, and length of bread shelf-life, stability and protection from undesired microorganisms. Sourdough fermentation is also linked to the improvement of nutritional value and health effects of final food baking goods. Among those are, for example, the reduction of glycemic response, the increase of mineral bioavailability and the formation of bioactive compounds (*e.g.* prebiotic oligosaccharides). Furthermore, extended sourdough fermentation is more efficient than baker's yeast fermentation in reducing phytic acid (an anti-nutritional factor). Some sourdough bacteria produce exopolysaccharides (EPS) – which improve rheological, flavor, and textural traits of bread, exhibit prebiotic properties, and are potentially beneficial to gut health. Sourdough fermentation is also crucial to dietary fiber degradation or solubilisation. As previously mentioned, grain dietary fiber contributes positively to a long list of diseases. It also reduces starch digestibility, thus lowering glycemic and insulin index. Resistant starch (and other dietary fibers) are linked to health potential benefits and functional (prebiotic) properties. Sourdough fermentation may positively influence gut health as a result of its role in modulating dietary fiber pattern, producing EPS with prebiotic properties and, probably, providing favorable bacterial metabolites to gut microbiome. Sourdough fermentation and baking play also an important role upon bread flavor and aroma, respectively. Compounds bearing a major effect upon bread flavor are organic acids, alcohols, aldehydes, esters and carbonyls; while aroma compounds upon bread flavor conveyed by bread are mainly a result of non-enzymatic browning during baking, fatty acid peroxidation, and release microbial metabolites. Sourdough fermentation leads to production of microbial metabolites that contribute not only to food flavor, aroma, texture, digestibility and nutritional quality, but also to food preservation (Rocha 2011; Novotni et al. 2020).

3 Corn, Rye and Sourdough *Broa*

3.1 Corn

Creal cultivation in Portugal is dispersed by three geographical areas. Wheat (*Triticum* spp.) in the South, characterized by fertile plains and very hot and dry Mediterranean summers. Indeed, the South region of Alentejo was known as the barn of Portugal, before joining the EU in 1985. On the other end, the rye (*Secale cereale*) is cultivated mainly in the North and Central East, characterized by a typical geomorphology of mountains with poor soils, severe Winters and some altitude. Finally, corn (*Zea mays*) is typical from the Atlantic area, due to the favorable conditions of hot and humid climate. In the Centre Portugal, corn and wheat are cultivated to similar proportions (Barboff 1997; Costa 1959; Pereira 1952, 1959; Ribeiro 1991; Rocha et al. 2003).

In Portugal, maize (Fig. 13.6) is typically a grain of small-scale farms, and entails careful care of weeding and watering, whereas rye grain is characterized by a collective exploitation and wheat by extensive plantation. The origin of wild species of American corn is not entirely known, but is thought to descend from *teossinto*. Corn is native to Central and South America, and it grown spontaneously in the Cordilleras of Mexico and Guatemala – and has eventually hybridized with some other (already extinct) species. Numerous maize varieties were found in excavations in the Aztec,

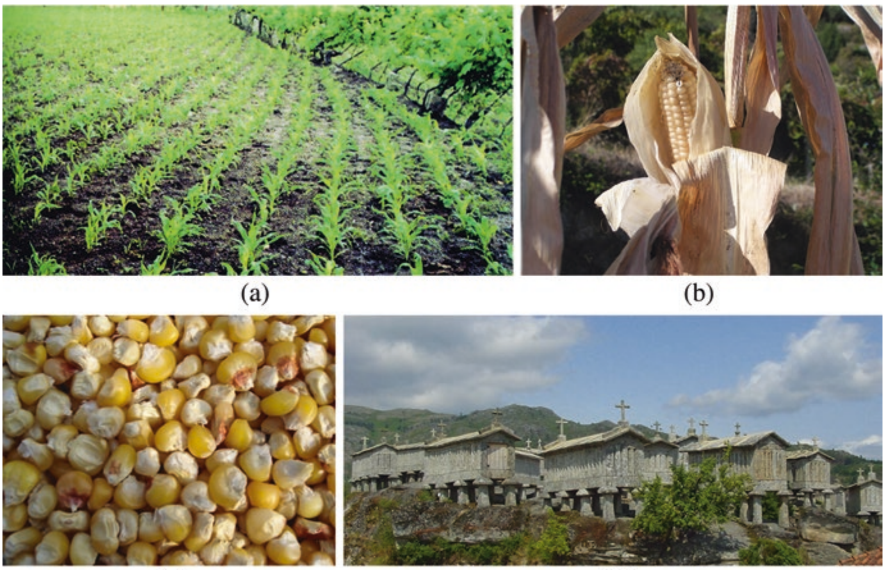

(a) (b) (c) (d)

Fig. 13.6 Photograph of (**a**) Maize (or corn) cultivation field in smallholding regime before harvest, (**b**) Maize crop with the kernels on the cob, (**c**) Maize grains/seeds, and (**d**) typical stone granaries. (Courtesy of authors Alda M. Brás [(**a**)] and Jorge Miranda [(**b**–**d**)]) and aged of 4000 years (Barboff 1997; Cacérès 1987; Costa 1959; Cruz 1996; Dupaigne 1999; Montandon 1974; Pereira 1952, 1959; Rocha et al. 2003).

Maize is a summer's cereal grain, ideally produced in hot and wet summers, and is a weeded and watered cereal. The growth cycle is of only 4–5 months, attaining 3 m in height, and a cost-effective large number of grains are produced per spike. Water is crucial, particularly throughout formation of the reproductive organs. The harvest extends from August to October. Among the major world producers are United States of America (USA), Mexico, Italy, France, China, Argentina and Brazil (Amaral 1999; Barboff 1997; Costa 1959; Pereira 1952, 1959; Ribeiro 1991; Rocha et al. 2003).

In Middle Ages, maize was mainly cultivated in Northwest Portugal as Pearl millet (*Panicum miliaceum*) and Foxtail millet (*Setaria italica*), whereas wheat and barley (*Hordeum vulgare*) were grown from Minho (North East) to Algarve (South), and rye in mountainous zones. When Europeans discovered America, they encountered several varieties of maize grains – white, yellow, blue, red and green; however, they embraced the yellow grain due to the highest yields of production and greater likeness to Pearl millet, which was called maize. Nowadays, a large variety of maize subspecies can be found based on techniques of selection, crossbreeding and genetic manipulation (Barboff 1997; Cacérès 1987; Costa 1959; Cruz 1996; Dupaigne 1999; Ferreira 1995; Montandon 1974; Pereira 1952, 1959; Rocha et al. 2003).

Maize cultivation in Portugal was rapidly employed after the first journey of Cristovão Colombo (Christopher Columbus) in 1492, a Portuguese navigator at the service of the Spanish crown (Santos 2010). Cristovão Colombo married (around 1479) in Porto Santo, Madeira archipelago (Fig. 13.2), Filipa Moniz – daughter of Bartolomeu Perestrelo, the first captain of the donee. Its cultivation started in the Centre of the country and, especially, in Northwest coast. The rise of this new species in Portugal led to a reduction of Foxtail and Proso millet cultivars, as well as of wheat and rye crops. Currently, traditional *broa* baked with regional maize is quite popular – in which recipe rye flour is added to compensate for the lack of gluten typical of maize (Barboff 1997; Cruz 1996; Costa 1959; Pereira 1952, 1959; Ribeiro 1991; Rocha et al. 2003).

At the beginning of the nineteenth century, corn replaced other less profitable crops in the interior regions of the country, Trás-os-Montes and Beiras, as well as in the South regions of Alentejo and Algarve. With the advent of the Portuguese maritime expansion, corn cultivation was spread through all continents: Atlantic Islands of Madeira, Azores and Cape Verde; off the coast of West Africa (Angola and Congo) and other parts of the African coast; and in Asia, specifically in India, China, and Japan. In 1874, corn was the most cultivated cereal – yet overtaken by wheat in twentieth century. Corn has become a landmark in Portugal regarding its status in people's diet, especially in the Northwest – with obvious consequences upon agriculture, economy, society and regional culture. For these reasons, corn was seen as the Revolutionary Cereal: against hunger and scarcity, corn appears as a miracle plant. In the perspective of the agricultural methods, corn implementation converted indeed the landscape and the yearly scheduling: the meadow becomes field-meadow, and the fallow ground of winter cereals (wheat and rye) was suppressed. Since the late season of maturity of corn, it was necessary to build stone threshing floors and (wooden or stone) granaries, making them a typical landmark of Northwest landscapes (Fig. 13.6d). Corn became grown in polyculture mode, simultaneously with other cultures that also require irrigation, *viz*. beans and pumpkins; and corn cultivation areas and terraces were spread in detriment of other crops. Characteristics of maize cultivation such as growth in small threshing floors (Fig. 13.6a), producing each year and the possibility to practice polyculture resulted in important advantages to the local rural economy. Moreover, the small portions of land and the irregular relief characteristic form the Northern Portugal fits very well with the manual work of weeding in small-scale corn cultivation. Indeed, the terraced cultivation of corn breaks the slope of the rough terrain, increases the arable area and smooths the irrigation. As a matter of fact, the yield of corn per hectare is three to four times higher than that of wheat (Barboff 1997; Cruz 1996; Costa 1959; Pereira 1952, 1959; Ribeiro 1991; Rocha et al. 2003).

From a social standpoint, cultivation of corn brought an increase of income and, therefore, led to better living standards. On the other hand, the smallholding cultivation regime changed the rural habit, because the dispersion of small fields for cultivation led to the dispersion of housing. Nevertheless, such dispersion in Northern (Minho) region was prior to the introduction of corn. In terms of cultural standpoint, the cultivation of corn brought about many outcomes. *Broa* became ubiquitous in the dairy diet of Portuguese people. Subsequently, breadmaking of *broa* brought new rituals, religious symbols and sacralization of corn and *broa*, thus contributing to the current cultural heritage. Other type of breads can be prepared from corn in addition to *broa*. In other countries, maize flour is also consumed in gruels and porridges. Maize is used in many other purposes, for instance in thickening sauces, unleavened breads and biscuits, sweets, cornflakes and popcorn, and beverages such as whiskey and *chicha* (Barboff 1997; Cruz 1996; Costa 1959; Ferreira 1995; Novotni et al. 2020; Pereira 1952, 1959; Ribeiro 1991; Rocha 2011).

Proso millet, common millet, broom corn millet, hog millet or white millet (*Panicum miliaceum*) has essentially been discontinued for breadmaking, even though it is still used in Russia, China, Japan, India, and USA for forage and human consumption. Other corns are still employed quite often in certain regions, though bearing a lesser economic interest: *Panicum miliare*, similar to *Panicum miliaceum* but less than half its size, and cultivated in the tropics due to its high resistance to weathering; *Setaria millet* (Foxtail millet), of similar size to *Panicum miliare*, and grown in temperate climates; *Pennisetum* spp., a grain that produces small and rounded yellow (*P. typhoideum*) or white, or Pearl millet (*P. glaucum*) grains, very resistant to drought, and widely used in the climatic limits, namely the South of Sahara desert, as well as semi-desert areas of Pakistan and India; and *Eleusine coracona* (Finger millet, also known as Ragi or Mandwa in India), grown in semi-arid regions of India and Africa, among other examples. Several of these species are consumed mostly as porridges (Barboff 1997; Costa 1959; Cruz 1996; Pereira 1952, 1959; Ribeiro 1991).

3.2 Rye

The etymology of rye (*Secale cereal*, *centeio* in Portuguese) (Fig. 13.7) comes from the Latin *centeni* (cent), as it was believed that each grain yielded a cent of new grains. Rye is also frequently referred by the Latin term *messis*, and in Northern Portugal this name is still employed: *messe* or *messes* (Barboff 1997; Cacérès 1987; Cruz 1996; Dupaigne 1999; Ribeiro 1991; Rocha et al. 2003).

Rye is a cereal grain with exceptional capacity to grow in cold as well as warm temperatures, and in schist and granite soils. It is used not only for bread, but also for fodder and beverages – such as beer in Russia, whiskey in North America and brandy in Netherlands. It is thought to have originated from spontaneous varieties (*Secale montanum*) in the mountains bordering the Mediterranean, chiefly Atlas and Sierra Nevada, and the high plateaus of the East. By hybridization processes, *Secale montanum* has given rise to edible varieties.

It was through a process of hybridization that new edible species resulted. It is believed to be a cereal with later occurrence than wheat, because traces were not found prior to the Bronze Age (Barboff 1997; Cacérès 1987; Castell-Perez 1992; Cruz 1996; Dupaigne 1999; Juntunen 2003; Montandon 1974).

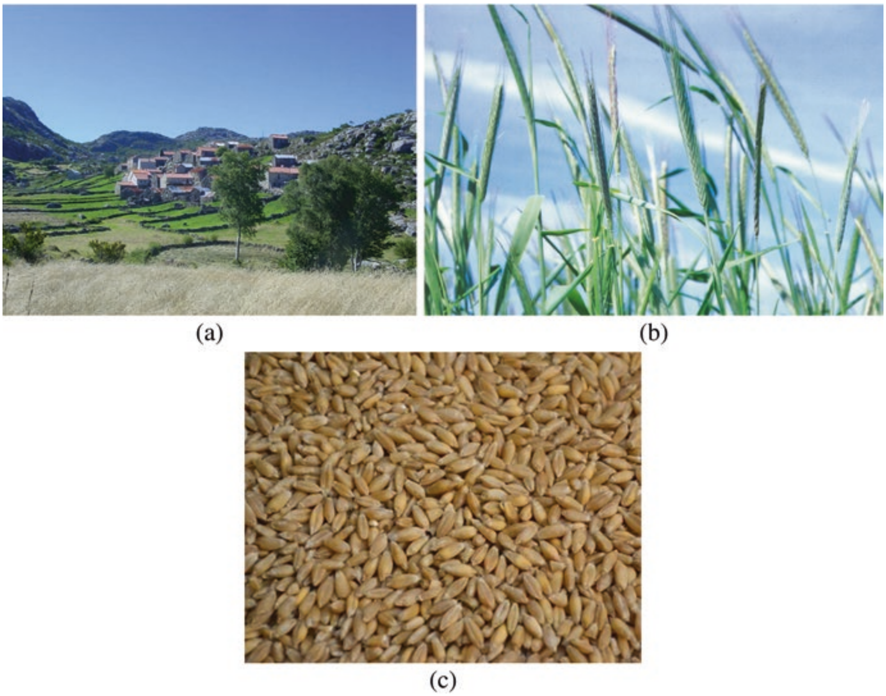


Fig. 13.7 Photograph of (**a**) Rye cultivation field in smallholding regime before harvest, (**b**) Rye crop, and (**b**) Rye grains/seeds. (Courtesy of authors Jorge Miranda [(**a**)] and Alda M. Brás [(**b**) and (**c**)])

The growing cycle of rye is 10–11 months, and reaches 1.60–1.80 m high by the end of the cycle. The harvest occurs in July, one month after wheat. In Europe, the main producers are Russia, Poland, and Ukraine. In Portugal, it is typically produced in the interior central and Northwest (Trás-os-Montes). In terms of composition and nutritional value, rye varieties are quite similar to wheat. Once rye has a relative high content of gluten, it is possible to manufacture bread exclusively of this bread – but resulting in less elastic and darker bread than that obtained from wheat. Traditional rye breads are also produced in Portugal, especially in the North (Barboff 1997; Cacérès 1987; Cruz 1996; Dupaigne 1999). Rye bread, and specially, whole rye bread, is known for its positive effects upon cardiovascular diseases, diabetes, gut heath, among several others. Its importance led researchers to designate rye as "miraculous cereal" (Bushuk 2001; Cruz 1996; Juntunen 2003).

3.3 Broa

3.3.1 *Broa* with Maize (*Zea mays*)

Household breadmaking of sourdough bread is much more than craft, it is an actual art (Fig. 13.8). In spite of *broa* and other corn breads having already been baked before discoverers, the introduction of maize by the navigators in the fifteenth and sixteenth centuries was a milestone towards the breadmaking of *broa*. Prior to introduction of corn or American *maíz* (*Zea mays*) – a more robust and profitable plant, *broa* was baked with Proso millet (*Panicum miliaceum*). The cultivation of Proso millet in the Iberian Peninsula occurred for at least 30 years before the first voyage of Christopher Columbus in 1492, despite the references to its use for human consumption having been almost lost (Barboff 1997).

The word *broa* – which refers to bread made of maize and/or rye flours, is more consumed in Northern Portugal, and derives from the Celtic *bron* or the Germanic *broth* – which only means *bread* in these languages. On realizes that the words *broa* (in Portuguese), *brot* (in German), and *bread* (in English) are very similar to each other. Conversely, the Southern Portugal consumes more wheat bread because of its greater Roman influence and, thus, adopted the name *pão* (bread), which derives directly from the Latin *panis* (Barboff 1997; Costa 1959; Pereira 1959).

The Aztecs, who trained the European invaders in the process of corn cultivation, consumed maize flour mostly in the form of baked cookies (precursors of bread) on hot stones, as did the ancient civilizations with unfermented breads from other cereals. Even today, these specialities are very appreciated in Mesoamerica. Such porridges and gruels (slightly sweet due to the maize flour) are still used by the Westerns, especially in Italy (*polenta*) and Spain (*gachas*) – who prefer wheat flour, and in Portugal – where an abundant variety of forms remain alive (Cruz 1996).

Breadmaking of *broa* always involves another cereal, chiefly wheat and, more frequently, rye; and, in the latest case, this has led to a heavier *broa*. The reason behind this is that maize flour lacks leavening ability due to the absence of gluten

Fig. 13.8 Rural household baker of traditional sourdough *broa*: (**a**) Heating the wood oven; (**b**) Molding; (**c**) Putting the sourdough into the wood oven; and (**d**) *Broa* after baking. (Courtesy of author Alda M. Brás)

(despite being rich in starch, approximately 70%, w/w). Therefore, *broas* (plural of *broa*) are always *meadas*, *terçadas* or *quartadas*, which means a bread made of a mixture of maize flour and other accessory flour in proportions of a half, a third and a fourth, respectively (Cruz 1996).

3.3.2 *Broa*, Its Assignments and Popular Meanings

As already mentioned, *broa* or *boroa*, a brown and tawny bread (Fig. 13.1), is particularly appreciated in the Northern coast and Centre of Portugal, where maize is mainly cultivated. The name and recipe comes from *borona* of Foxtail millet (*Setaria italica*), reported in Portuguese documents of the twelfth century (Costa 1959; Pereira 1959).

The designation *broa* is firstly applied to Foxtail bread. Despite its roughness in mouth, Foxtail bread was, in gone times, the daily food of farmers. In documents of the thirteenth century, the term *boroa mossegada* was employed to designate bread made of maize; and a document of 1417 described it as *boroa scarolada*. Nowadays, *broa*, *pão broa* (bread *broa*), or *broa de milho* (corn bread) is used in Minho and

Douro regions (Fig. 13.2) to designate bread baked with maize flour (Costa 1959; Pereira 1959).

In many sub-regions of Minho (Fig. 13.2), the word *broa* still uniquely refers to each batch of corn bread: "*uma fornada de quatro broas*" (a batch of four *broas*), "*meter as broas ao forno*" (put the *broas* in the oven), *etc*. In ordinary language, Portuguese people call *pão* (bread) referring to *broa*, and *trigo* (wheat) referring to wheat bread. The term *broa* can also be given to circular and small sized breads: for example, in Trás-os-Montes region (Fig. 13.2) the terms *broa de centeio* (rye bread), *broa de trigo* (wheat bread), and *broa de milho* (corn bread) are still used. In Beira region (Fig. 13.2), the terms *broa* and *pão de milho* (corn bread) are used interchangeably; while in the Southern regions of Ribatejo and Alentejo, and in the Azores islands (Fig. 13.2), the word *broa* is not used to describe corn bread. *Broaça* is a *broa*, and a low-fat woman is called popularly, *broa*. *Broeira* is the wooden board, suspended on the ceiling, where they place the *broas* after baking. *Broeiro* is, popularly, the one who eats too much, or has rude manners and appearance. The inhabitants of Porto city, the second Portuguese city, are also called *broeiros*, because *broa* was the most common bread of the humblest people (Costa 1959; Pereira 1959).

Although wheat bread is very common in Minho and Douro regions (Fig. 13.2), corn bread or *broa* is stills nuclear in their diet. *Broa*, which results from a mixture of flours, has different names depending on the region (Fig. 13.2) and its composition. Bread made of maize and rye flour: *Boroa centeia*, in Bornes from Vila Pouca de Aguiar county; and *Pão de meias*, in Laje from Vila Verde county, which is manufactured mainly with maize and some rye flour. Bread made of maize and wheat flour: *Broa espoada*, in Miranda do Corvo county, with equal amounts of the two flours (*espoar* is the second stage in sifting flour); *Pão premido*, in Aveiro county; *Pão traçado*, in Lage from Vila Verde county, with two pieces of wheat flour and one of maize flour; and *Trigamilha*, in Beiras region. Bread made of maize and rye or wheat flours: *Broa de mistura* or *Broa misturada*, in Miranda do Corvo county, with two pieces of maize flour and one of wheat or rye; *Pão demeado*, in S. Francisco de Assis from Covilhã region, with equal parts of two flours (this adjective comes from the word *meio*, *i.e*. middle, and also appears in the expressions *meado* e *meias*); and *Pão meado*, in Monção and Vila Verde counties. Bread made of maize, rye and wheat flours: *Pão de toda a farinha* (bread of all flours), because it uses several flours; and *Pão terçado*, where the adjective *terçado* (3 parts) comes from *terçar* that formerly was pronounced as *terciar*. Other corn bread: *Pão coado*, made with wheat flour, corn, barley and rye flours; *Pão escolheito*, in Minho region, is the same as *pão coado*; *Pão colheito*, in Trute from Monção county, is the same as *pão coado*; *Pão de boa peneira*, in Sá from Monção county, is the same as *pão coado* or *pão escolheito*; *Micha*, bread made of several flours that was distributed to the poor at the gate of the convents; and *Pão quartado*, made with maize, wheat, rye and barley flours (*quartar* means bend four flours to make the bread) (Costa 1959; Pereira 1959; Rocha 2011).

4 Traditional Breadmaking of Sourdough *Broa*

Every Portuguese rural community possesses their own rules, baking practices and customs, representing their cultural identity and heritage – and directly leading to unique recipes, bread volumes and shapes, tastes and aromas. Breadmaking of *broa* belongs traditionally to the household woman; when a man helps, his job is usually restricted to heating the wood oven and taking the *broas* off the oven. Traditional sourdough *broa* is regularly baked once a week or every fortnight. In the hot summer, *broa* is baked less often, for instance on a monthly basis (Barboff 1997; Rocha 2011; Rocha and Malcata 2016a, b). Figure 13.9 displays a general flowchart of the traditional household breadmaking of sourdough *broa*. Recall that there are considerable variations in the breadmaking process of *broa* among the local farmers sampled, belonging in turn to the more representative sub-regions (Alto Minho, Basto, Vale do Sousa and Avintes) of Minho and Douro region (Fig. 13.2).

Breadmaking of traditional *broa*, starts with another secular practice, the milling of regional maize in watermills (Fig. 13.10c–i) – where the corn seeds are sometimes stored in stone or wood granaries (Figs. 13.6d and 13.10a, b). Despite having practically fallen into disuse, some household bakers and farmers still grind their maize flour in a water-mill. Rye flour can also be ground in watermills – but, depending on the regions, it is more common for the farmers to get it from the local market.

The laborious art of *broa* breadmaking frequently starts on the day before, with preparation of sourdough (Fig. 13.11a, b), known as *crescente* (crescent) (Fig. 13.11b). In this preliminary process, maize and rye flours and water are manually kneaded in the wooden kneader. The sour ferment or mother-dough, *i.e*. a piece of ripened dough kept aside from the previous batch, is added and the mixture kneaded again (Fig. 13.11a). The mixture is then left in the wooden kneader to ferment (first fermentation) – usually overnight although this period may last from *ca*. 4.5 to 28 h, thus giving rise to sourdough, the acidic dough (Fig. 13.11b). Based on this type of fermentation process, *broa* belongs to the type I sourdoughs (Novotni et al. 2020; Rocha 2011).

The process starts again very early in the next morning. The maize flour is sieved on the day before or on the day of baking (Fig. 13.11c, d), by the household bakers, using a sieve of nylon or silk to separate the bran from the flour. To help the baker, a grid over the kneader is sometimes used – which is called *cernideira* or *urnideira* in the Northwest region of Trás-os-Montes (Fig. 13.2), and allows manual sieving by rotating movements on top of the grid.

Bread kneading differs according to type of flour and tools employed, in addition to local customs and practices (Fig. 13.11e, h). After warming up the water to boiling point, table salt is added and mixed, and finally added to the maize flour (previously sieved in the wooden kneader) for scalding. The scalding process may also be carried out in a bowl. Since water is often very warm, the mixture is usually kneaded with a wooden shovel. Kneading – as in many other stages of breadmaking of *broa*, has a moment of a prayer (Fig. 13.11e). After scalding, the maize is mixed with the sourdough (from the first fermentation in the night before), and rye flour is

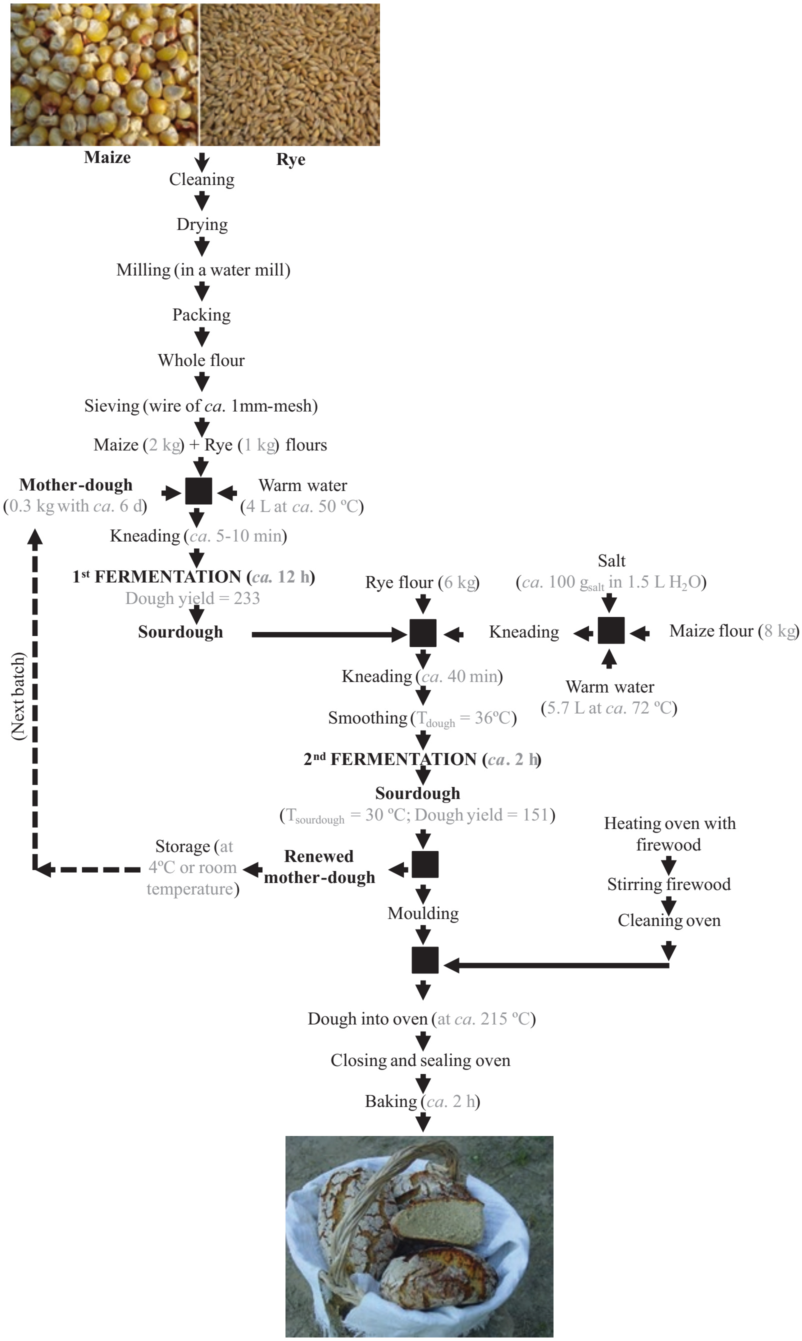


Fig. 13.9 Flowchart of the classical breadmaking of *broa* made of ca. 59% (w/w) regional maize flour and 41% (w/w) of rye flour. (Adapted from Rocha and Malcata (2016a, b) and Rocha et al. (2011). Photographs: courtesy of author Jorge Miranda)

gradually added and manually kneaded for *ca*. 30 min – *i.e*. the time required to give *ca*. 4 "turns" to the dough. At the end of this stage, the baking dough is smoothed, greased with some rye flour, and left to ferment after making a cross and saying some prays (Fig. 13.11i, j). Kneading is typically a very hard and laborious work that requires strength and dexterity from the woman baker. The amounts of each ingredient were those learnt by the farmers from previous generations, who gained knowledge by empirical observation. Kneading allows absorption of water by

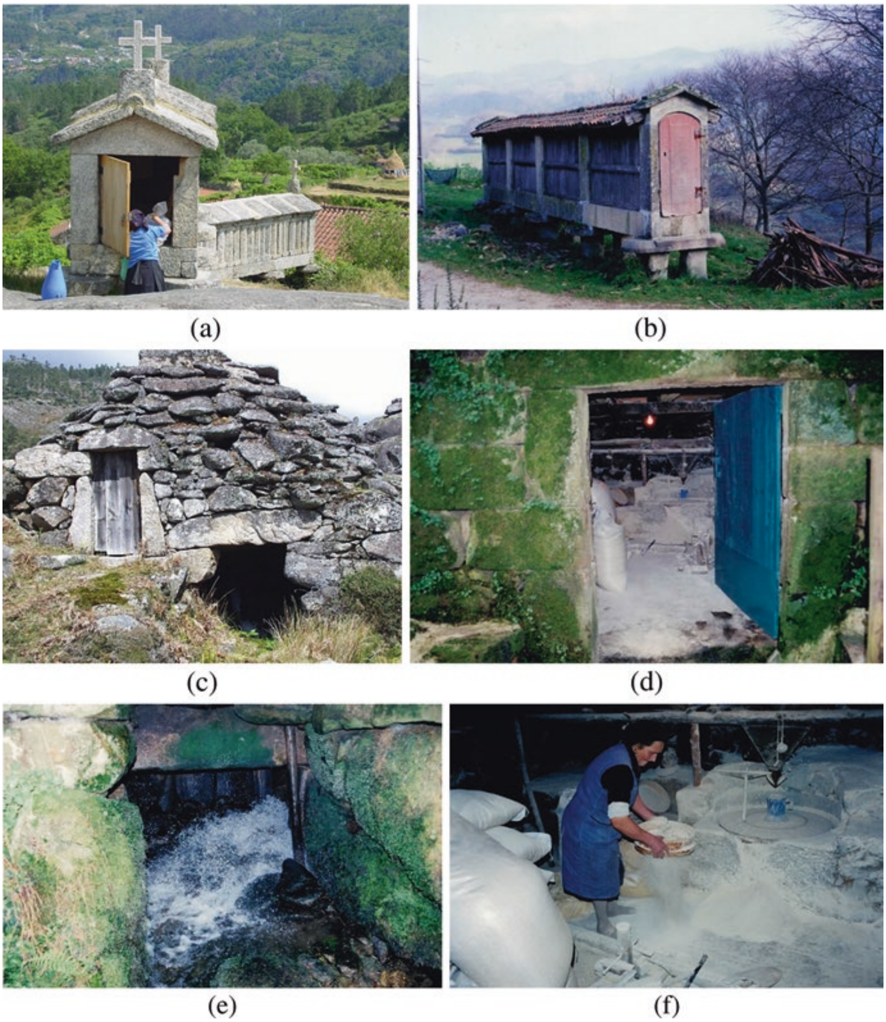


Fig. 13.10 Traditional (**a**, **b**) stone and wood granaries for the corn seeds and (**c**, **i**) watermill to produce the regional maize flour for breadmaking of sourdough *broa*. (Courtesy of authors Alda M. Brás [(**b**, **d**–**f**)] and Jorge Miranda [(**a**, **c**, and **g**–**i**)])

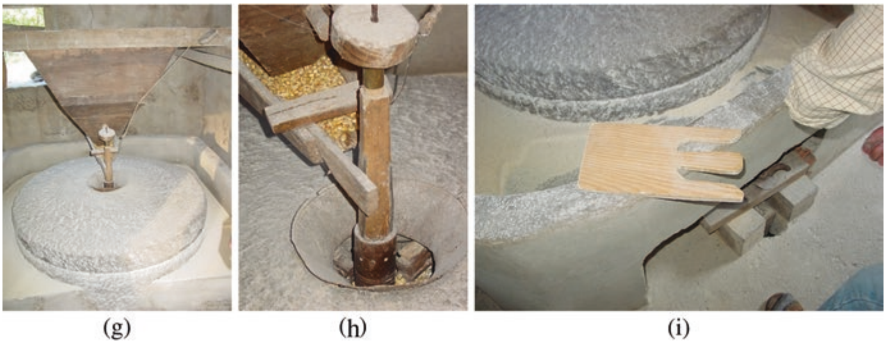


Fig. 13.10 (continued)

gluten of rye flour and oxygenation of the baking dough, which improves its plasticity, fermentation capacity, and discoloration.

Fermentation is a key step in breadmaking. Dough fermentation takes place in the wooden kneader for *ca*. 2 h, at room temperature. Recall that this is the second fermentation, since the first one happened on the day before. To attain a successful fermentation, the woman baker resorts to empirical methods and, frequently, to ritual practices. After kneading, the household woman baker makes a cross on the dough (Fig. 13.11k), sometimes adds a few cloves of garlic in dough, and says a prayer. Afterwards, she covers the dough with a clean towel, blanket, apron or a piece of clothing from her husband – in this last case, an analogy between fermentation and fertility is obvious. Monitoring the progress of fermentation is done empirically. When baking dough starts opening (*i.e*. when "cracks" appear), this is a signal that is fermented. The fermented dough is called sourdough; at this stage, the dough temperature is ca. 30 °C.

While the dough is left to ferment, the oven is heated with firewood (Fig. 13.11l, n). Occasionally, the firewood is stirred to better burn and warm up the oven firewood (Fig. 13.11m). The oven temperature is empirically controlled: when the bricks are whitened, the oven is ready to be used. At this stage, the oven is cleaned with an iron shovel and swept with a broom. The charcoal is removed, thus leaving a few embers at the entrance until before closing the woven door (Fig. 13.11n, p).

After the end of fermentation, a wooden bowl (called *gamelo* or *tigelão*) is used to mold *broa* (Fig. 13.11o). In this process, and after greasing the bowl with white flour, the wooden bowl is filled with sourdough (the fermented dough) and shaped. As happens in other stages of baking, shaping the bread requires good training and skinless by the women baker.

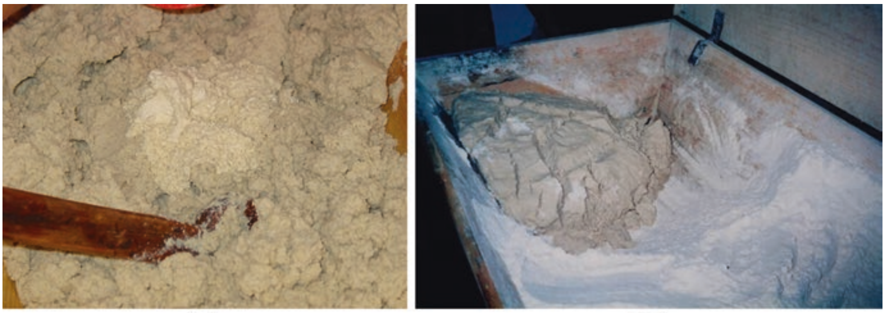
To bake *broa*, a round or rectangular wooden shovel is used, bearing a handle that is more or less long depending on the depth of the oven (Fig. 13.11p). This work is particularly tiring, due to the constant and rapid repetition of movements, and the intense heat felt near the oven. This job often requires two people, one to place the *broa* in the shovel and another to bake.

At this stage, there are also sometimes certain rites. The woman bakers make a cross with the shovel at the entrance to the oven, and say some prayers (Fig. 13.11q). A handful of rye flour is thrown over the *broas* to aid in developing color (Fig. 13.11r). Finally, the oven is closed with a granite slab or a metal door, and sealed with clay or ash (Fig. 13.11s, t). The temperature inside the oven may reach 250 °C.

When baked in community ovens in the older villages, usually belonging to the church, *broas* from each farmer are marked to distinguish them. During baking, the women have the opportunity, in an exclusively female space, to enjoy some moments of well-deserved rest and relaxation, talking to each other and taking the opportunity to eat something (Barboff 1997). Baking is in fact the last stage of the breadmaking cycle.

A portion of sourdough is always left for the next batch of baking (Fig. 13.11u, v) and, as already mentioned, is called *massa-mãe* (mother-dough), massa-azeda (sour dough), or isco (bait). Refreshed mother-dough is left on a small bowl (called *gamelo pequeno*), or simply on the corner of the wooden kneader (Fig. 13.11v). In Minho region (Fig. 13.2), the mother-dough is sometimes covered with a cabbage leaf to keep it from drying out. Nowadays, the mother-dough is often kept in the refrigerator. Sometimes the mother-dough becomes inactive, so the farmers need make a new one or ask a neighbor to share hers.

As happens during cultivation of maize, the traditional breadmaking of *broa* is linked to human fertility as per very old traditions. Daughters begins to learn the art of breadmaking at the stage of puberty. When they help in the dough kneading, the girls sleep with a piece of mother-dough to have a well-endowed body. When the



(a) (b)

Fig. 13.11 Household breadmaking of traditional Portuguese sourdough *broa*. (**a**) Preparation of sourdough in the day before of baking, with addition of the mother-dough; (**b**) Sourdough after overnight fermentation; (**c**) and (**d**) Sieving; (**e**) to (**h**) Scalding of maize flour and manual kneading of the mixture of maize and rye flours, sourdough from the first fermentation and warm water with salt; (**i**) to (**k**) Smoothing of baker's dough and holding to ferment; (**l**) and (**m**) Heating of the oven with firewood; (**n**) Cleaning of the oven by removing the charcoal from the oven; (**o**) Molding of the sourdough; (**p**) putting bread into the oven with a shovel; (**q**) Making a cross with the shovel and saying a prayer; (**r**) *Broas* in the oven; (**s**) and (**t**) Closing and sealing of the oven; (**u**) and (**v**) Removal of a piece of sourdough left aside (leavened dough) to be used as mother-dough in the next batch; and (**x**) and (**y**) final *Broa*. Courtesy of authors Jorge Miranda [(**a**), (**x**) and (**y**)] and Alda Brás (other photographs)

Fig. 13.11 (continued)

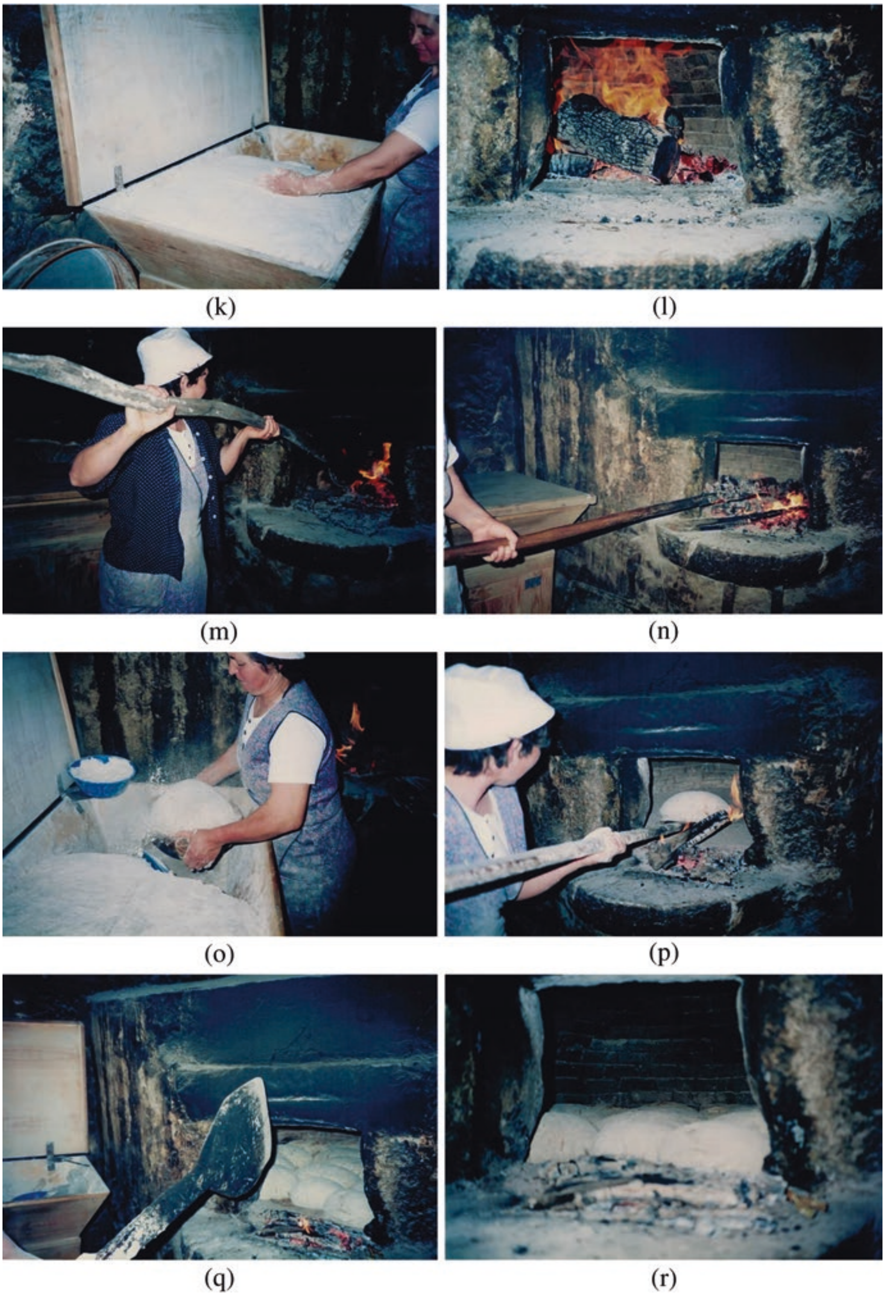


Fig. 13.11 (continued)

Fig. 13.11 (continued)

girls get married, they take a mother-dough from the mother and make *broa* by themselves. As described above, fermentation is linked with fertility and pregnancy: fermentation is when sourdough grows in volume, and is associated to the male's clothing placed next to the wooden kneader (Barboff 1997).

After approximately 2 h, and resorting to the same shovel that was used to bake the bread, the hot *broas* are removed from the oven one by one (Fig. 13.11w, x). By the color and texture of the crumb and by the sound of crust touching, the baker women can immediately ascertain whether the fermentation and baking went well.

Finally, after almost uninterrupted hours of work, a *broa* results – ready to feed at meals, but also to feed beliefs and religion. It is a symbol of conviviality, hospitality, generosity and communion!

5 Recipe of a Traditional Sourdough *Broa* from Northern Portugal

There are hidden "secrets" in every step of the farmers who cultivate maize and rye, in the use of grinding watermills, and in the empirical know-how transmitted throughout generations from mother to daughter. The mysteries of breadmaking of *broa* are intrinsic to its simplicity, the same simplicity that will appear complex to the eyes of the researcher. The unique manufacturing process of *broa*, using a portion of sourdough (mother-dough) produced by spontaneous fermentation, and using less frequent flours (maize), leads to development of unique sensory characteristics in this traditional bread – thus accounting for the important economic, social and cultural features of *broa*.

As already mentioned, other regional *broas* may be found throughout Portugal. DGADR (2022), in collaboration with two other institutions (FPCG 2022; MINHA TERRA 2022), made an inventory of traditional Portuguese agricultural products and foodstuffs – carried out through collecting references and obtaining elements related to history, know-how and related issues. This work mentions numerous *broas* made of maize and rye flours, *viz*. *Broa à Lavrador*, *Broa de Avanca*, *Broa de Milho*, *Broa de Milho da Beira Alta*, *Broa de Milho e Centeio*, *Broa de Vil Moinhos*.

The usual weight of *broa* from Northern Portugal (Figs. 13.1 and 13.11x) is *ca*. 1.5 kg, but may vary from 1 to *ca*. 3.5 kg. It has a circular to ellipsoidal format, a round top and a flat basis, and possesses a crust of *ca*. 1–2 cm. In some sub-regions, *broa* is wrapped in cabbage leaves before baking (Rocha 2011; Rocha et al. 2011; Rocha and Malcata 2016a, b).

The traditional breadmaking of flour schematized in Fig. 13.9 can be replicated for home baking. To produce a single sourdough *broa* of *ca*. 2 kg, the values in Fig. 13.9 can be decreased to 10%. The first challenge that household bakers will face is how to get the mother-dough to be used as ferment (or microbial starter culture) in the first time of baking. This process should start 1 or 2 weeks prior to baking the sourdough *broa*. To that purpose, 120 g of maize flour is mixed with 80 g (to produce 200 g mother-dough, although only 30 g will be used) and warm water (at *ca*. 50 °C). The mixture is kneaded for 10–15 min, and left to spontaneously ferment at room temperature covered with a towel. The home baker will figure out an aroma of baker's yeast, and then a more pronounced acidic aroma (due mainly to the lactic and acetic acids). Three to five days are reasonable to get a developed mother-dough – but the more acidic, the more fermented *broa* will be. The mother-dough can be kept in the refrigerator. If the mother-dough is not going to be used within 2–3 weeks, then it may be necessary to refresh the mother-dough with more flour and water to the same proportion. This continuous propagation of the mother-dough promotes spontaneous selection of the microbiota to only a few species (mainly yeasts and LAB), as already discussed. For the first try, a mother-dough with 6 days is suggested.

The process of breadmaking of *broa* starts in the day before of baking, by preparing the sourdough. Two hundred grams of maize flours and one hundred grams of rye flours are mixed, then 400 ml of warm water (at *ca*. 50 °C) is added and kneaded for 10 min, after which 30 g of mother-dough is added and the mixture kneaded for another 10–15 min. The dough is left to ferment (1st fermentation) overnight (*ca*. 12 h), to give rise to the sourdough. On the next morning, it is time to prepare the dough for *broa* and bake. Eight hundred grams of maize flour is mixed (scalded) with 570 ml of warm water (at *ca*. 70 °C), plus 8–10 g of salt in 150 ml of warm water. The mixture is kneaded for a while (*ca*. 10–15 min), and 600 g of rye flour is then gradually added to the previous maize dough; 30 g of mother-dough is also gradually added, and the mixture kneaded for *ca*. 20–30 min. The mixture is smoothed afterward, and left to ferment (2nd fermentation) during 2 h at room temperature, after covering with a towel. Depending on the room temperature, the dough can be fermented under controlled temperature (for example using the oven). It will be interesting to try to ferment at different temperatures, e.g. at 30 and 37 °C, and for different times. After fermentation, a piece of sourdough (*ca*. 50 g) is kept aside and stored in the refrigerator. This piece of sourdough will be used as mother-dough in the next batch of baking. The oven should be pre-heated at *ca*. 215–250 °C (the temperature should be tested and adjusted according to the oven) some minutes before the end of fermentation. The sourdough is molded with a bowel and sprinkling some rye flour, giving it a round top and a flat basis format; and, finally, left to bake for *ca*. 2 h.

6 *Broa* of Avintes

Traditional sourdough *broa de Avintes* is certainly one of the most iconic *broa*. It is produced at (semi-)industrial scale, although stills following ancient practices (Fig. 13.12). For this reason, *broa* of Avintes has currently a greater economic impact than the other *broas*. Additionally, it has a significant socio-cultural impact in Portugal, demonstrated by existence of the “Brotherhood of *broa de Avintes*” – established in 1997, and the mission of which is to disseminate and preserve this traditional bread (Gondim 1990; Madureira 1987; Natal and Luz 1999; Queiroz 1997; Rocha 2011; Rocha et al. 2003; Vaz 1999a). The commercial impact is such that an annual fair is held in the Portuguese village of Avintes (municipality of Vila Nova de Gaia) (Fig. 13.2). The town is known as “the land of *broa*”, and has ascribed its name to this traditional *broa*.

Due to commercial exploitation, it is very difficult to retrieve rigorous information on the recipe for this bread. *Broa* of Avintes comprises hidden secrets, and full knowledge of its processing still remains somehow a mystery; its production is indeed based on a family "secret", revealed from generation to generation. The baking process of *broa* of Avintes is still mostly artisanal, yet kneading became mechanical not many years ago. Water-mills also fell in disuse, thus giving rise to large factories. But other operations remained unchanged, including oven heating with firewood. In the market, *broa* de Avintes appears in two typical sizes. The larger one

(a) (b) (c) (d) (e) (f)

Fig. 13.12 Breadmaking of the traditional Portuguese sourdough *broa de Avintes*. (**a**) and (**b**) Mixing and kneading the maize, rye and malt flours; (**c**) and (**d**) adding warm water with salt and kneading, which is followed by the addition of mother-dough and fermentation; (**e**) Heating of the oven with firewood; (**f**) Aspect of the top of the oven; (**g**) Cleaning of the oven by removing the charcoal from the oven; (**h**) Molding of the sourdough; (**i**) Closing and sealing of the oven; and (**j**) final *Broa de Avintes*. (Courtesy of the authors Alda Brás and João Miguel Rocha)

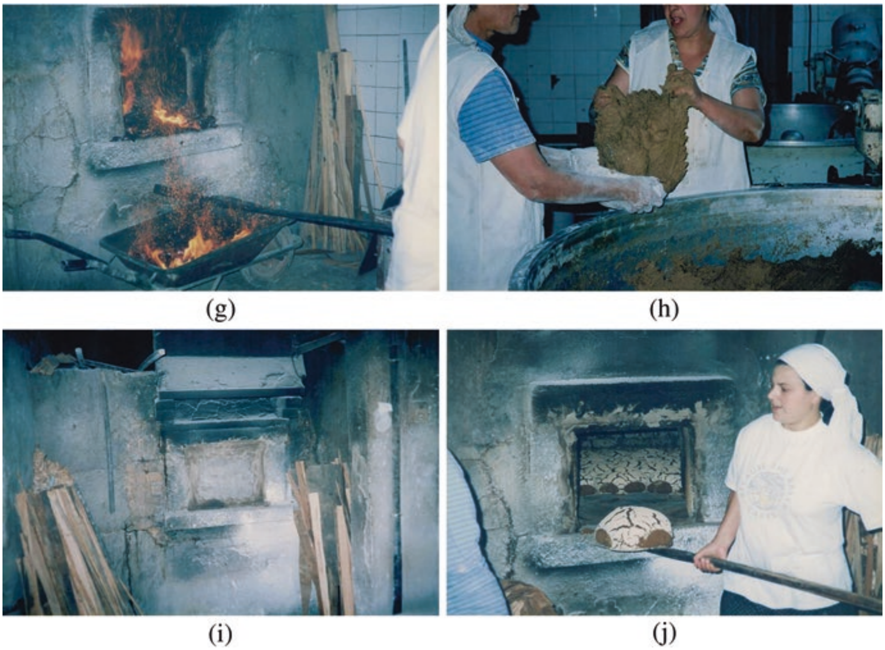


Fig. 13.12 (continued)

weighs 8–9 kg, and holds around 30 cm in diameter and 15 cm height. The smaller one weighs 1 kg, and with holds ca. 10 cm in diameter and 15 cm height.

Broa of Avintes is made of regional maize and rye flours, warm water with salt and malt flour; the latter provides a dark brown appearance with a sweet and sour taste. Its shape is typically a tower, with a round top and a flat bottom. A possible recipe is 1.25 kg of regional maize flour, 1.25 kg of rye flour, 50 g of malt flour, 1.25 l of warm water (≈50 °C) with salt, and 25–50 g of mother-dough. The time of fermentation can vary, for example from 30 min to 2 h. The amount of water with salt can be decreased or increased (around 50%), depending on whether a harder and taller *broa* or a softer and smaller *broa*, respectively, is envisaged. The amount of mother-dough and time of fermentation can be increased for a more acidic bread. Baking takes place in the oven preheated to 260 °C, for *ca*. 1 h.

Avintes county is located only at 6 km away from Porto (Fig. 13.2), on the left bank of Douro river. The iconic Douro river is intrinsically associated with Port wine and the Alto Douro wine region, classified by UNESCO in 2001 as World Heritage. The demarcated Region of Douro, created by Marquês de Pombal (Marquis of Pombal) in 1756, is indeed one of the oldest wine-growing regions of the world. The North and East of Avintes is served by Douro river, which passes through the whole extension of Avintes, from the mouth of river Febros to the brook of Arnelos (Almeida 1999; Amaral 1993, 1999; Gondim 1990; Oliveira and Pignatelli 1999).

Over the centuries, the history of Avintes has been deeply connected to that of traditional *broa*. In fact, *broa* is manufactured in Avintes since the reign of D. Dinis (1261–1325), who granted the exclusive right of breadmaking to Avintes, meant to supply the population of Porto city. D. Dinis forbid baking of *broa* in Porto to reduce the risk of fires, thus moving the woman bakers of wheat to Valongo county, and those of maize outside to Avintes county on the other riverbank (Almeida 1999). The first document found on a woman baker dates back to February of 1282, and refers to the need to pay taxes of goods transported from Porto to Vila Nova de Gaia village on the other bank of river Douro (or vice-versa) (Almeida 1999; Amaral 1993, 1999; Gondim 1990).

The references to supply of flours to Porto to make bread appear more frequently in the reign of Afonso IV. The reason was that, at that time, the millers from the surrounding areas were not fulfilling a very old obligation to go to the river with their boats and beasts, and bring to the citizens of Porto (*Portuenses* or *tripeiros*) wheat, maize and rye flours. Indeed, the millers started refusing to go to the riverside to take the cereal and leave the flours, because they wanted to be paid for the freight in addition to the price for grinding (Almeida 1999; Amaral 1993, 1999; Gondim 1990).

In the following reign, D. Pedro I, the Royal Charter of 1366 freed the millers who milled flours for the city of Porto from being incorporated in the shipping galleys, because this affected food shortages to the city. The reason was that the millers' young men escaped to avoid recruitment for the maritime expeditions, so the mills eventually stopped; this, in turn, compromised shipping and maritime expeditions of Portuguese navigators due to lack of flours to the manufacture of biscuits (Almeida 1999; Amaral 1993, 1999; Gondim 1990). The biscuits (*panis nauticus*, or bread of the sea) – already known in antiquity among the Greeks and Romans, was the bread consumed on board of Portuguese *naus* (ships) and galleons. This flat bread made of cereal flour or flours, salt, and water was twice baked in the oven to stay edible for several months on board (Rocha 2011).

A letter from December of 1811 makes reference for the first time to woman bakers of Avintes and Valbom, for the "intolerable" abuse of selling bread by weight. This issue of weight and price of bread has lasted for many years. Additionally, the people complained that the cost of bread was unacceptable, in view of the small size of the bread, knowing how cheap the cereal grains were. The city hall of Porto did not take any action, so complaints eventually reached the government. As a consequence, queen D. Maria II ordered the Civil Governor of Porto to have in consideration those complaints of the people, but nothing was meanwhile solved. It was around 1854 that the fearless man and woman bakers of Avintes went on strike, and refused to sell bread by weight. This attitude caused great harm, because bread was a staple food for the population. Consequently, the city hall took a position of strength, ordering ovens to be built in the city of Porto; and in May 1858, a decree was issued that the bread baked in the square had the weight of two, one or half pound, or even quarter-pound (Almeida 1999; Amaral 1993, 1999; Gondim 1990).

From the seventeen century on, shortly after the arrival of the corn or American maize (*Zea mays*), a new product was born that would be largely consumed ever since. In the nineteenth century, its production grew to such an extent that hundreds of people were involved in breadmaking of *broa*, thereby conveying to Avintes a significant source of economic income. However, because of the aforementioned dispute between the city of Porto and bakers of Avintes (concerning the weight of bread), and because the bakers of Avintes did not want to follow the position decreed by the City Hall of Porto, the latter authorized bakers of *broa* to operate within the city, thus leading *broa de Avintes* to a background position. Therefore, Avintes lost the privilege of making *broa*, thus leading to the notable decay of this industry. In fact, by the mid-century, manufacturing of bread was limited to two or three bakers only (Almeida 1999; Amaral 1993, 1999; Gondim 1990).

From the second half of the nineteenth century, references to a curious kind of woman who lived on the left bank of the Douro river began appearing in the Portuguese literature. The fame of *broa* of Avintes transformed the woman baker of Avintes into an iconic figure of Vila Nova de Gaia, motivating their immortalization by painters, writers, and other artists of the nineteenth century. Camilo Castelo Branco, Eça de Queirós, Ramalho Ortigão, Júlio Dinis, Alberto Pimentel, Júlio César Machado, Carlos Augusto Pereira Bastos Rodrigues, and Joaquim Costa Gomes Canedo used the designations of woman of Avintes, boatman of Avintes, or woman baker of Avintes to describe such unique characters. Columbano draw, Alberto de Sousa Moreira painted, and Henrique immortalized the woman baker of Avintes with a soul of bronze. Sung, painted, and carved, the woman baker of Avintes was also immortalized in post stamps (Amaral 1999; Gomes 1979, 1999; Machado 1999; Vaz 1999b).

The woman baker of Avintes was the baker, the boatman, and the seller at a time when river Douro emerged as the main road to Porto. In turn, the men worked the land and planted maize in the fertile lands along Douro river, or in the valley of Febros river. With the baked *broa de Avintes*, the woman baker of Avintes embarked in the typical boats (*Valboeiros*) and arrived at the riverside of Porto. With the basket on top of their heads, with the white towel covering the *broas de Avintes*, the strong woman baker of Avintes ran at their inimitable step, up and down the hills. The woman baker of Avintes earned a reputation of being pretty, along with the woman boatman; the latter knew the river better than most men, and were known for always having the right answer on the tip of their tongues for all those who made jokes at them – sometimes in a language full of realism, but always with grace. The woman baker of Avintes was never woman boatman, and *vice-versa*; but both were exuberant, and left deep roots in Porto city (*cidade tripeira*). In addition to the woman baker of Avintes, the water trilogy Febros, Esteiro, and Douro contributed to the socio-economic development of Avintes village. A brief reference should be made to the water mills. According to popular testimony in 1747, approximately 50–60 horizontal water-mills existed along the margins of the small Febros river. Nowadays, there are only 3 or 4 that grind, but only intermittently to satisfy small private demand (Amaral 1999; Costa 1999; Gomes 1979, 1999; Oliveira and Pignatelli 1999; Vaz 1999b).

As mentioned above, *broa* of Avintes is typically shaped with a narrow base, with a round top and a flat bottom; and it was the incident with the city hall of Porto – who decided, in 1811, to sale *broa* by weight rather than by unit, that opened a thriving that would relegate the then prosperous industry of *broa* of Avintes to a far more modest rank. At a certain point, however, *broa* of Avintes became the most important industry of the Avintes county, and even today it is one of the most profitable activities. The bakery industry in Avintes continued to flourish remarkably until approximately 1854, and then declined as a result of the strike of the bakers. Until that time, Avintes held the monopoly of manufacture of *broa*, with more than 50 bakers. Despite these events, the production of *broa* is still currently one of the most important industries in Avintes (Almeida 1999; Amaral 1999; Madureira 1987; Vaz 1999b).

7 Conclusions and Future Outlooks

Nowadays sourdough breads and other sourdough-based baking goods (*e.g.* biscuits, crackers, pastry, pizza, pasta) are enjoying an increasing popularity as convenient, nutritious, stable, natural, low processed, and healthy food. However, increase of sourdough bread consumption will depend on innovation and improvement of cereal and breadmaking products and technologies, able to meet the required quality and demand by modern consumers, while addressing the preferences of consumers and market trends. Moreover, baking companies are developing innovative products to compete in a global market, and sourdough biotechnology may play an important role in such goal. In fact, the use of sourdough in bakery industry has recently received a gr eat deal of attention worldwide, as apparent from the advent of a diversified (but still limited) number of commercial products and the research activities dedicated to this topic. Lastly, research around sourdough technology is decisively a hotspot in biotechnology worldwide – already noticeable by the scientific activity and production, and the number of research groups focused on this field.

Traditional *broa* is an example of sourdough bread stills being baked at farm and household levels following ancient protocols. Sourdough *broa* is baked chiefly in Northern Portugal (Fig. 13.2) for historical reasons, since the cultivation of regional corn has been practiced in this region for a long time. Traditional sourdough *broa* conveyed a great economic importance throughout the entire economic sector, from the small farmers who cultivated the regional maize in smallholding to the farmers and householders who baked this typical bread. In addition, such local farmers play crucial roles toward the environment – in line with EU and Portuguese policies. As a matter of fact, these small farmers and rural communities are seen as protective elements to the environment and guardians of biodiversity.

As an ancient product, sourdough *broa* has also an important social and public character, by guaranteeing a market niche to the small farmers and their concomitant integration into the commercial agri-food sector. In this way, the production of regional maize and *broa* helps fixating the population in more isolated rural areas. Settling people in rural areas is seen as a must to avoid the current exodus toward the urban areas, and contributing to a sustainable economy. Moreover, it is and effective way of fighting against the scourge of more and more frequent and violent forest fires faced every year in Portugal, as a result of desertification of the interior further to climate change.

The production of regional specialties, such as sourdough *broa*, also contributes to the income of the small farmers. Modern consumers appreciate artisanal products with unique and inimitable traits, thus justifying the high added value of traditional *broa*. Rural tourism has been gaining an increasing importance at present, and the chance of exploring traditional *broa* as a local attraction is promising. Traditional products such as *broa* serve as vehicle for the valorization and promotion of other regional forms of cultue and tourism. The still existing ancestral community ovens and water-mills at the service of local communities in some small villages in Portuguese countryside are, perhaps, the best example of the socio-cultural character related to manufacture of *broa*.

Therefore, there is a potential way to increase the sources of incoms for small farmers in the Northern Portugal, especially those in poor areas – where, in general, sourdough *broa* originates. However, this increase of market penetration, in absolute and relative terms, will require a higher quality and a greater consistency of the final product. Toward this goal, more scientific and cultural knowledge is necessary, and certification of the product through a protected designation of origin (PDO) is a *sine qua non* as a means to help preserve this product and know the characteristics that make it distinct from any others aliases, thus also aiding in deserved socio-economic and cultural projections.

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Chapter 14
PASCA – Traditional Festive Romanian Easter Bread

Alexandru Rusu, Alexandra Moldovan, and Monica Trif

1 Introduction

1.1 Our Daily Bread. Bread and Salt ('Mother of God') – Romanian Tradition

The "daily bread"is so beautifully said in the founding prayer of the Orthodox Church, The Lord's Prayer: "Give us this day our daily bread". The Lord's Prayer is the most important prayer for Romanians, that's why is it recited before every meal, as gratitude for the food. At weddings, before everyone starts eating, the priest or a close person of the bride and groom say The Lord's Prayer to bless.

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The Lord's Prayer (Romanian: Tatăl nostru):

Tatăl nostru	Our Father
Tatăl nostru care eşti în ceruri, sfinţească-se numele Tău, vie împărăţia Ta, facă-se voia ta, precum în cer aşa şi pe pământ. *Pâinea noastră cea de toate zilele*, dă-ne-o nouă astăzi şi ne iartă nouă greşelile noastre precum şi noi iertăm greşiţilor noştri şi nu ne duce pe noi în ispită ci ne izbăveşte de cel rău. Că a Ta este împărăţia şi puterea şi slava, Acum şi pururea şi în vecii vecilor, Amin!	Our Father, who art in heaven hallowed be thy Name, Thy kingdom come, Thy will be done, on earth as it is in heaven. Give us this day our *daily bread* And forgive us our trespasses, as we forgive those who trespass against us. And lead us not into temptation, but deliver us from evil. For thine is the kingdom, and the power, and the glory, for ever and ever. Amen!

In the Christian-Orthodox tradition, bread is the symbol of life, which people offer to God. These sacred values were transmitted, in fact, from the popular traditions, the bread itself carries the meaning of life.

Romanians live in a culture of bread, a food with a sacred load. Bread incorporates into it a true cosmic universe, full of meanings, and the process of making it was, and it still is, a complex ritual meant to create a bridge to the past. Bread, an ancient symbol of life, and salt, the "mother of God", as it is called in the sayings of the people, are two sacred elements for Romanians.

The addition of salt to the bread dough further enhances its symbolic meaning. The addition of salt, personified in some popular beliefs as the 'Mother of God' or holy (called holy justice), is likely to increase the magical-ritual powers of the bread.

In fact, the salt next to the bread is perhaps the oldest habit of hospitality of the Romanians, who, since ancient times, greeted their guests with bread and salt, as a sign of love, kindness and respect. Most Romanians know that bread and salt are given as a housewarming gift. However, very few people know where this tradition comes from and what to look forward to. The kind attention is certainly a rather unusual gift in a today's consumer society, but it has so much meaning and links the people to their past and culture.

Bread and salt were in the past, and actually are still, the most important staple foods in many cultures. The tradition of giving bread and salt dates back to the Middle Ages, a time when people were exposed to even more uncontrollable factors such as natural disasters, bad harvests and wars. The daily bread and the salt in the soup were therefore not a matter of course, and had far more value.

In the Christian religion, bread and salt were even regarded as gifts from heaven. They have a strong symbolism for hunger and persistence in the Bible (*Faith as the bread of life – John 6/35*; *The salt of the earth – Matthew 5/13*).

Fig. 14.1 Bread and salt given nowadays at inaugurations and welcome greeting ceremonies. (Source: Locals from Borșa commune, Cluj County, Transylvania)

In the past, bread and salt were always a sign of greeting to guests. Eating bread and salt together in times of uncertainty became a sign of hospitality, appreciation and community.

Bread and salt are also given when moving in, and were also typical gifts at inaugurations, greeting ceremonies (Fig. 14.1), and weddings (Fig. 14.2). According to historians, the first testimonies of this ritual form of hospitality are pre-Christian, and the offering of bread (the grains of wheat in the beginning) and salt was a sign of acceptance towards one who came to one's house or land.

When it comes to an official reception, Romanian thoughts turn, almost reflexively, to bread and salt. It happens so often that at any greeting of distinguished guests a well-made roll is brought, or only a nicely browned bread, with a piece of salt next to it, so that the gesture is hardly noticed. It is lost among the details of the official script, overshadowing the extraordinary symbolism of the offering of bread and salt.

Bread (wheat) symbolized the richness of the field, and salt was the true gold of antiquity, being, for millennia, the most expensive product of trade.

Fig. 14.2 Bread and salt given at the wedding: (**a**) modern traditional wedding from Maramures County (Sighetul Marmatiei); (**b**) nowadays *colăcăia* from Sighetul Marmatiei, Maramures County; (**c**) old traditional wedding from Borșa commune, Cluj County, Transylvania. (Source: Locals Maramures County (Sighetul Marmatiei); Historical and Ethnographic Museum, Borșa commune, Cluj County, Transylvania)

Similar beliefs and customs in the immediately pre-Christian atmosphere of the pagan Roman world and the monotheistic Jewish world were found. The history of using sacramental bread (leavened or unleavened) as an element of communion, of living together, goes back close to the time of the historical Jesus (Jacob 1994). Thus, the practice of blessing and breaking bread in the Judaism of centuries before Christ has been attested, but also in the Roman world, at the assemblies called the Symposium. In the Christian-Orthodox tradition, bread is the symbol of life, the symbol of the supreme gift from God to humankind—eternal life, the body of Christ in the Eucharist: "Take this and eat, for this is my body". In Hebrew "Bethlehem" means 'house of bread'. These sacred values were transmitted, moreover, in the popular tradition, which intertwined the old customs with the Christian teaching (Fabiani 2001; Macherel 1994; Rousseau 2001).

In other countries, the consumption of bread and salt is considered a ritual to protect family, friends and acquaintances against illness, evil and, earlier, even against the devil.

Bread and salt are also given at the Romanian weddings to wish the newly married couple prosperity (Fig. 14.2). A tradition from the villages of Moldova, but also in the area of Maramures and Bucovina is the so called *colăcăia*, meaning the passing of the godparent's *colac* (made from bread dough) above the godchildren's heads, so that they have a prosper life together. Then they tear it and share it with all the guests as a sign of joy sharing (Fig. 14.2b). These ritual rolls have a certain meaning. It is believed that just as these scrolls are large, round and beautiful, so will the lives of those who are crowned or baptized.

Regardless of faith, bread and salt are gifts that come from the heart. Just as minimalist as the gift itself, bread can be wrapped in a cloth very well, which is not only practical for storage, but also looks pretty with the right cloth.

Bread is also a symbol of death. Here is what the *Vulgate* (Latin translation of the Holy Scriptures) says about the first Christians gathering for breaking the bread (*Acts 2:42*): "They devoted themselves to the apostles' teaching and to fellowship, to the breaking of bread and to prayer". The grains, the flour, the dough and, finally, the bread are loaded with an archaic symbolism, still strongly present in the rural space, as a sign of joy, fruitfulness, abundance, purity.

In different forms, bread accompanies man throughout life, in moments of joy, like weddings, but also in sadness, like funerals, meaning the closing of the life cycle (Marian 2010).

Fig. 14.3 Prescura (leavened bread): (**a**, **b**) prescura making; (**c**, **d**) prescura ready. The Romanian Orthodox-style prescura seal can been seen. IC- XC NIKA which means 'Jesus Christ Conquers' in Greek. (Source: Historical and Ethnographic Museum, Borșa commune, Cluj County, Transylvania)

In Romanian tradition bread is used for the holy care (communion) and as anafura – Romanian word for a small loaf of leavened bread (Fig. 14.3), or Pasca (Fig. 14.8), in the following situations (Lupescu 1899, 2000; Marian 2010):

– Memorial service for the dead; in remembrance of the deceased;
– Salt and bread for traditional welcome and greeting ceremony;
– Throwing small pieces of bread over the bride and groom as they return from the wedding;
– Feeding lepers with bread and walnut kernels consumed at that Passover meal.

The Eucharist (Romanian: Euharistia), or the act of “Breaking of Bread”, is the central ritual of the Christian cult, having a double meaning: on one hand, the communion with the Eucharistic elements, representing a holy mystery, and, on the other hand, the celebration of the death and resurrection of Jesus Christ (Walvoord and Zuck 1983; Wiersbe 2007; Wilmington 1981).

Our Daily Bread Recipe
Flour, yeast, and salt are the simple ingredients that make the bread dough. The bread is not made in a hurry, the dough is kneaded until it is smooth and elastic. In fact, the whole journey of bread making lasts at least 4 h. After kneading, the dough is left to rest. Then is the dough broken by hand, carefully, and placed in trays, left to rest again until sufficiently leavened, before being placed in the oven.

The bread making ritual is shown in Figs. 14.4 and 14.5. Another breadmaking secret, besides the dough and recipe, is the oven for breadmaking. At the country side, a traditional oven is specially built, made of brick on the outside and with a stone hearth. Each loaf of bread is carefully placed in the oven as can be seen in Figs. 14.4 and 14.5.

The darker the crust at the end of baking – the better. The bricks are excellent for energy distribution, as the heat is conducted and spreads around in the dense material evenly. Traditionally, the bread is cooked with the oven’s radiant heat, placing breads into the oven right as the temperature reaches the stage appropriate for the bread. When the oven gets closed both vault and floor become equally radiant in the heating sense. It is possible to economically reload several bread batches.

1.2 “Before the bread”

Before the bread is served, we need to refer to the production of wheat, to the specific tools and ovens used (Fig. 14.6). Agriculture was the main occupation in all ethnographic areas of Transylvania, although in some areas it was practiced in difficult conditions, due to the poverty of the land (Butură 1989).

The geographer Ptolemy said that in the second half of the IV century BC “in the Romanian Plain the wheat fields were so wide and abundant that the soldiers of Alexander the Great (Romanian Alexandru cel Mare, 20/21 July 356 BC – 10/11 June 323 BC) had to lay the wheat with their spears on the ground to advance” (Vlăduțiu 1973).

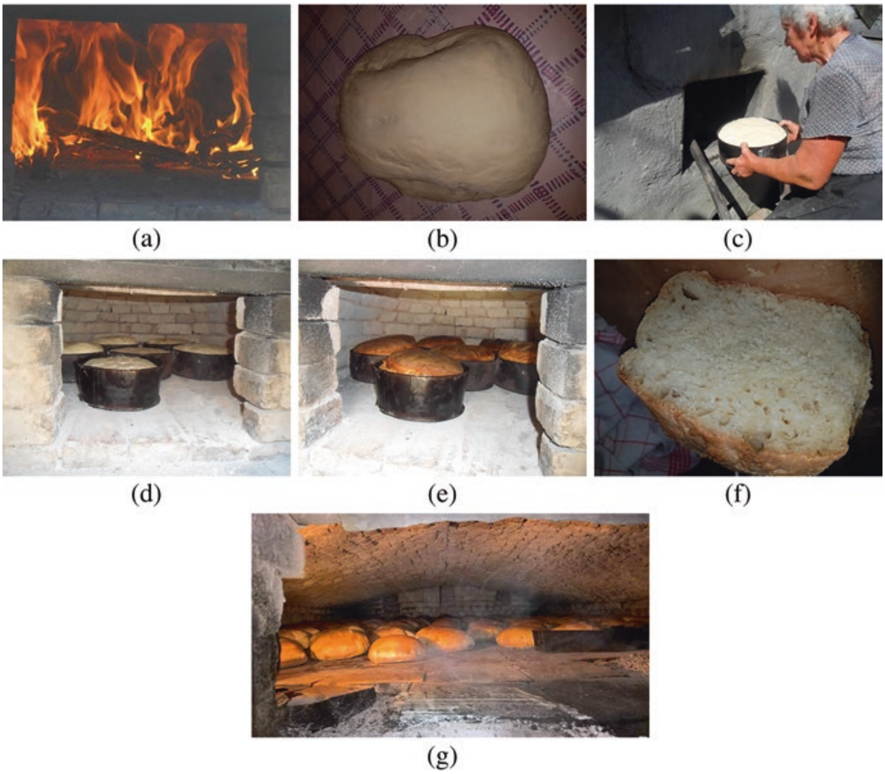


Fig. 14.4 Making of cozonac and Pasca bread in "modern" ovens: Traditional from countryside: (**a**) heating the oven with firewood; (**b**, **c**) home bread-making; inside oven: (**d**) Putting the bread dough into the oven and (**e**) baking bread; (**f**) bread ready for cutting; (**g**) "modern" oven from the countryside. (Source: Historical and Ethnographic Museum, Borșa commune, Cluj County, Transylvania)

During the reign of Mircea the Elder (Romanian: Mircea cel Bătrân, c. 1355 – 31 January 1418) 3200 hectoliters of wheat were harvested in Wallachia, and over time, in the first five years of the twentieth century, 20,000,000 hectoliters of wheat were obtained annually in the country (Chivu 1997).

Practicing agriculture in Romanian land is testified by many beliefs, customs and magical practices related to the cultivation of plants. Habits of the cycle of the year were dominated by those related to agriculture: in them were expressed the desires of abundance. There were many habits in the phases of agricultural work, starting with the ploughing and ending with the end of the harvest. The fear of natural and supernatural forces determined the appearance of many magical practices, in order to prevent theft, to invoke rain in times of drought, to drive it away when there was too much.

The practice of agriculture from ancient times is proved by the tools discovered, from the most rudimentary stone, to the iron plow with handrails.

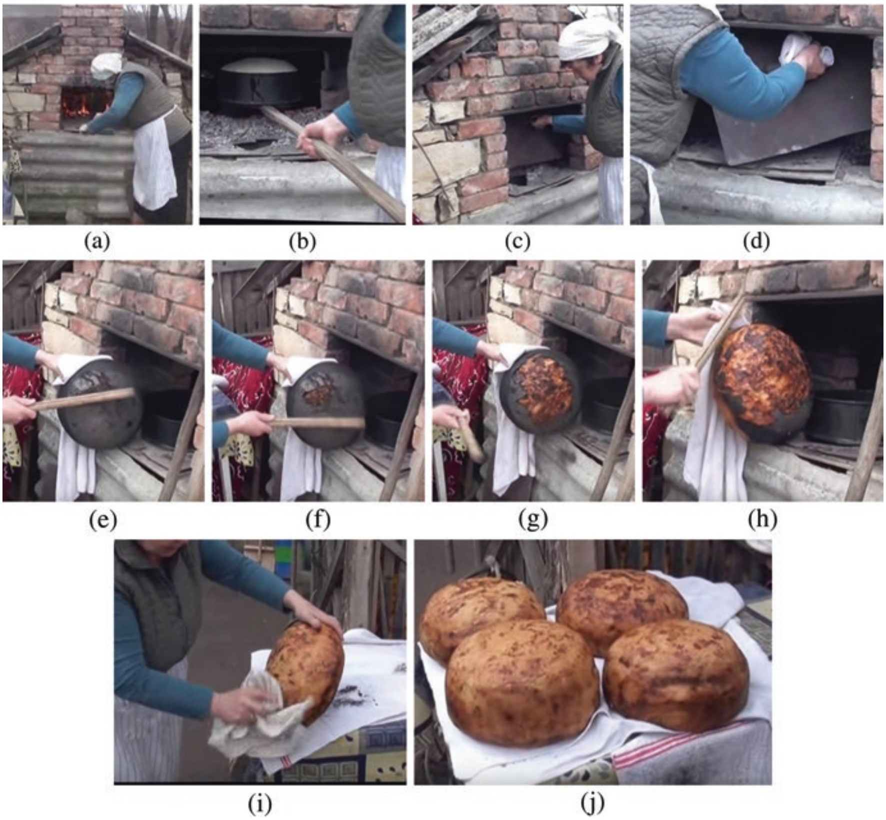


Fig. 14.5 Making bread in wood traditional oven made from old convict bricks or natural stones of different shapes at the countryside: (**a**) bread maker heating the oven with firewood; (**b**) placing bread into the oven; (**c**) closing and sealing the oven; (**d**) opening the oven door; (**e**–**h**) "beating" the bread until the burned dark crust is completely removed; (**i**, **j**) bread ready for consumption. (Source: Locals from Borșa commune, Cluj County, Transylvania)

Agricultural work is a ritual, not just because it fulfils the Mother-Earth's body and unleashes sacred forces of vegetation, but also because it involves integration of the ploughman in some benign periods of time. This is what Mircea Eliade said. The Romanian peasants had in their calendar holidays that were strictly respected, in order to ensure a good harvest. The unwritten laws of agriculture were strictly respected. The optimum time to start plowing was established after all rituals were fulfiled. Plowing was made individually by every agriculturist. Bread was a present when the plow was taken to the field. In Bucovina bread was put on the plow or on the first furrow made that year (Chivu 1997).

In Romanian traditional alimentation, bread and polenta (after the discovery of corn) were basics elements. Bread for richer areas in cereal production, and polenta for poorer areas, because corn has always been cheaper and easier to grow compared to wheat. Even though wheat was harder to grow, farmers kept planting it,

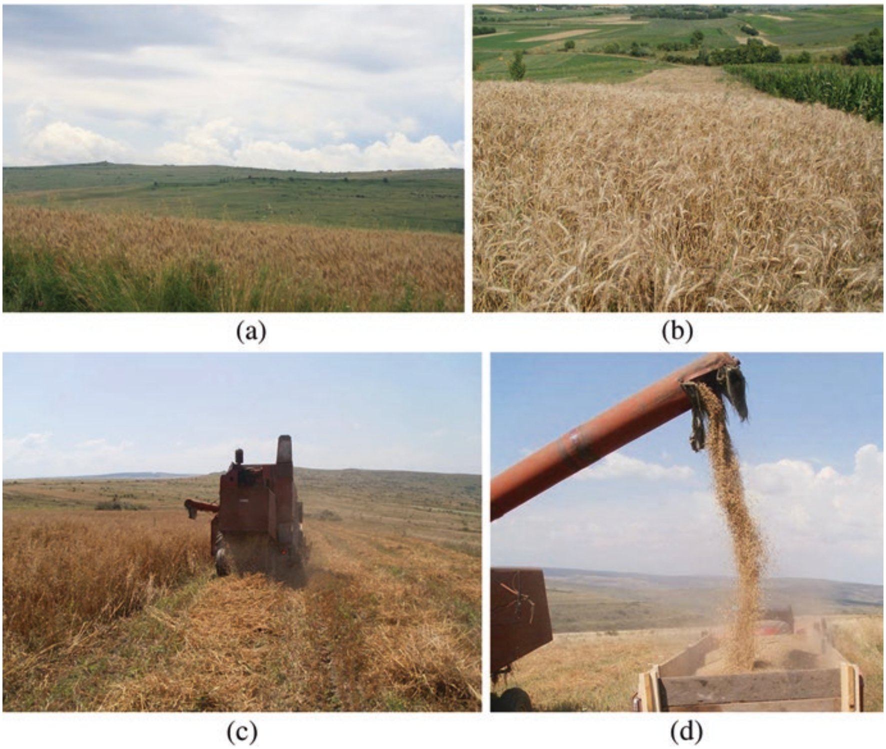


Fig. 14.6 The cult of wheat: (**a**, **b**) wheat plantation field; (**c**) harvesting wheat; (**d**) bringing wheat into barn. (Source: Borșa commune, Cluj County, Transylvania)

because bread was the basic element for lunch, especially for those in the field or for traveling.

Wheat flour was used in preparations of various ritual and ceremonial forms of bread, for cultic practices, for festive meals around the year, and especially for moments of the life cycle, such as: prescura (white bread that is blessed in church), Pasca (Easter bread), the memorials, the wedding cakes, coliva (sweet cake made with nuts at funerals). The oven and the țest (clay pot that covered the bread while baking) were used to bake the bread. The oven was more frequent. In some areas, the oven was in the house and it evolved with the development of the house plan, moving from one room to another. In some areas it was outside the house under a shed. The oven was used not only for baking but also for cooking. Only in the warmer seasons they used the oven under the shed (Chivu 1997).

Wheat was considered the body of Jesus. The Romans considered that in Eden there was "much wheat and wine", but due to the fact that people weren't thankful enough, God took the wheat and left only enough for the priest to serve in the church. Wheat was used in various customs and enchantments related to honor, love, or even used for cures (Niculiță-Voronca 1998).

Bread is appreciated as a sacred symbol, but its sacredness is not constant. Through all the work of shaping the wheat, including those of bread preparation and consumption, this sacredness is always reinforced. The correlations of the symbols are dominated in all structures of popular culture. They represent decipherments of the same theory developed by man after the discovery of agriculture: “What he saw in the grain, what he learned from this contract, what he understood from the example of the seeds that lose their shape underground, these were all the decisive lessons”. The cultural dimensions of wheat in human imagination, clearly exceed its practical values. Wheat is the only grain fundamentally circumscribed to the popular cosmogonic model (Varvara 1998).

Wheat and bread, with their significance in daily social life, became objects of worship through biblical verses whose teaching is related to the parable and through their acceptance in the Orthodox Church, for example, in the Liturgy. The Holy Tradition also contributed to this effect, which came in parallel with legends, such as the one related to the origin of bread, wine and myrrh. The cult of wheat and bread, one of the fundamental pagan cults, was not abolished by Orthodox Church, but was adopted as a Christian virtue (Chivu 1997).

“Wheat is the honor of meal”, said the folklorist Simeon Florea Marian in 1901, referring to the role of the bread.

In the world of the Romanian village, there is still the tradition that the master of the house, or the mother of the children, makes the sign of the cross over the bread dough before it is left to be leavened, and on the bread, and only then break it and eat it.

“The first piece (especially of new wheat bread) is considered an offering for the dead and should be ritually thrown away for them. The latter, also called ‘the piece of luck’, ‘the piece of power’, concentrates, in popular thought, a magical power to influence the future of children, but also of adults,” says the ethnologist Ofelia Văduva (1997).

2 PASCA – The Traditional Festive Romanian Bread

2.1 *The History Behind Pasca*

Although many researchers are trying to understand and to link the existence of the Pasca to the Jewish tradition, this can still be accepted only on a symbolic level. Indeed, the ancient Jews, in remembrance of the wonderful passage through the Red Sea, ate lamb and unleavened bread. In Jewish tradition, the lamb was eaten with unleavened bread and bitter herbs (maror). This remind us of the hardships endured in bondage of Egypt. At the Last Supper, Jesus Christ and the apostles ate lamb, and unleavened bread, according to the Jewish ritual, as the Gospels tell us. But for Christians, lamb, bread, and wine are symbols with new meanings. The bread and wine became, during the Divine Liturgy, through the coming of the Holy Spirit, the Body and Blood of the Savior Jesus Christ, through whom we unite with God. From a historical point of view, information about the Pasca cannot be found in the

Hebrew ritual, but only symbolically – through the presence of the unleavened bread with which the Easter lamb was eaten (Caraman 1995).

In the Christian faith, the Jewish "Pesah" took on a different connotation. The same "passage" but not through the divided waves of the Red Sea but "from death to life and from earth to heaven", as we sing at the Resurrection. Continuing the connection with the great feast of the Resurrection of the Savior Jesus Christ, Christians felt the need to materialize the great joy in their daily diet. To this day, to mark a holiday or an important event in our lives, locals dress in the right clothes. This is what Christians have sought. They tried to express the joy of the Resurrection in a culinary way.

This is how the Pasca was "born" in the Balkan area, especially in the Danube and Carpathian countries. Simply, a pie with cheese, flavors and honey or, later, sugar (Zamfira 1993).

Serbs, Bulgarians, Montenegrins, Christian Albanians, part of Croatia, Greeks from Pind, all celebrate Easter.

For more than 1000 years, the "vlach" shepherds traveled with their flocks from the Tatra Mountains to the Greek Pindus, then in the steppes between the Carpathians and the Caucasus, thus ensuring the unity of Romanian language, thought and feeling. That's how Mioriţa ballad was born. Mioriţa ballade is the old Romanian pastoral ballad and is considered to be one of the most important pieces of Romanian folklor (Ghinoiu 2003).

From the sweet curd put to keep the little fir, the Romanians made the second element of Easter (Butură 1989).

Bread, cheese, spices, honey or sugar sweets, for at least 1600 years, were the main ingredients for Pasca in Romania. The researcher Constantin Tomescu, son of a mocan (local pastoral communities of shepherds) from Mărginimea Sibiului (called 'țuțuieni' or 'mărgineni'), concluded several times that where the Romanian shepherds passed, they left behind the practice of making Easter and pies. Therefore, we can say that the Passover of the Lord's Resurrection was shaped by the faith of the Romanian people. Among the Romanians, Easter is rich and with boyar generosity, even if it is celebrated in the humblest hut (Caraman 1995).

The bringing of wheat in the third century to the Balkan lands, the Byzantine Empire being the "granary" of Europe, made the bread more widely used than the Eucharistic prescura or anafura (communion wafer).

Thus, the civilization of wheat made bread to be eaten in daily life. The bread was taken on a sacred form, remembering the prayers of the grandparents, who cherished the bread as a sacred element, after centuries of rituals. If the liturgical rules for the precursor are strict and clear, our ancestors added to the Easter cake another element that was at hand – sheep's cheese.

2.2 *Pasca Meaning*

Pasca can have two meanings: a kind of unleavened bread that was eaten by religious Jews during the Jewish Passover, or a special cake eaten by Easter Christians.

Pasca is made from an unleavened dough, obtained from a mixture of water and one of the five cereals: wheat, rye, barley, oats or spelt. In the Jewish tradition, Passover is nicknamed "the bread of the poor," due to the fact that poor Jews continued to eat it even after Easter.

The book of Exodus tells us that the Jews left Egypt in a hurry and did not have time to prepare leavened bread. In memory of this event, the Jews eat only Pasca for eight days (instead of the usual leavened bread).

Christians borrowed the custom of eating lamb and took over the Passover meal from the Jews. The Lamb is Jesus Christ, who accepts his sacrifice. Broken Pasca and poured wine signify Christ's sacrifice. Pasca is prepared on the eve of the Resurrection. The Pasca is cut into small pieces, put into bundles, and taken to the church to be sanctified. The pieces are taken home and kept to make believers partakers of God's blessing, having the power to ward off sickness and trouble.

According to DEX (Academia Română 1998, 2005, 2009, 2010; Colectiv 2002) Pasca comes from – Lat. *Pascha* meaning "Easter", and has different forms:

- *Cozonac*, a traditional cake, made of leavened dough filled with cottage cheese, raisins, cream, etc. which is usually eaten during Easter Holidays by Orthodox Christians.
- *Anaphora* that the priest distributes to the faithful on Easter day.
- *Traditional food*, made of unleavened dough, baked into thin sheets, which the Jews eat during Easter instead of bread.

From other sources (Macrea and Petrovici, 1955–1957, Litera 2002, Scriban 1939, Șăineanu 1929):

- In Moldova and Transylvania, it represents a kind of traditional cake, which is usually eaten at Easter by Christians, and which is made of leavened dough covered with a layer of cheese or cream.
- "I had eaten cake and Easter, I had honored wine". Sadoveanu (one of the most prolific Romanian-language writers), O. VIII 12.
- Unleavened dough, baked in thin sheets, which is a traditional food for Jews during Easter, replacing bread.
- Very thin cake, made from unleavened dough and baked with mosaics on the occasion of the Easter holiday.
- A kind of cake that is made at Easter from milk with rice mixed with eggs (pudding) or from cow's cheese with eggs and then placed on a sheet of cake dough and fenced with a circle of dough.
- Jewish Easter, a kind of coca cake (azĭma – (unleavened bread) that Jidaniĭ makes at their Passover and grits his teeth in it, which is so virtuous. Ghismani comes from *ebr. Ghetsemani,* the name of the garden at the foot of the Mount of Olives, where Christ prayed, Cp. with Pasca, martyrs and saints).
- A kind of peasant flatbread (cake) made of poplar flour and wheat garnished with cheese and sour cream (which at first has been made in memory of the sufferings of Christ).

There are several traditional Easter foods including Pasca bread. Pasca remained a Romanian Easter bread tradition, but it is particularly spread in countries with predominant Eastern Orthodox religious or cultural connections to the ancient Byzantine Empire.

Paska breads are a traditional element in the Easter holidays of Ukraine, Armenia, Belarus, Romania, Russia, Georgia, Moldova and parts of Bulgaria, as well as Turkey, Iran and the Assyrian–Chaldean–Syriac diaspora.

Pasca is prepared on the eve of the Resurrection. In some areas the Pasca is cut into small pieces, put in bundles and taken to the church to be consecrated. The pieces are taken home and kept to make believers partakers of God's blessing, having the power to ward off sickness and trouble. According to Romanian tradition, if the Pasca is not blessed, than it is just a cake.

2.3 PASCA – "The Bread of Christ"

The tradition, left by the ancestors and sacredly respected by today's Romanians, indicates the fact that the dishes specific to the Easter period: Pasca, cakes, red eggs and Easter lamb, also have a special symbolism.

Initially, Easter Pasca was made from unleavened dough and without filling, but later, it was prepared from cake or bread dough, to which raisins and cheese are added.

Pasca is said to represent the tomb or cradle of Jesus Christ. Its round shape symbolizes the celestial vault, the promise of the Resurrection and eternal life. The sweet dough from which Pasca is made signifies the fulfillment of the soul deserved after the effort of fasting. In its traditional form, the Easter Pasca is adorned with a cross in the middle, symbolizing the cross on which the Savior was crucified. On the edge it is decorated with two twisted coffin strips, which embody the crown of thorns of Jesus Christ.

According to tradition, Pasca is baked on the Eve of the Resurrection, more precisely on Holy Thursday or Holy Saturday, and women followed a whole ritual before starting work: they bathed, combed their hair, put on clean clothes, prayed, and only then did they begin to knead and prepare the Pasca.

Pasca is the one who gave the name of the holiday. In Romania, the Easter holidays are focused on two symbols: the egg and the bread. Unlike the egg tradition, that of Easter bread has been insufficiently researched. The descriptions of Marian (1901), Constantinescu and Stoian (1936), the considerations of Zamfira (1993) and the contribution of Văduva (1997), plead for a tradition of Easter bread as an identity mark (Varvara 1998).

Pasca is a symbol of the bread blessed by Jesus Christ at the Last Supper. The women used wheat flour, milk and cow's cheese most of the time to prepare it. Sometimes they mixed wheat flour with corn flour.

Pasca has different shapes, depending on the types of tray that housewifes have, so it could be round or square.

On the last day of the Holy Week – Saturday – the women have to prepair the food. Women who did not bake Pasca on Holy Thursday, need to bake it then. On Saturday Romanian women bake pies, cakes and cozonac, that will be served at Easter feast. Ritual doughs refer to the body and tomb of Jesus.

Round and long cakes with walnuts or poppies, pies and rolls are prepared, in addition to Pasca. Some other ritual doughs prepared by women for Easter are "Moşii" and "Babe". They are made from the same dough as Pasca, but smaller and with a spiral shape. They bake in round clay shapes. "Babe" and "Moşii" are offered to alms with a red egg on top, on Easter Sunday, to commemorate the dead.

The importance that our ancestors gave to Pasca made it a part of the commemoration of the dead. The liturgical rules established that, in the period between the Lord's Resurrection and His Ascension, the place of the wheat cage and the coil is taken by Pasca and red eggs. Thus, Romanians celebrate the day of the Ascension with Pasca and can eat Pasca 40 days after the Resurrection.

2.3.1 Cozonac

Cozonac (elongated shape) is a symbol of the tomb in which Jesus Christ was placed after being descended from the Cross. *Cozonac* is a traditional cake baked only for important holidays as Easter and Christmas.

Cozonac is made of leavened dough and then filled with different types of filling. Depending on the region there are many types of fillings: cottage cheese, raisins, cream, walnut and/or poppy seeds and/or cacao. Sometimes it is even called according to the region of origin: Moldavian cozonac, cozonac from Bucovina, etc. (Băşoiu 2012)

Traditional cozonac recipe:

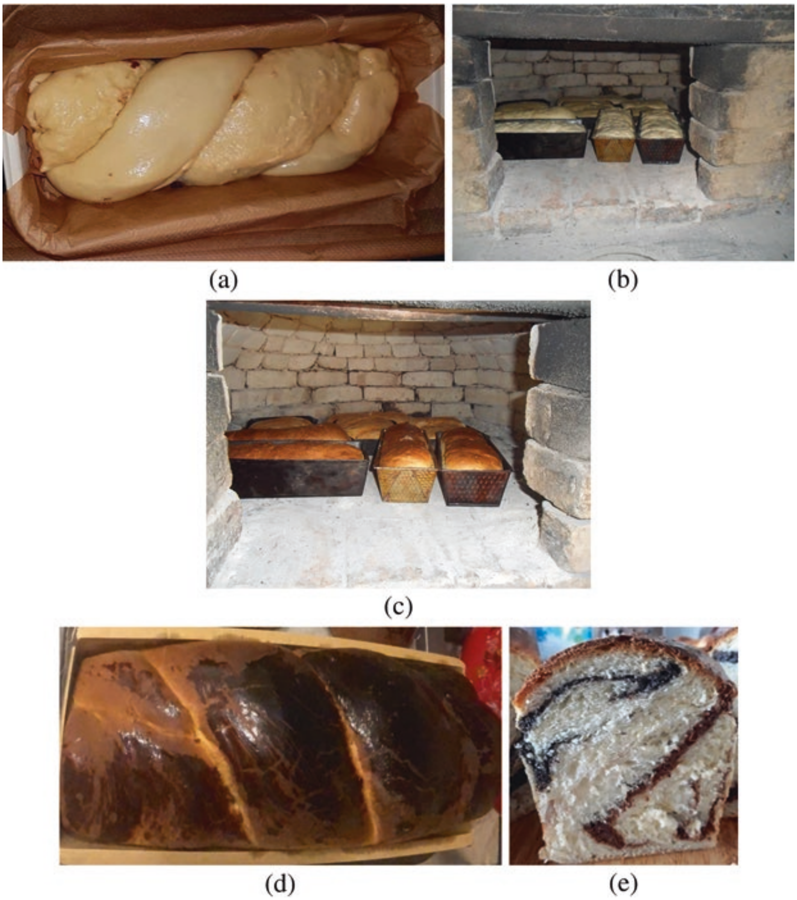
– Prepare the leaven from about three tablespoons of flour, that are put in a bowl and scalded with half the amount of hot milk and beat until it becomes a soft paste, and then crush the yeast over this mixture and place it in a warm place away from cold air.
– Meanwhile, rubbe whole eggs with the rest of the milk and add some essences. When the leaven is risen, add it over the flour, pour the egg mixture to the milk, add melted butter, and also lemon and/or orange peels can be added.
– Knead this mixture well for 35–45 min continuously. When kneading, grease your hands with oil and continue kneading until the crust forms blisters. The resulting dough should not be hard but rather soft. If it is firm, add more oil and continue kneading.
– Cover the dough with a clean, thick napkin, put it in a heated space and allow it to rise. When the dough has risen well, take the pieces one by one, stretch them a little, sprinkle the filling and then roll them. Then, place them in long and high cake trays, prepared with baking paper and greased with butter (Fig. 14.7a, b).
– Grease the cake with egg yolk and sprinkle with sugar for a brown appearance (Fig. 14.7d).

– Baking should not take more than 60 min (Fig. 14.7c–e).

2.3.2 Traditional Recipes for Pasca

Pasca is a tart with a cozonac dough base filled with fresh cheese like urdă or cottage cheese (Fig. 14.8.), raisins, eggs and sugar. Other variants include sour cream, chocolate, or berries fillings. In Maramures but also in many of the counties of Transylvania, Pasca is prepared without cheese or any filling.

Pasca has been adapted in time in different forms and recipes. From the unleavened bread that the Jews ate, to the cake crust mixed with cheese that Christians eat,



(a) (b) (c) (d) (e)

Fig. 14.7 Cozonac (traditional cake): (**a**) cozonac dough; (**b**) cozonac in the oven; (**c**) baked cozonac; (**d**) cozonac ready for consumption and (**e**) cozonac filled with walnut and poppy. (Source: Locals from different regions of Transylvania, Romania)

Pasca has been and it still is prepared in countless ways. The housewives are saying that the secret of a perfect dish preparation is the same as in the case of the cake: quality flour, a lot of warmth and the confidence that you will not fail. The creativity of good housewives has taken unexpected turns, and today, the Pasca recipe is prepared from several ingredients, taking many forms, shapes in various recipes (Fig. 14.8) (Sibaev and Alexandrescu 2017).

In Moldavia, especially in Bukovina (Romanian: Bucovina), but also in the other areas of Muntenia, Dobrogea, Oltenia, Pasca is the most important ritual of the Easter. Pasca is considered the honor of the Easter feast.

Pasca usually has a round shape being surrounded by a simple circle of dough or braided like a rope. The Pasca is embellished with a cross made of two rolls of dough twisted together, in memory of the cross on which Jesus Christ was crucified. Between the arms of the cross, the cottage cheese mixed with raisins or slices of curd is added, and on top it is greased with egg yolk. In some villages, around Easter, Pasca has "scalloped edges". It needs to be baked at the right heat to grow and brown nicely.

Apparently, simple decorative elements, the shapes molded from the dough to decorate the Pasca are in fact embodiments of the interweaving of ancient pre-Christian beliefs related to sun worship – round shape, "scalloped edges" embodying the sun's rays, rope, expression of day/night succession – with the precepts of Christian faith: the cross is the symbol of Jesus' sacrifice for the redemption of man's original sin.

Pasca Recipe with Cozonc Dough

The traditional Pasca is made according to cozonac recipe. The recipe has been already detailed in Sect. 2.3.1. Cozonac. The cheese filling with raisins is well known.

(a) (b)

Fig. 14.8 Different shapes of Pasca: (**a**) rectangular shape (source: Bucharest) and (**b**) round shape (source: Transylvania). Pasca is decorated with a main Christian symbol – the cross, recalling the tragic moment of the Savior's crucifixion

Pasca Recipe Without Dough

This type of Pasca is made with semolina and other ingredients: sweet cottage cheese, cream, eggs, sugar, vanilla pudding, baking powder, lemon peel, vanilla sugar, raisins.

The cheese is mixed with sugar, vanilla sugar, lemon peel, pudding powder and baking powder, sour cream, semolina, raisins, egg yolks and beaten egg whites. If the cheese is too soft, semolina can be added in higher quantities. After baking for about one hour, Pasca without dough is left to cool in the pan, powdered with sugar and cut when it has cooled completely.

Pasca Recipe with Sponge Cake Dough

This type of Pasca is made from sponge cake dough which is not baked completely. After about 15 min in the oven, while the sponge cake is still soft, it is taken out and spreaded with cheese filling. This type of Pasca is looking almost like a tart.

Pasca Filling

The cow's cheese for Pasca filling is made in a traditional way from fresh non homogenized milk, at the countryside. The process involves the milk fermentation. The milk was simply left to spoil, to harden, hence the slightly fermented (sour) smell of the cheese, and then boiled for a few minutes and afterwards separated thorough a cheesecloth, as shown in Fig. 14.9.

An old legend from Bihor mentions Pasca as a symbol even in the Bible. It says that "when the Jews passed through the desert, they didn't have anything to eat, and then God, as his grace, threw them from the sky manna and saved them from famine. Then when Jesus dined for the last time with his disciples, He shared pieces of azyme to remember him forever". Since then we make bread with cheese, as a

Fig. 14.9 Making fresh cow's cheese (cottage cheese) for Pasca at the countryside. (Source: Locals from Borșa commune, Cluj County, Transylvania)

holiday food, from the fruit of land and from the cattle manna and call it: Pasca, after the name of Easter which in Romanian is called Paşte (Bocşe 2006).

Pasca is made from the best quality wheat flour. The leavened dough is placed in special trays for Easter, after which, all around, the braided dough is placed in two or three twists and everything is left to rise. Then the cottage cheese is placed in the middle of the tray, prepared with sugar, eggs, spices and raisins.

2.4 Pasca and Traditions in Different Parts of Romania

Around Easter, throughout Romania there is an irresistible scent of Pasca and cakes. Every area of the country has skilled housewives, who can't wait to share their own tricks and secrets that help them prepare a delicious Pasca treat.

The basket of goodies, that is blessed at the church, is prepared strictly according to the customs transmitted from the ancestors: along with food, poppy seeds, salt, sugar, flour, onions and garlic – symbols of joy over the year. Besides, ham, money, flowers, beetroot with horseradish and red eggs are usually put on top of the Pasca. The basket is also covered with a sewn blanket with area-specific patterns, Fig. 14.10.

In baskets or towels, each family brings their Easter Offering to the Holy Night Liturgy. Many times, the faithful distribute it to those present at the service of the Resurrection, these being the first dishes tasted after the Pasca or anaphora, before enjoying the other prepared goodies. All over Moldova, in Maramures and in the northern part of Muntenia, the Easter goodies from basket are not tasted until the blessed Pasca is brought from church.

In the area of Călăraşi County (Southern Romania), the Easter basket for sanctification contains, in addition to dishes, a white rooster. There is a tradition that when the rooster crows it means that Christ has Risen, and the luckiest is the one whose rooster crows first. After the service, it is customary for all roosters to be given to the poor.

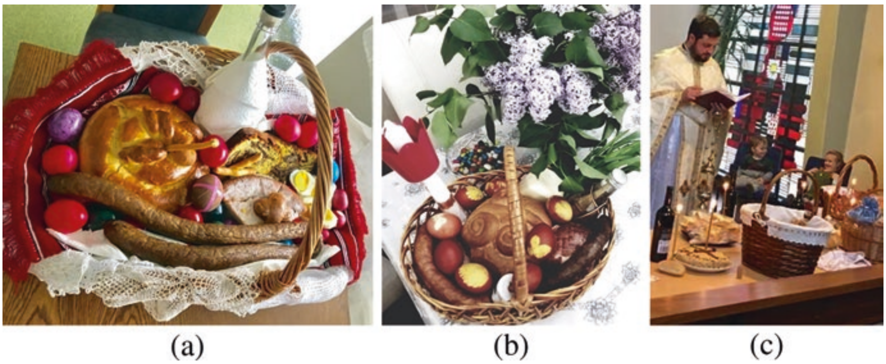


Fig. 14.10 Easter basket of goodies with Pasca: (**a**) Moldavia county; (**b**) Maramures county; (**c**) The service in the church, orthodox parish Bremen-Bremerhaven, Germany. (Parohia Ortodoxă Bremen-Bremerhaven, Germany)

In the Câmpulung Moldovenesc area, the tradition is distinguished by the complexity of the symbols, the belief in the miraculous power of the prayer, of blessing the dishes. At dawn on Sunday, the faithful go out into the churchyard, sit in a circle, carrying lighted candles in their hands, waiting for the priest to sanctify and bless the pieces of the Easter basket. In front of each householder such a basket is prepared. In the basket covered with a woven napkin with a specific pattern of the area are placed, on a plate, the symbols of joy for the whole year: poppy seeds (which will be thrown into the river to ward off drought), salt (which will be kept to bring abundance), sugar (used whenever cattle are sick), flour (so that the wheat fruit is rich), onions and garlic (as a protection against insects). On top of this plate are placed Pasca, ham, cheese, red eggs, but also scrambled eggs, money, flowers, smoked fish, beetroot with horseradish, and cakes. After the consecration of this Easter basket, the Easter ritual continued whithin the family (Caraman 1995).

The Pasca legend says that, while preaching with the apostles, Jesus was hosted by a very welcoming man who put in their sacks, on departure, bread for the journey without their knowledge. Asking Christ when Easter would be, the Savior responded that when they would find bread in the sack. Looking for the apostles, they found in the bag what the man had put for them. Since then, housewifes have been making Pasca.

In addition to Easter Pasca, besides cozonac, plăcinţelele şi învârtitele (mini quiches, pies and rolls) are made from the same leavened dough. The moşii and babele are part of the ritual in some Romanian regions. Shaped from the same dough as Pasca, but smaller in size with round and spiral shapes, Fig. 14.11.

To mark the importance of this event in their lives, Romanian locals dress in the festive traditional clothes (Fig. 14.12). The feast of Easter is marked by ancient customs that support the faith through an inner cleansing. This belief is often manifested by renovating the house and renewing clothes. Besides, the new clothes are a symbol of purification and renewal of nature in spring. In the villages, the tradition is still respected in some areas, that the woman must wear a new shirt, and the man at least a similar hat, as a symbol of purification and rebirth.

(a) (b)

Fig. 14.11 Romanian moşii and babele made from Pasta dough. (Source: Locals from Moldavia)

Fig. 14.12 Locals dressed in their traditional clothes ready to celebrate Easter: (**a** and **b**) Women and a child, and (**c**) Man, all locals of Finciu, Călățele, Cluj, Apuseni Mountains, Transylvania; (**d**) Married couple from Southern Romania; (**e**) Men from Borșa, Cluj county; (**f**) Children from Sibiu region, Transylvania; (**g**) Women and (**h**) Men, locals of Maramureș (Sighetul Marmatiei), north-western Romania

2.4.1 Traditional Pasca and Traditions Related to Transylvania (Romanian: Ardeal or Transilvania)

In Transylvania, every day of The Holy Week is devoted to the last preparations for the great feast. People purify their body and soul, they go to the great confession, at the church, or to the fir tree, in nature, when the circumstances – the distance from the holy place – prevents them from doing it in the church, although everyone believed in the true prayer from the holy places (Bocșe 2006).

Pasca, according to the Romanians from Transylvania, is being baked on Wednesday of the Easter week and then on Thursday it is sanctified. Nobody throws away Pasca crumbs because they think these are holy, so they gather every crumb and feed it to the animals they own, so God can bless them (Marian 1899).

According to the lessons from grandmas in Transylvania, the traditional Pasca making ritual says that one has to make a cross with tongue touching the palate before the start, after kneading (see Fig. 14.13), and before putting the Pasca in the oven.

Housewifes fill Pasca bread with many raisins. Before being put in the oven, Pasca is bathed in a rain of egg yolk, as it is done in Moldavia (Romanian: Moldova) as well.

Fig. 14.13 Pasca making in Transylvania: (**a**–**c**) Preparing and kneading the Pasca dough; (**d**, **e**) A housewife makes the sign of the cross over the dough and let it to leaven; (**f**) Pasca ready to be baked. (Source: Locals from Transylvania)

A traditional recipe from Transylvania uses cozonac dough, made with egg yolks, sourdough leavening, kneaded and "scalded flour". The secret is that it must be kneaded for at least an hour. After that, it is left to leaven for another hour (Fig. 14.13).

In Sibiu, semolina is used in Pasca formulation. Once the semolina is mixed with eggs, milk, flour, cheese, raisins, rum and lemon peel, it absorbs like a sponge the excess moisture from the cheese. The housewives in Sibiu are generous with raisins, and sometimes even add butter. Then, they decorate the Pasca with various braids and put it to face the fire in the oven for 30 min.

In Sibiu county, the Pasca with poppy seeds is traditionally made. In the village of Alamor, the housewives gather the poppy over the summer, dry it well, and then boil it over low heat in sweet milk. After the dough is heated, it is softened under the towel and sprinkled with poppy seeds.

In the Apuseni (a mountain range in Transylvania, Romania, which belongs to the Western Romanian Carpathians), women go to the cemetery on the night of the Resurrection to light candles at graves, and the first day of Easter begins with the Pasca communion, after the faithful wash themselves with water in which a red egg, a gold coin and a nettle have been placed.

At the end of the service, the priest at the church door will offer the parishioners Pasca soaked in wine. Those who did not arrive at the church will receive Pasca from acquaintances or family. Pasca is the first food to be eaten on the day of the holiday. This tradition of Pasca bread is specific to the area of Transylvania and Wallachia (Romanian: Muntenia).

2.4.2 Traditional Pasca and Traditions Related to Moldavia

Locals say that the best Romanian traditional Pasca is made in Moldavia, and this is because of the significant amount of cheese. Moldavian Pasca contains only four tablespoons of flour.

Pasca with sweet cheese is an old type. When Pasca is made, is first shaped and then placed in the oven. It is the only type of bread taken to church to be blessed. After Pasca is brought back from church, everyone in the house is blessed with it, by eating a small piece. The cross that is placed in the middle of Pasca is called the Easter cross.

The Pasca's wreath is eaten by people during the three days of Easter, and the cross is given to the cow during this period or by St. George, to keep their milk. Pasca is served as a staple food at the ritual meals of the three days of Easter. Pasca is correlated with the symbols of rebirth and regeneration, and it gives strength to those who eat and have an effect on their health. In the period from the Resurrection to the Ascension in the funeral tree in Moldavia and Bucovina, all bread is replaced with Pasca. According to popular belief, it was to be accompanied by the deceased soul and ordained in post-existence as long as the heavens were open (Varvara 1998).

Folklorist Simion Florea Marian, discovered a legend from Bucovina about the tradition of the Easter specific bread: "Once upon a time Jesus travelled with his disciples through some villages and cities to help people. In their journey they decided to camp at a farmer and then move on. The farmer, a good man, he received them and feasted them with what he had better, and when they left, he give them food for the road. After that, Jesus and his disciples thanked the farmer for his hospitality and said good bye, they kept going on their journey. They got to a forest and while travelling through it the disciples asked Jesus Christ:

- When the Easter will be?
- When you will find wheat bread in your bag, then the Easter will be – Jesus said. The farmer gave them wheat bread. They found it in their bags and told Jesus that they have it.
- Enjoy then because now is Easter – Jesus told them.
  Since then Christians make Pasca for Easter." (Bocșe 2006)

For the peasants, Pasca is made on Saturday. Pasca in Moldova is made from cake dough. That is, in addition to the white wheat flour, salt, water, yeast, from which the bread is made, milk is added, many eggs to make the dough yellow and vanilla essence. The filling is made from cottage cheese mixed well with an egg, two tablespoons of sour cream and sugar to taste. The cottage cheese is rubbed well with the sugar until it becomes a cream. The dough is rolled out as a round sheet, and put in the tray. Another sheet of dough is then placed around the first one, filled with a mix of sweet cheese and eggs, topped with milk, greased with yolk, and garnished with flowers made of raisins. Pasca filled with curd is made for Ispas or St. George and it is decorated with lovage leaves.

In Moldova and Bucovina, a dough cross is made in the middle, braided like the crown. Before put Pasca in the oven, a cross is made with the shovel, on the four walls and then at the oven door saying:

"Cruce-n casă Cruce-n masă Cruce-n tuspatru Cornuri de casă."	"Cross in house Cross on table Cross in all four Corners of the house."

When all the Pasca are placed in the oven, each member of the family chooses one. The most beautiful Pasca brings prosperity and good luck for the one who chose it. Then two Pasca are put in a clean white napkin and taken to the church by a man dressed in clean or new clothes, one with a cross and one without, which is for the priest. Bacon, red eggs, salt, garlic, and frankincense (incense) can also be added (Niculiță-Voronca 1998).

2.4.3 Traditional Pasca and Traditions Related to Maramureș

As the weather and climate conditions did not favour the wheat crops in this region, hilly par excellence, agriculture focused mainly on corn crops. Corn flour has been, since the seventeenth century, the main nutrient for the rural population. White wheat flour was used to make pasca, prescuri, and ritual rolls, used for the big holidays (*Maramureș. Istorie, cultură, identitate* website).

In Maramureș, the Pasca is simple as recipe but it is complex as the symbols that are represented. A simple piece of bread can sum up a whole universe of meanings. This kind of bread it is made only on The Holy Week (Maramureș 2020).

For making the Pasca, the housewives of Maramureș, use wheat flour, salt, sugar, eggs, water, yeast, and in the modern times they put raisins. Mix all the ingredients and a wooden trough. Then the dough is kneaded and let aside until it doubles the volume (Fig. 14.14).

Fig. 14.14 Making Pasca (**a**) kneading and moulding, (**b**) home-baker from traditional Maramures County (Sighetu Marmației), northwestern Romania. (Source: Locals from Maramures County (Sighetu Marmației))

Until the dough rises, the housewife makes the fire in the clay oven, heating it well. The leavened dough is kneaded and placed in round trays made of tin. On top of the Pasca women put all kind of shapes made from dough, in order to make it beautiful, but also because they have religious signification. First of all, they put a spiral around the Pasca, that signifies the cyclicality of human life on Earth, but also the cyclicality of nature that influences the human life. Then a large cross is made, which signifies the sacrifice that Jesus made for humans. The cross is the most come across symbol in Maramureș. It is to be found on paintings and sculptures, because people that live in this place were and still are in direct communion with God. Then the braided is put on Pasca, in the form of a circle, which is the symbol of the Godhead. It is life giving, being an essential element of agriculture, and life in general. Then women grease it with egg and place it in the oven. When it is baked, and red on the top, it is pulled out of the tray and sprinkled with cold water in order of make the bread crust moister. Afterwards, it is put under two traditionally made towels to cool down.

From Saturday evening until Sunday at noon, people from this part of the world won't eat anything, waiting for the holy meal. At midnight or Sunday at 4–5 o'clock in the morning the service of the resurrection takes place at church, which is specific for the Orthodox Easter. The man of the family, which is the head of the house, is taking the Pasca to be sanctified by the priest. In the basket, beside Pasca, salt, garlic, red eggs, sausages and wine are also carried (Andreescu 2006). In the Easter morning, girls used to run at the church to ring the bell so they will become famous and the lads will court them.

For the locals of Maramureș, eating is a cultural act, with social valances, that is held following ancient customs. In subsidiary, the process of eating is a necessary integration ritual, even if we speak about community meals (in which all villagers attend, even the priest), about family meals (baptise, wedding of funeral meal), about feast meals (for Christmas, Easter), about every day meals or about the meal that they offer when they have guests (Maramureș 2020).

Easter is a very important feast for the locals of Maramureș. They dress their traditional clothes and go to church (Fig. 14.12). On their tables you can find a lot of food: Pasca, red eggs, lamb, sausages, sponge cake, but for the locals of Maramureș, the sacrifice that Jesus Christ made for people to erase their sins is of utmost importance. They love to have this feast with their family, which is the community base for this people. Easter is not a feast of joy, like Christmas, but it is a feast of piety and thanksgiving to God, for all the good and not so good things across the year.

Based on this principle, the Easter meal is a ritual one. First of all, people give a bit of Pasca to the animals of their household, to grow and bring family prosperity. Then, all family members gather around the table and start eating the food that has been hallowed by the priest, after they fasted for almost a day.

3 Conclusions

For Romanians wheat and bread are related with the Christian belief, because in the Bible, at the Last Supper, Jesus Christ has given his disciples his “flesh” metamorphosed as wheat bread. Wheat is considered the most valuable cereal, because it does not grow everywhere and has a great nutritional value. At the end of the seventeenth century, corn was brought to the land inhabited by Romanians, and after that wheat remained as a feast cereal, because corn was easier to grow and it could be cultivated up in the mountains.

Pasca is the traditional festive Romanian Easter bread and is made in different ways across Romanian country. In some areas it is made with cow cheese, in others it is made of bread dough. Sometimes it is made only by the priest wife, but what bounds this together is the belief that Pasca is the representation of Jesus flesh. Easter is the most important feast for Christians, because it is the moment when their religion started, and in order to celebrate that, Romanians have chosen to create a special ritual and the special bread.

Pasca is made only in specific days, the women have to fulfil an entire ritual when they make it. Afterwards the priest sanctifies it in the church, and only then, it can be eaten by the family. The first day of Easter is also a special day, because people go to church service and then they can eat for the first time that day. It is a sin to waste Pasca, so the crumbles are given to the family animals in order to protect them across the year.

In other words, Pasca is the most important type of bread in Romanian culture, because it is made only for this important feast and it is blessed by the priest.

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Supplementary Annex

For interested readers a detailed *Mioriţa* ballade:

Mioriţa ballade
Near a low foothill
At Heaven’s doorsill,
Where the trail’s descending
To the plain and ending,
Here three shepherds keep
Their three flocks of sheep,
One, Moldavian,
One, Transylvanian
And one, Vrancean.
Now, the Vrancean
And the Transylvanian
In their thoughts, conniving,
Have laid plans, contriving
At the close of day
To ambush and slay
The Moldavian;
He, the wealthier one,
Had more flocks to keep,
Handsome, long-horned sheep,
Horses, trained and sound,
And the fiercest hounds.
One small ewe-lamb, though,
Dappled gray as tow,
While three full days passed
Bleated loud and fast;
Would not touch the grass.
“Ewe-lamb, dapple-gray,
Muzzled black and gray,
While three full days passed
You bleat loud and fast;
Don’t you like this grass?
Are you too sick to eat,?
Little lamb so sweet?”
“Oh my master dear,
Drive the flock out near
That field, dark to view,
Where the grass grows new,
Where there’s shade for you.”
“Master, master dear,
Call a large hound near,
A fierce one and fearless,
Strong, loyal and peerless.
The Transylvanian
And the Vrancean
When the daylight’s through
Mean to murder you.”
“Lamb, my little ewe,
If this omen’s true,

If I'm doomed to death
On this tract of heath,
Tell the Vrancean
And Transylvanian
To let my bones lie
Somewhere here close by,
By the sheepfold here
So my flocks are near,
Back of my hut's grounds
So I'll hear my hounds.
Tell them what I say:
There, beside me lay
One small pipe of beech
Whith its soft, sweet speech,
One small pipe of bone
Whit its loving tone,
One of elderwood,
Fiery-tongued and good.
Then the winds that blow
Would play on them so
All my listening sheep
Would draw near and weep
Tears, no blood so deep.
How I met my death,
Tell them not a breath;
Say I could not tarry,
I have gone to marry
A princess – my bride
Is the whole world's pride.
At my wedding, tell
How a bright star fell,
Sun and moon came down
To hold my bridal crown,
Firs and maple trees
Were my guests; my priests
Were the mountains high;
Fiddlers, birds that fly,
All birds of the sky;
Torchlights, stars on high.
But if you see there,
Should you meet somewhere,
My old mother, little,
With her white wool girdle,
Eyes with their tears flowing,
Over the plains going,
Asking one and all,
Saying to them all,
'Who has ever known,
Who has seen my own
Shepherd fine to see,
Slim as a willow tree,
With his dear face, bright
As the milk-foam, white,

His small moustache, right
As the young wheat's ear,
With his hair so dear,
Like plumes of the crow
Little eyes that glow
Like the ripe black sloe?'
Ewe-lamb, small and pretty,
For her sake have pity,
Let it just be said
I have gone to wed
A princess most noble
There on Heaven's doorsill.
To that mother, old,
Let it not be told
That a star fell, bright,
For my bridal night;
Firs and maple trees
Were my guests, priests
Were the mountains high;
Fiddlers, birds that fly,
All birds of the sky;
Torchlights, stars on high."

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Chapter 15
"CIPOVKA" – Traditional Bread from North Serbia

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1 Introduction

Look carefully at the map of Europe. There, at the south, surrounded with high mountain ranges of Alps, Dinaric and Carpathian mountains, there is a plain region – the Pannonian Plain. This plain was once the bottom of the Pannonian Sea. The sea disappeared long time ago flowing irreversibly through the Danube basin leaving sediments at its bottom, forming the fertile soil - chernozem – that covers the Pannonian Plain region. Due to its arable agricultural land Pannonian plain is often referred to as "the granary and bread basket of Europe".

At the very center of Pannonian Plain there is the piece of land known as the Province of Vojvodina which is today the part of the Republic of Serbia. It had a very rich demographic history which resulted in multiple diversities that characterize this region, including the specific bread that has been made in this part of the world for centuries: "Cipovka"– large, round shaped bread with well-baked crust made from "white" wheat flour with large cut across the entire side (see Fig. 15.1).

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Fig. 15.1 Cipovka – traditional bread from north Serbia

2 Emergence of Cipovka

“Cipovka”, the bread with distinctive properties, was not created by chance. There is a set of circumstances related to geographical, climatic, biological, socio-demographic and technological development factors which led to the emergence of such a product.

In addition to the fact that the soil in Vojvodina is considered to be among the most fertile not only in Europe, but in the whole world (Nešić et al. 2008), the mild semiarid-climate and abundance of water resulted in long tradition of field crops cultivation in Vojvodina, particularly wheat (Sekulić et al. 2010). In the past, populations of autochthonous wheat were grown in Vojvodina. They were named after the regions of Vojvodina: “Banatka”, “Stara Banatka”, “Potiska”, and “Bačvanka”. Autochthonous populations of wheat traditionally grown in Vojvodina were characterized with poor agronomic properties and low yields reaching up to 1 t/ha (Pavlović et al. 2001), but they had excellent bread-making quality resulting in their utilization as genetic material in many wheat breeding programs (Denčić et al. 2009).

The fact that traditional bread in Vojvodina was predominantly made from “white” flour was not only due to the technical possibilities for “white” flour production, but also due to the cultural values nurtured among the people of Vojvodina. The culture of multiethnic groups that came from different parts of the world and settled in Vojvodina in order to find prosperity on its fertile fields influenced the choice of ingredients for breadmaking. Utilization of “white” flour for “Cipovka” preparation was a result of a prevalence of inclinations towards the nobility of the Viennese court and the Austro-Hungarian Empire, under which Vojvodina existed for a long time, over a simple-minded peasant life. Bread made from “white” flour at the table of families of Vojvodina was a symbol of abundance, a synonym for reputation and an indicator of wealth. Whole wheat flour obtained from numerous stone mills in Vojvodina was separated by sieving long before the roller mills started to spread in Pannonian plain. However, the roller mill inventions, which transformed flour and bread production, emerged and spread exactly in the Pannonian plain in the second half of eighteenth century in the vicinity of Budapest (Mastilović 2020) contributed to the easy accessibility of "white" flour in this region long before its worldwide spread.

"Cipovka", with all its variations, was not created by professional bakers. It emerged from the tradition of bread production in rural households in Vojvodina. Peasants' families in Vojvodina, used to live at specific farms called "salaš". The households were multigenerational with many household members for whom food, including bread was prepared. These households were isolated, surrounded with endless fields and distant from any source of supply. There was a lot of work at the farm for all family members and thus, there was no time for bread making on daily basis. Bread preparation was more a ritual, performed once or twice a week by the housewives who prepared bread for the whole family to be consumed during several days. For this reason traditional "Cipovka" was big, with weight of 4–5 kg.

Round shape of "Cipovka" was also not designed by chance. The fact that bread was prepared once a week imposed the need of bread freshness preservation. Round shaped bread has the smallest outer surface for water evaporation resulting in lower bread crumb drying. Nowadays, it is well-known that moisture migration from the crumb to the crust accelerates starch–gluten interactions and bread firming (Dapčević Hadnađev et al. 2014). However, smart housewives that prepared bread for their families probably derived that observation from practical experience and adopted round shape which characterizes "Cipovka".

Specific starter for dough rising named "komlov" used to be prepared from locally available raw materials. The procedure for its preparation and its exact composition was the secret of each individual household with many different approaches for its preparation.

Thick crispy crust is another sensory characteristic of traditional "Cipovka". Crust properties of this traditional bread are the consequence of oven construction which was used for its baking (Stepanović 2018). Robust masonry ovens existing in Vojvodina in rural households (see Fig. 15.2) were not built only for the bread baking purpose. Large ovens positioned between the living room and the separately positioned kitchen were integral part of each house. Ovens were built from specific mud-bricks named "čerpić" made from loam, mud, straw and sand, dried in the sun and used widely as building materials for houses in Vojvodina. The back of the oven, facing the living room was conically shaped with extensions at lower part forming banks around the body of the oven where household members used to gather, sit and chat during cold winter days. The oven was heated by fire burnt directly in the fireplace positioned at the kitchen side. Crowned corn cobs, characterized with low caloric value, but abundantly available at traditional farms, were used to burn the fire in the oven to allow accumulation of the heat in thick oven walls. During bread baking heat was gradually released with the temperature in the oven gradually decreasing. For proper baking of large dough pieces almost 2 h were needed for completion of baking of inner crumb layers. During that time specific properties of crust were formed. The crust was formed gradually in the closed environment of well-sealed oven which kept evaporated water in the oven providing

Fig. 15.2 Traditional masonry ovens in Vojvodina ("paorska peć"), retrieved from https://www.ravnoplov.rs/paorska-pec/

high humidity. Crust formed in such environment was very thick and aromatic with uneven color – light yellowish brown at the sides, dark brown and caramelized at the top due to nearly touching oven roof and with pale underside with traces of soot.

Ultimately, the main distinctive property of "Cipovka" is the large cut along one side of round shaped dough resulting in asymmetric shape of bread (Fig. 15.1). The cut was made with sharp knife immediately before the baking, which allowed faster and better oven spring. That large, widely opened cut bread resembles a big smiling face. Thanks to this association, "Cipovka" earned the epithet of "the bread that laughs at the moon".

3 Traditional Preparation Process

Bread was made in the rural households in Vojvodina from stone milled flour long before the establishment of first bakeries and roller mills in the region. Natural starters were used to ferment the dough long before the process for commercial bakers' yeast was invented. On the basis of available historic data, the insight in the traditional process, which was used for production of bread in Vojvodina for centuries, is provided. Production of dough for traditional bread in Vojvodina was conducted in three phases described below mainly by the housewife of each household.

3.1 Production of Dry Starter "Komlov"

"Komlov" was most often prepared during spring, late summer or early autumn, when the weather was nice and not excessively hot. The "komlov" was produced in high amounts accounting for the entire product needed for the next season. Traditional "komlov" recipes available from different sources are highly variable both in the raw materials and production procedures used. It seems that each housewife had her own secret how to produce the best starter for her bread. On the basis of analysis of available records about "komlov" preparation, the composition and procedure for its preparation with all relevant elements is provided in Fig. 15.3.

The process of "komlov" preparation consists of 4 steps:

1. In the first step the flour is mixed with lukewarm water into soft dough which is left overnight. During that period flour microflora is being activated (Knez 1972; Tišma 1995).
2. Separately to the first step, the aromatic plants characterized by their strong antimicrobial activities (Peter 2000; Šarić et al. 2009), such as hops, acacia flowers, sage leafs or onion peels are boiled in wine. Thus, natural preservatives are obtained to prevent the development of molds which may spoil the starter. Additionally, the extract of aromatic plants in wine will alter the rheological properties of dough (Mišan et al. 2013; Pestorić et al. 2017) acting as natural dough conditioners and enabling the loaf to achieve an optimum bread quality.
3. The aromatic plants are then removed and the liquid that is mixed with wheat, corn bran or a mixture thereof. In this way, the ingredients rich in enzymes naturally present in aleurone layer (Žeželj 1995) are provided in the starter, ensuring sufficient enzymatic activity in the process of starter and subsequent dough fermentation.
4. Finally in the fourth step, soft dough initiated overnight and a portion of sourdough from ongoing bread production are mixed with the extract of aromatic plants in wine and bran obtained in the third step of starter production. From listed ingredients moderately soft dough is mixed, divided in fist size pieces, rounded and placed in wicker basket.

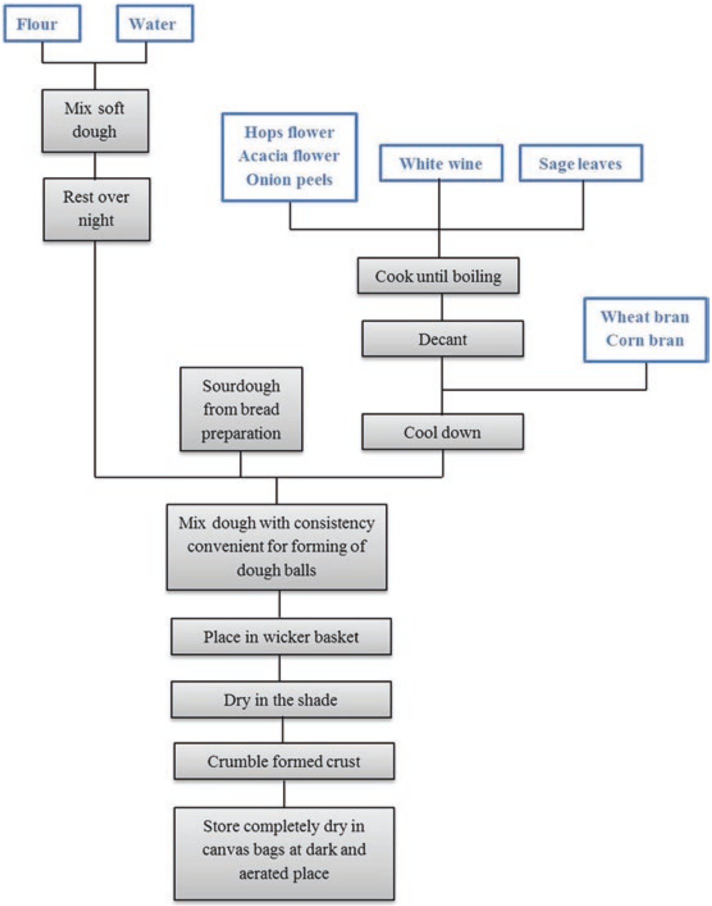

Fig. 15.3 Steps in preparation of traditional starter “komlov”

Starter pieces are dried naturally at well ventilated place protected from direct sun irradiation. As the drying process proceeds, the gradual initiation of complex microflora present in starter is enabled. During the drying process, the outer layer of the starter portions dry faster and become firm, being then combined and crumbled into small portions, allowing the inner and wet material to dry further until achieving the desired dried “komlov”. This crumbled starter is placed in canvas bags and stored in well aerated dark room until its utilization in bread baking.

The described procedure for “komlov” preparation could vary in terms of quantities of the ingredients used. The composition of this product could also vary in terms of the selection of aromatic plants which will be included as the antimicrobial agents, and the “komlov” can even be prepared without these aromatic ingredients. Moreover, the duration of preparation steps and temperatures at which each step was conducted could also be the source of “komlov” variability. Housewives who

Table 15.1 Reconstruction of composition and production procedure for "komlov" preparation

Raw materials		Total weight	Processing parameters
Step 1	Flour 3000 g	5000 g	Water temperature 35 °C Duration 12 h
	Water 2000 g		
Steps 2 and 3	White wine 500 g	800 g (aromatic plants discarded)	Heating and boiling for 10 min Decanting of liquid, discarding of aromatic plants Cooling to 50 °C Soaking of bran 4 h
	Sage leafs 100 g		
	Hops flours 100 g		
	Wheat bran 300 g		
Step 4	Sourdough 1000 g	1000 g	Stirring with all other ingredients
TOTAL		~6800 g	Wet "komlov" with moisture content over 50%
Drying		~4000 g	Dry "komlov" with moisture content under 15% (sufficient for production of 30–40 loafs of bread)

used to prepare "komlov" had their own secrets in terms of the selection and quantities of used ingredients. Although they were routinely preparing "komlov", they were not aware about the emphasized roles of each ingredient and each step as it is available today. Still, "komlov" presents an example of ideal product containing all ingredients with specific techno-functional role, which involve all phases necessary for the achievement of optimal results. "Komlov" is an example of empirical and intuition based optimization of a complex technological process.

On the basis of contemporary knowledge, the traditional "komlov" preparation procedure can be supplemented with exact quantities of ingredients and processing parameters. The ingredients for "komlov" extracted from historic records and upgraded with missing empirical information derived from contemporary starter production knowledge is provided in Table 15.1.

3.2 Dough Mixing

In the traditional process for "Cipovka" preparation, dough mixing consists of three phases:

- Dissolving of starter – "komlov" in water and initiation of microflora from the starter
- Mixing and fermentation of sourdough
- Mixing and fermentation of bread dough

Traditionally a housewife that had to prepare the bread by next day, usually on a Tuesday or Friday, had to prepare the starter on the previous day. For a 5 kg bread loaf, a handful of dry “komlov” was dissolved in lukewarm water and left overnight. The dried “komlov” contained all components needed for initiation of the fermentation processes, including lactic acid bacteria, wild yeasts from flour and added sourdough, enzymes from bran and starch from flour. This allowed prompt initiation of the fermentation process upon adding dissolved “komlov” into the flour.

To complete the bread preparation by lunch time (usually at 1 pm), the process involved an early start in the morning between 2 and 3 AM on the day when bread was prepared. The process started with sifting one third of the flour needed for bread preparation, adding the dissolved “komlov”, a pinch of salt and water to obtain a very soft, almost liquid dough. The dough was shortly mixed with a wooden spatula and left to ferment for 5–6 h. During this period the process of gluten hydration was completed, strong gluten network with established disulfide bonds was formed and through hydrolytic processes the balance in gluten properties was achieved (Tomić, et al. 2013) and the enzymatic processes of starch degradation and fermentation and other biochemical processes described in Chap. 1 of this book occurred in the dough.

Around 7 AM the sourdough was ready to be used for bread dough preparation. The additional quantity of flour needed for bread dough preparation was sifted and placed in a shallow wooden trough named “naćve” (see Fig. 15.4). The dough was very intensively manually kneaded for a quite long time, exactly until it became shiny, started to form bubbles and separated easily from hands and the dish.

Due to multistep process enabling high hydration rate, the quantity of water which could be added to the dough characterized with optimal consistency was high (Knez 1972; Pyler and Gorton 2009).

Fig. 15.4 Bread mixing bowl “naćve”, Serbian museum of bread – Jeremija, retrieved from http://www.muzejhleba.rs/o-hlebu.htm

3.3 Bulk Fermentation and Proof

By the time when dough was mixed, the fire in the oven had to be already started. Since the outer walls of the oven were already warm, the dough was placed close to the oven to provide the optimal temperature for fermentation and rising of the dough. The dough was left for additional 2–3 h to rise and kneaded shortly two to three times. Around 10 AM, the dough was ready to be divided to individual 5 kg pieces and molded in round shaped forms, placed in a basket and covered with cloth for final proof.

Proof time was about 60 min. Dough ready for baking was placed on a large wooden shovel. Before baking, the final step providing specific shape of "Cipovka" was performed: a deep cut along the entire side of proven dough was made with a sharp knife (see Fig. 15.5).

The long multiphase fermentation of the dough resulted not only in the development of sufficient quantities of gas and rise of the dough, but also in the development of significant quantities of organic acids, predominantly lactic and acetic acid responsible for pleasant, mildly acidic taste of bread (Ognean 2015). During long fermentation process, the complex profound aroma of bread was also developed providing unique sensation of aromatic properties of bread (Pétel et al. 2017).

Fig. 15.5 Deep cut along the entire side of the dough enable forming of final shape of "Cipovka"

3.4 Baking

Dough was inserted into the oven with a wooden shovel and the cast iron door of the oven was closed. There was no possibility for addition of steam into the interior of the oven, but a well-sealed oven enabled retention of the entire quantity of vapor obtained from the evaporation of the water from the surface of the dough in the confined and limited oven (Rubel 2011). Thus, the condensation of vapor on the surface of the dough occurred soon enough to enable the retention of the elastic properties of the outer layer of the dough and a significant oven spring (Rubel 2011).

The real secret of the excellent oven spring of "Cipovka" is not related only to the good sealing and small interior of traditional masonry ovens available in the rural households in Vojvodina (see Fig. 15.2), but to the deep cut made in the dough prior to its baking in the oven. Due to the enlargement of the outer surface created by the freshly cut dough, the tensions limiting the oven spring of the dough were significantly lower. Thus, after the exposure of the dough to the heat in the oven, the expansion of developed gasses in the central part of the bread resulted in specific intensive rising of the central part of dough with the upper edge of the cut becoming the highest point of the loaf. At the same time, the surface of the cut, which did not have a compact outer layer, enabled a quick release of the gasses from the dough through the surface of the cut (Knez 1972). This phenomenon caused a drop of the height of the dough beneath the cut thus leading to formation of asymmetric shape of "Cipovka" bread loaf.

In this way, besides obtaining the specific, recognizable shape of the bread, several additional effects were enabled contributing to the visual identity of the whole bread (see Fig. 15.6). The upper edge of the cut which rose high was the closest to the red-hot oven roof, so that the Maillard reactions and caramelization processes in this part of the crust were more intensive resulting in intensive dark brown crust color. The gas cells developed in the dough at the surface of the cut which were exposed directly to the heat from the oven remained visible and provided a highly recognizable visual identity of the product. Due to wide surface of the cut, the

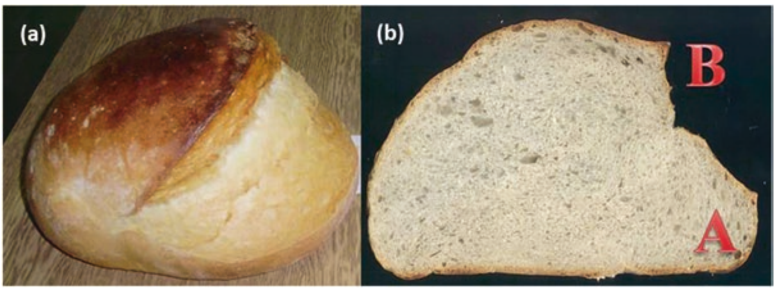

Fig. 15.6 Due to the large deep cut along its entire side, "Cipovka" is characterized by its uneven crust color and asymmetric shape (**a**). The deep cut along the entire side of the dough results in forming of the most appreciated parts of "Cipovka": (A) crusty part under the cut called "Pupuška" and (B) the upper caramelized edge of the cut with perfect aroma (**b**)

excess of gas expanding in the dough was released avoiding the cracking of the crust that characterizes the rustic bread baked in masonry ovens. Thus, the remaining crust surface, except the cut, was smooth and shiny. The shiny effect of the crust was additionally emphasized by washing of the hot bread with a wet cloth immediately after its baking.

During the baking process the temperature in the oven gradually decreased, enabling a slow completion of the baking process or time for the heat to penetrate to the central part of the bread with decreased irradiation from the oven walls that prevented the excessive caramelization of bread crust (Knez 1972). However, crust obtained in this way was very thick and compact (Pestorić et al. 2008a) and overall this baking process of a traditional 5 kg "Cipovka" took almost 2 h to be completed.

3.5 Storage and Shelf Life

Baked bread was cooled and stored covered with a clean cloth. "Cipovka" was characterized by its long shelf life, being able to be preserved for over a week. The long fermentation, with intensive lactic acid bacteria activity and the acidic environment, prevented the mold growth on the surface of bread crumb (Gerez et al. 2009). The spoilage of bread was additionally prevented by the natural preservatives from the aromatic plants included in the starter (Garcia and Copetti 2019). The thick and compact crust prevented the loss of moisture and drying of the bread crumb, while a high water absorption and a complete hydration of gluten resulted in a moist bread crumb with low staling rate (Choi et al. 2008; Dapčević Hadnađev et al. 2014).

Although the peasants in rural Vojvodina did not know anything about the processes and biochemical phenomena behind "Cipovka", this fact did not hinder their ability to prepare and consume perfect, high-quality bread. Todays' lifestyle in rural households are modernized, old masonry ovens disappeared and only the elderly vaguely remember these practices and the shape, the smell and the taste of traditional "Cipovka".

4 From Tradition to Modern Bakeries

Urbanization characterizing the industrialization era did not bypass the rural areas of Vojvodina that suffered extreme lifestyle changes with young people moving to the cities, while the rural areas remained deserted (Stojanović and Vojković 2005). Without large number of hardworking family members there is no longer a need for preparation of large breads for the whole family. However, some of the skilled artisans recognized the market need for traditional breads emerging at that time in big cities and started preparing breads that were sold at the farmers' markets in the cities. Unfortunately, this activity gradually disappeared and only the tale remained.

On the other side, in emerging small towns, the demand for bread increased and artisan bakeries started to operate (Richardson 1972). Luckily, the process for production of traditional bread and its traditional shape were preserved. However, the commercial bakers were more prone to the adoption of technology advances to achieve the process by simplifying and reducing the labor and costs of bread production. At the beginning of the second half of eighteenth century in Vienna, the process for industrial production of bakers' yeast was developed and few years later the first roller mill started to operate in the vicinity of Budapest (Mastilović 2020). Thus, in Vojvodina "white" flour and bakers' yeast were available earlier than in any other part of the world. Commercial bakers' yeast replaced the utilization of traditional starter "komlov", manual multiphase mixing of dough was replaced with direct mixing of dough in mechanical mixers. Masonry ovens were replaced with high capacity steam ovens with indirect heat transfer, which drastically reduced the baking process duration (Knez 1972; Giz Hera 2018).

Moreover, in contemporary lifestyle, the multigenerational households is a practice that almost disappeared (Vujadinovic 2013) resulting in the reduction of the bread size.

What was left from the tradition of "Cipovka"? Well, in spite of the promotion of the beneficial health effects of wholegrain bread consumption (Askari et al. 2013), in the region of Vojvodina consumers still prefer bread made from "white" flour. "White" bread is still considered to be the symbol of wealth and prosperity. The shape of "Cipovka" also resisted the ravages of time. In the assortment of almost every bakery, round shaped bread with deep cut along the entire side is present, but in smaller size - usual weight of contemporary "Cipovka" is up to 0.7 kg. However, its crust is evenly colored, thin and elastic, without characteristic, deep aroma. Unlike traditional "Cipovka", the modern counterpart is characterized with plane taste and crumbly and non-cohesive crumb which stales very fast. All of these properties are due to the application of direct dough mixing process (Cauvain and Young 2001) in the production of contemporary "Cipovka".

The production of home-made starters was almost forgotten. Moreover, according to the regulation that defines the conditions that have to be fulfilled in bakery production (Rulebook 1983) the utilization of hop-based starters was forbidden, so that the preparation of traditional starter "komlov" was outlawed. Additionally, in agricultural production, old wheat varieties characterized by low yields and high bread making quality were substituted with new, high-yielding varieties with low protein and gluten content and poor processing properties (Denčić et al. 2011). In contemporary milling, the production of flours with smaller particles, which is not suitable for long fermentation and indirect dough mixing, became dominant in the market (Voicu et al. 2013).

Finally only the name "Cipovka" remained. Moreover, this name generically designates any type of round shaped bread. All in all, the modern trends in bread production have contributed to the traditional production process of "Cipovka" almost forgotten, eradicating the practical utilization of this product.

5 Salvation of Tradition

"Cipovka"- bread that laughs at the moon' (Vujadinović 2016), whether it depicts a documentary film or the text of a book, always evokes in us a pleasant feeling of all the beauty of the Vojvodina tradition of making bread with specific sensory properties. "Cipovka" bread reminds us that our ancestors prepared durable bread without additives and that novel technologies are not always the triumph of exclusively sensory good bakery products. The question of eating or not certain foods has become an issue, because food progresses irresistibly from a source of nutrition and sensory pleasure to becoming a social marker, a source of meaning, and metaphor, or often a part of cultural heritage (Kihlberg 2004).

Fortunately, before the tradition of "Cipovka" production was completely forgotten, emerging consumer trends succeeded to reverse the situation in favor of traditional "Cipovka" which positioned this product out of the history of cook books and into the desired niche market of traditional breads.

In 2009, the process for protection of "Cipovka" as traditional specialty guarantee (TSG) of Vojvodina was initiated. This process which involved food researchers, historians, bakers, and consumers resulted in the collection and preservation of materials from different sources, so that almost forgotten traditional production process of "Cipovka" was reconstructed. Experimental quantities of traditional "Cipovka" were produced and experiments in which consumers' preferences were translated into sensory properties characterizing traditional "Cipovka" were conducted (Pestorić et al. 2008a).

The process of "Cipovka" protection has never been completed due to administrative problems, but the collected material and activities that followed provided a new framework for preservation of traditional bread "Cipovka" in a form that adjusted to the contemporary bread production trends and in accordance with consumers' requirements.

6 Contemporary "Cipovka"

The notion of food quality, considered in its full sensory complexity, is crucial for the liking, choice and purchase of food by consumer. Among all the quality aspects, the sensory quality of food, expressed often by consumers as "taste", is reported to be the most important criterion. What would be different with a "Cipovka"? The enjoyment of food which is a combination of sensory sensations, cognitive and emotional processes, improves the quality of every day's life. The pleasure of table belongs to all times and all ages, to every country and every day; they go hand in hand with all our other pleasures, outlast them, and remain to console us for their forgetfulness and disappearance. However, this is not the case with "Cipovka", bread that was presented to consumers again through numerous events organized by the Institute of Food Technology in Novi Sad, evoking the spirit of past times and

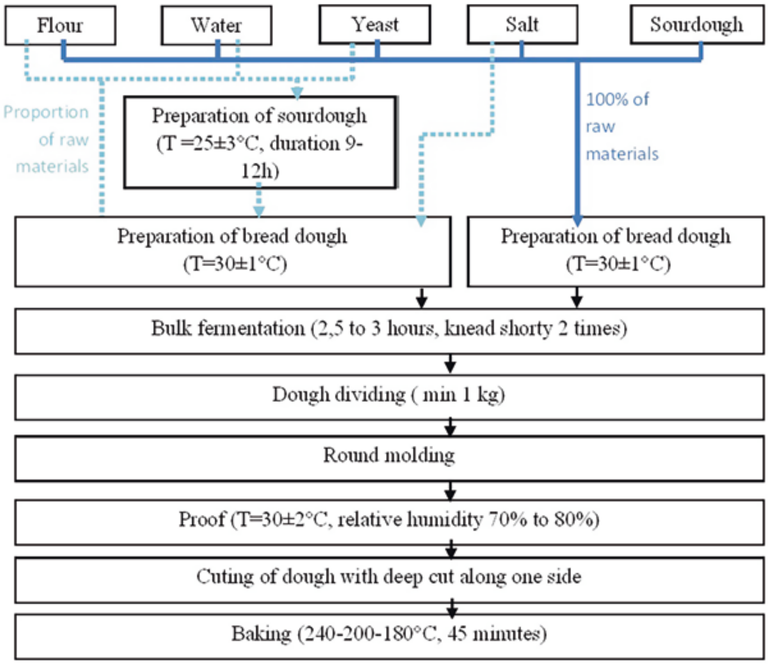

Fig. 15.7 Comparative presentation of traditional indirect procedure for "Cipovka" production in parallel to contemporary process with commercial sourdough

tradition through all the beauty of sensory sensations caused by this type of bread (Pestorić et al. 2008b, 2010a).

As a result of activities conducted in the process of "Cipovka" preservation, the sensory properties that characterize the traditional "Cipovka" were defined, together with the specificities of contemporary process for production of bread allowed to be named "Cipovka".

According to the achieved consensus among baking technology experts, "Cipovka" can be produced according to alternative indirect bread production procedure with mixing of the dough in 2 phases or with the application of industrially produced liquid or powdered sourdough. The comparative presentation of the traditional indirect procedure for "Cipovka" production, in parallel with the contemporary process of commercial sourdough is presented in Fig. 15.7.

Contemporary process of production of "Cipovka" must either include the phases of starter preparation, sourdough mixing and bread dough mixing or utilization of the commercial sourdough product. Special emphasis is given to the dough cutting which provides characteristic traditional shape of the bread. Suggested minimal weight of the loaf was set at 1 kg and the demand for minimal specific volume was set at 3 ml/g. The sensory properties of traditional "Cipovka" were described in terms of its shape, crust and crumb properties and its specific flavor (Pestorić et al. 2010b, 2012) as presented in Fig. 15.8.

TYPICAL CHARACTERISTICS:

Weight: 500 g; 1000 g

Shape:
Round or elliptically shaped bread with maximal length to width ratio of 1.5:1.

Color
Upper bread crust has to be golden yellow to dark reddish, with uneven intensity of the color, more intensive at the edges of the cut and lighter inside the cut. Bottom surface has to be dark, not shiny with traces of flour on the surface.

Surface appearance
Rustic appearance, with little shines (more matte and floury surface); cracked crust.
Upper crust surface has to be formed in two levels with minimal differences in height of 2.5 cm between them.
Strongly cracked at the cross section (rustic look); characteristic bulging so-called "pupuška".

Slice appearance and structure
Crispy crust that should be at least 2 mm thick (usually about 5 mm); compact, without cracks.
In the region of dough cut, lower thickness of bread crumb is also acceptable.
Stable structure with very uneven, coarse and large pores (e.g., *Dallman* porosity number ~ 5).

Flavor
Crust flavor should be intensive with somewhat expressed sourness. The flavor should also be aromatic, fairly sour, with more expressed notes of upper crust surface.
Intense flavor as a consequence of using an indirect production process or sourdough.

Fig. 15.8 Description of "Cipovka" sensory properties

The scheme for assessment of the sensory properties of "Cipovka" was developed. The assessment of the properties of this bread was conducted using an ordinary scale with answers from 0 – completely unacceptable, to 5 – completely characteristic. The levels to which certain properties of "Cipovka" can deviate from a perfect alignment with the defined sensory properties were also defined (see Fig. 15.9).

Other properties characterizing the product which can be named "Cipovka" were suggested too. "Cipovka" should be characterized with higher crumb moisture level due to the prolonged duration of baking at lower temperature. Such baking conditions cause a slow water migration towards the outer layers of the dough and a high moisture content of the crumb. Low baking temperature and prolonged baking duration results also in the gradual formation of a thick crust which presents an additional barrier for the evaporation of water from the bread and improves its preservation during storage. Bread produced by conventional production process contains up to 46% of moisture in the crumb, whereas "Cipovka" can contain up to

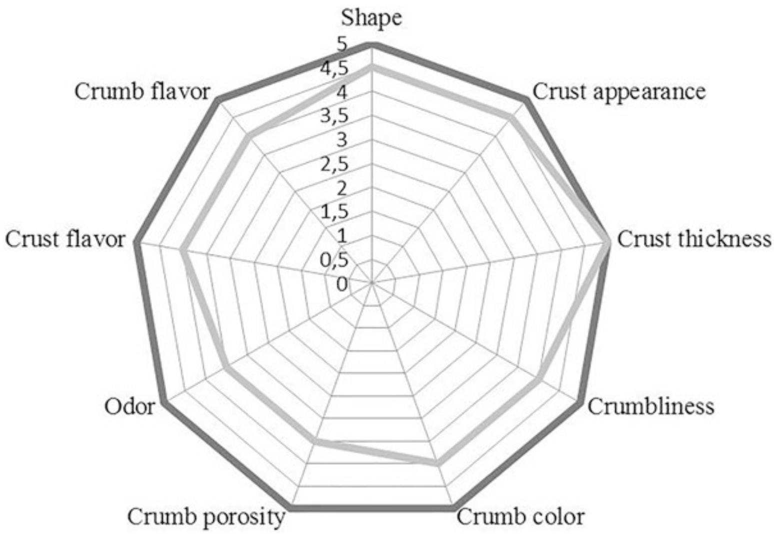

Fig. 15.9 Sensory properties of “Cipovka”– desired (dark grey) vs. acceptable (light grey) quality

50% water in the crumb. Prolonged baking at lower temperature ensures that the central parts of the crumb are completely baked and the gelatinization processes of starch are completed in spite of higher moisture content. Moreover, the increased content of organic acids in “Cipovka” prevents the development of molds in spite of higher moisture content in bread crumb.

“Cipovka” should be produced from “white” flour. However, in the case of traditional “Cipovka” the meaning of “white” flour is not equal to the current milling and baking industry standards and regulations in this field. Although the regulations in Serbia (Rulebook 2018) define “white” or refined flour as a product with ash content of up to 0.60% dry matter (DM), it was agreed that for “Cipovka” production, flour with ash content of up to 1% DM can be used. This means that any flour with visual impression of “white” color, free from large bran particles is adequate for production of “Cipovka”. In contemporary roller mills “white” flour can be characterized with ash content as low as 0.4% DM, unlike “white” flour obtained by stone milling, which visually can be characterized as “white” flour although containing up to 1% DM of ash. Due to the fact “Cipovka” do not contain baking additives, only main ingredients – flour and salt, the ash content of bread calculated and experimentally confirmed is in the range from 0.55% to 0.95% DM.

One of the major properties of “Cipovka” is its prolonged shelf life in comparison to conventionally produced breads. Sensory properties and safety parameters of “Cipovka” should remain unaffected for at least 4 days, or even longer – preservation of freshness and safety of 5–7 days is desirable.

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Chapter 16
Traditional Breads from Spain

Elisa Luengo, Jorge Pastor, and Guillermo Saldaña

1 Introduction

"Bread has been present from the origin of the most remote civilizations and has brought together feelings and beliefs, has caused social riots and economic confrontations. From a generic outlook, bread is seen as an old Mediterranean Totem splashed out with value judgements and multiple connotations. It is both a reality and a myth, an allegory and a concept, a warm product, something essential, trivial and almost unavoidable; a life symbol that becomes a paradigm of the basic principles of daily nutrition" (Capel 1997).

"The trilogy, wheat, flour and bread, carries the history of Europe. It is the main concern of all the States, merchants, and human beings for whom living means "biting bread"" (Braudel 1984).

For millennia, bread has been the fundamental nourishment of the Occidental Civilization, gathering its influence on the Fertile Crescent, the Mediterranean world and also remotes areas like the Silk Road (Uzbekistan, Kyrgyzstan or actual areas of China) (Braudel 1984; Shevchenko et al. 2014; Shewry 2009).

It is impossible to understand the current world and its civilization without considering bread. Bread is a product food made of wheat flour but also multiple types of cereals, pseudocereals, grains and seeds which are melted with other ingredients like legumes, dried and fresh fruit, etc. This marvellous food was the social, economic, nutritional and religious centre of Spanish society from ancient times up to the present day.

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2 Historical Background

To understand the evolution of bread in Spain during the last centuries and to value its antiquity, there is no better way than studying ingredients used for millennia in bakery, mainly the cereals. The "Centro de Referencia Fitogénetica" (CRF) (Phytogenetic Reference Centre), located in at Alcala de Henares (Spain), aims to "contribute to preserve the genetic diversity of all disused species, varieties and vegetable autochthonous ecotypes and wild species and other materials with genetic potential, which can be used in agriculture and nourishment". The CFR has registered 9.252 inputs of 11 different cereals and pseudocereals and 77 varieties of the genus *Triticum*. These data give a wide vision of the cereal biodiversity through history and allow to understand the wide range of bread making recipes in Spain in previous centuries (CRF n.d.; Sánchez-Monge 1957) (Table 16.1).

Ancient genus and species can be found through the Spanish geography, including wild wheat genus like *Aegilops*. Therefore, bread baking cereals have been present in the Spanish landscape, agriculture and food scenography for thousands of years. The presence of *Aegilops, Triticum monococcum*, *Triticum turgidum* (durum wheat), *dicoccum (*Emmer), *Triticum aestivum* subsp. *spelta (*Escanda) in Spanish geography and agriculture confirms the elaboration and consumption of sourdough bread since ancient times (Goncharov 2011). Additionally, other cereals and pseudocereals like barley, rye, millet, sorghum, oats, buckwheat and, more recently, rice and corn, have been also identified at the CRF and, they would be very likely included in bread recipes.

Even since the ancient Roman Empire, it was frequent to find bread made by mixing different cereals (wheat, rye, barley, oats). All these cereals can be found in Spanish traditional varieties and sometimes in wild crops. The trend of eating bread made with a mixture of cereals was also common in Europe during the Middle Age. This habit was extended until the middle of the nineteenth Century. It is estimated that less than 4% of the European population consumed white bread made of wheat (Braudel 1984). The wide cereals and pseudocereals stocktaking from CRF reveals that this type of multicereal bread should prevailed also in Spain. Until the invention and use of the railway at the beginning of the nineteenth century, the Spanish population fed mainly with cereals and agriculture products of proximity, maximum 20–30 km (Braudel 1984). This fact indicates that the Spanish population elaborated bread from hundreds of different autochthonous cereal varieties (Table 16.1). Exceptions to this rule were the coastal zones or those areas near to big ports like Seville, Barcelona, Málaga, Cádiz or La Coruña, cities with trading capacity with America, Africa and, India.

Bread was mostly baked in small home ovens at home. Additionally, there were community ovens used for the final bake of doughs made at home (Molinero n.d.). The presence of bakers and professional bakeries is very ancient, according to the information gathered in different sources. It is known that about the year 158 BC there were groups of qualified bakers in Ancient Rome. The Roman Emperor Trajano, born in Itálica, near Seville, gave license in second century AC to constitute

Table 16.1 Traditional cereals and pseudo cereals in Spain

Genus	Species	Inputs	Spanish common names	References
Aegilops	*biunciales, geniculata, neglecta, triunicialis, ventricosa*	535	Rompesacos, trigo bastardo, trigo morisco, Flora Vascular de Andalucía (Ovate goatgrass, Barbed oatgrass)	Sánchez-Monge (1957)
Agropyron	*cristatum*	3	Agropyron	Sánchez-Monge (1957)
Avena	*byzantina, longiglumis, lusitánica, murphyi, prostrata, sativa, sterilis, strigosa*	1835	Avena (Oat)	Sánchez-Monge (1957)
Fagopyrum	*esculentum*	3	Trigo sarraceno, alforfón (Buckwheat)	Sánchez-Monge (1957)
Hordeum	*bulbosum, marinum, murinum, secalinum, vulgare*	2371	Cebada silvestre, cebada caballar (wild barley, barley)	Sánchez-Monge (1957)
Oryza	*sativa l*	67	Arroz (rice)	Sánchez-Monge (1957)
Panicum	*miliaceum*	5	Mijo, mijo primitivo (Millet)	Sánchez-Monge (1957)
Secale	*cereale, montanum, strictum*	359	Centeno tradicional, centeno silvestre (traditional rye, wild rye)	Sánchez-Monge (1957)
Sorghum	*bicolor*	60	Sorgo tradicional, Mijo de escoba (sorghum)	Sánchez-Monge (1957)
Triticum	*monococcum boeticum*	3	Escaña silvestre (wild einkorn)	Gadea et al. (1954) and Sánchez-Monge (1957)
Triticum	*monococcum monococcum*	33	Escaña (Einkorn)	CRF (n.d.), Gadea et al. (1954), and Sánchez-Monge (1957)
Triticum	*turgidum dicoccoides*	1	Emmer silvestre (Wild emmer)	CRF (n.d.)
Triticum	*turgidum dicoccum*	73	Farro (Emmer)	CRF (n.d.), Gadea et al. (1954), and Sánchez-Monge (1957)
Triticum	*turgidum durum*	508	Duro (durum wheat)	CRF (n.d.), Gadea et al. (1954), and Sánchez-Monge (1957)
Triticum	*turgidum polonicum*	5	Polonico	CRF (n.d.), Gadea et al. (1954), and Sánchez-Monge (1957)

(continued)

Table 16.1 (continued)

Genus	Species	Inputs	Spanish common names	References
Triticum	*turgidum turgidum*	171	Turgido	CRF (n.d.), Gadea et al. (1954), and Sánchez-Monge (1957)
Triticum	*aestivum spelta*	100	Espelta, Escanda (Spelt)	
Triticum	*aestivum compactum*	2	Trigo Club (Club wheat)	CRF (n.d.), Gadea et al. (1954), and Sánchez-Monge (1957)
Triticum	*aestivum vulgare*	1.064	Trigo Panificable (Bread wheat)	CRF (n.d.), Gadea et al. (1954), and Sánchez-Monge (1957)
Zea	*mays l*	2504	Maíz tradicional (Maize)	Sánchez-Monge (1957)
		9252		

Special emphasis on *Triticum* spp. due to its relevance on bakery

The Official College for Bakers of Rome (Capel 1997). The presence of baker's guilds and associations in Spain and the rest of Europe during the Middle Ages was determinant to maintain the knowledge of all procedures and processes of bread making and also, the quality of such an essential food. Spain has a very large tradition of local and provincial baker guilds, like the Baker and Pastry Guild from Valencia, whose first ordinances date from 1462.

3 Evolution of Bread Making in Spain

Until the beginning of the twentieth century, Spanish bread was elaborated with traditional processes and forms. The main ingredients used were sourdough, different types of cereals and pseudocereals and, water. Spanish concept of Sourdough ("masa madre") is a generic term that gathers different concepts of previous doughs made or stocked previously to the bread-making process. Sourdough has a very wide presence in Spanish geography with many different names, definitions and characteristics. Different denominations (1) in the Mediterranean area ("Llevat", "Creixen", "Ren", "Creciente", "Masa Mare", and "Peu"); (2) in the Cantabric coast and north of Spain ("Orantza", "Formento", "Dieldo", "Furmientu", and "Yelda"); (3) in the south of the country ("Creciente", "Reciente Ludia" or "Ensancha"); and, (4) in the central area and Castille ("Levadura", "Hurmiento", "Recentadura", and "Formento"). All these denominations of previously fermented doughs show a huge cultural richness of processes and types of fermentations, conditioned by the climatology and geographical zone, as well as, the selection of ingredients and crop varieties used. These preparatory doughs were fermented spontaneously and, in many cases, were shared by the inhabitants of small locations to facilitate the home bread-making.

Nowadays, this type of spontaneous sourdough is called in Spanish “masa madre de cultivo” and corresponds with the Type I sourdough described in the scientific literature (Corsetti 2013; RD 308/2019 2019; Rizzello et al. 2019). The elaboration and preservation of sourdough requires nourishment and controlled fermentation conditions to preserve its fermentative capacity, especially during the hot seasons. In the inland areas of Spain such as Andalusia, where the temperature is high during several months, it was an usual practice to have one person in charge of taking care of the sourdough. This person nourished the sourdough with wheat and water regularly (backslopping), to avoid its spoilage. The backslopping process was usually repeated every 6 h, so when the bread-making elaboration started at night, there should be enough active sourdough for the whole bread production. Since the discovery of beer yeast and its industrial production at the late nineteenth and twentieth centuries, the slow traditional method of bread making, turned into quicker and shorter processes. Sourdough elaborations were avoided just for convenience and different types of additives were used to reinforce and contribute to bread mechanization.

The industry industrialization and progressive integration of Spain in Europe and the occidental world during the nineteenth century, especially during the twentieth century, brought very important social, economic, and political changes for Spain. Among others, a huge amount of emigration from the rural world to urban cities took place. Consequently, there was a radical change in the way population feed themselves and, therefore, in the way of elaborating bread. The high concentration of people in urban centres, the long time needed for workers to commute and also the small houses, made impossible to bake bread at home or to have community ovens to do it like it had been traditionally considered as a routine. The population thus, demanded ready to eat cheap bread. This demand was initially covered by local bakeries, but sooner they developed into big bread factories in the cities, with big mechanical installations where bread was produced in quick and very mechanic processes; the huge amount produced and the low costs prevailed over any other nutritional aspect. Quick Bread making process was born and expanded quickly. This phenomenon took place in Spain especially in the decades from 1960 to 1990 and has been maintained over the years as a standard way of bread making.

Moreover, other trendy foods like the sandwich came from Europe and the USA and increased the consumption of sliced bread at the expense of loaf bread. Sandwich bread was considered the paradigm of quick bread, made by adding sugar, fat and additives. Spanish lifestyle and Mediterranean diet have changed gradually (Capurso and Capurso 2020). Consequently, these changes have resulted in a decrease in bread consumption from 43.25 kg per capita in 1999 to 31.08 kg in 2019 (MAPA 2018).

Changing the bread making and producing process had several consequences. One of them, it was the consolidation of *Triticum aestivum* subsp. *aestivum* as main bread cereal. The pursuit of cereals with a high protein content resistant to the mechanical stress of the industrial installations eliminated all other ingredients with no mechanical resistance. Consequently, cereals like einkorn, emmer, durum wheat, barley, rye, oats or corn, have a minor presence in all breads sold at shops and supermarkets, reducing their presene mainly to small local areas or regions. Hence, these practices brought a significant loss in sustainability and biodiversity, making Spain an important importer of bread wheat worldwide (MAPA 2020).

4 Breads from Spain

Despite the social, demographic, and structural changes, Spain still keeps a huge bread richness spread across the all country. The great diversity of Spain in its climate, geography, culture and, environment has been reflected in a great variety of breads made with different ingredients, mixtures, shapes and forms, some of them especially elaborated for popular festivals, rituals and religion celebrations (Capel 1997).

Depending on the geographic area, different types of bread are found. Breads with a soft and juicy crumb are particularly found in the Atlantic area and the North Coast: “Gallego” bread, “Cea” bread, “Bolla” or “Mollete de Santiago” bread. In Asturias and Cantabria there are ancestral cereal breads (*Triticum aestivum* subsp. *spelta*), like the “Escanda” bread and others with mixtures of cereals like “Borona” bread (corn and wheat). In the Basque Country it can be found the “Txakinarto” bread made with wheat and ancestral corn. In the Northeast area, near Portugal, we have others made of rye with a dark colour and a strong flavour.

The Peninsula Centre is the historical barn of our country. Typical breads from this area have a consistent dough and crumb, resulted from refined breads made of wheat with specific elaboration process. Examples of these breads are, in Castilla, “Lechugino”, in Extremadura and La Mancha “Pan de Cruz” and, in Andalusia “Telera” (Pascual 2015). In Andalusia, we also find very soft breads, with a juicy crumb and soft crust, like the “Mollete” bread from Antequera.

In the northeast, there is a long valley called Ebro Valley. Through these lands, there are wealthy regions with delicious breads with an open and spongy crumb. In Navarra “Taja” and “Cabezón”, in Aragón “Cinta Bread” and “Cañada”, in Catalonia, “Pa de Pages”, “Llonguet”, and “Pa de Crostons” and in Castellón and Valencia “Pataqueta”, “Sobao” and “Candeal” specialities (Montesa 1997).

With no doubt, there are not many countries to enjoy such an exceptional variety and richness in bread tradition (Yarza 2020). In order to show this tradition, breads described in the following section have their own Protective Geographic Identification (PGI) and they come from diverse origins and varied elaborations.

4.1 *Spanish Breads with Protected Geographical Indications (PGI)*

The particular geographical characteristics, climate and crops available in each region have determined the different kinds of bread, as well as the historic events affecting the country. Some of these ancient recipes are still produced nowadays as they were adapted to the modern bakery techniques. Considering that the land and climate of Spain is quite variable, from north to south and from coast to inland, the number of local specialities is huge. Nevertheless, only the breadmaking process of some traditional Spanish bread has been standardised via PGI and other local Product Quality Scheme Regulations that will be the main focus of this chapter.

A PGI is a document that describes the characteristics of a product that presents a high-quality standard and it is linked to a limited region or country within the EU and thus, it is regulated by the EU commission (MAPA 2014). There are five bread PGI in Spain (Fig. 16.1):

- "Pan de Cea" (in the year 2005)
- "Pan de Cruz" (in the year 2007)
- "Pa de Pagès" (in the year 2012)
- "Pan de Alfacar" (in the year 2015)
- "Pan Gallego" (in the year 2019) (Fig. 16.1)

Fig. 16.1 Geographical distribution of the PGI breads in Spain. (MAPA 2014)

The 5 bread PGI in Spain have been published from 2005 to 2019 (Table 16.2). The bread is described in shape, weight, structure and taste followed by the step by step processes to produce it, with special attention to those elements that make the bread unique (e.g. type of flour, baking conditions or type of oven). The quality control and labelling of these breads are also specified together with the history of the product and its link to a geographical zone of production. Although they are relatively new, some documents prove the link of each type of bread to the history of the area of production and therefore, there is a strong baking background on each loaf of bread. Indeed, each PGI aims to preserve the know-how inherited about traditional breads of these five regions of the Spanish geography.

As seen in Table 16.2, the Spanish PGI breads have some characteristics in common. The elaboration of all the PGI breads is predominantly made by hand, especially the steps concerning the shape, size and decoration. In some cases, in order to preserve the traditional process, the use of modern bakery equipment is discarded for certain elaboration steps. For example, "pan de Alfacar" discards the use of proofers for the final fermentation of the bread. Interestingly all the breads are baked in refractory ovens, although oven format or baking step may differ from one bread to others.

The PGI breads also have some similarities in shape and weight, with some particular variations. Big loaves are described in all the PGI, and in some cases smaller shapes like buns, baguette-shaped and ring-shaped loaves. This could be explained by the historical consumption of bread, especially at times when the bread was not baked every day and it was distributed along a wide area, mainly in rural environments (shepherds, farmers). Therefore, a big bread loaf has advantages in these cases aiming to maintain the freshness and extend the shelf-life of the products.

Another important point among all the PGI described is the use of particular ingredients. The PGI from Galicia ("Cea" and "Gallego") makes special emphasis on the flour used, that must be local varieties. The particularity of "pan de Alfacar" is focused on the water used, that must proceed from a specific aquifer from the mountains of Sierra Nevada. All the Spanish PGI breads are made with sourdough, although the sourdoughs mentioned in these documents are not well defined. Recently the sourdough has been described as the pre-dough composed by flour of any cereal and water that has spontaneously fermented by wild yeasts and lactic-acid bacteria. Its pH must be lower than 4.2 and at least a titratable acidity of 6 (mL of NaOH 0.1 N to neutralize 10 g of dough) (RD 308/2019 2019).

The PGI breads must be identified for the final customer in the selling points. This can be done by regular labelling and/or special logos or marks in the bread. For instance, the "pan de Cruz" must be marked with small perforations showing the traditional cross and a number in the loaf itself. In all the cases, the PGI establishes a control authority in order to ensure the fulfilment of the characteristics described for each speciality.

Table 16.2 Summary of the bread characteristics and process described in the corresponding PGI's

Bread	Date	Shape	Weight (kg)	Crust	Crumb	Flavour	Ingredients	Primary fermentation	Resting time	Forming	Final proofing	References
"Pan de Cea"	2005	Double length than width, rounded, central crossed cut	0.5–1.0	1 mm, hard, crusty, forming layers, dark golden	Creamy, irregular cells, spongy and firm	Toasted crust flavour, intense wheat taste	50% local wheat flour (Galicia), maximum 0,3% yeast, old sourdough	45–60 min, covered	2–3 re-kneading every 30 min	n.d.	n.d.	Publication (2004/C 98/09) (2004)
"Pan de Cruz"	2007	Rounded loaf	0.115–0.85	1–2 mm, soft and crusty, golden to brown	White, soft, spongy, without cells and "cotton like" aspect	Toasted crust flavour, slightly sweet and cereal flavour	W = 140–200, P/L = 0.5–1.0, pH 5–7, 40–50% hydration, 1.8 g/100 g salt, 15–25% sourdough, 1.8–2.2% yeast, additives authorized	No	No	Handmade, in circle	Room temperature, forming skin, 26–30 °C, 40–45% RH, 80–140 min	Publication (2008/C 324/12) (2008)

(continued)

Table 16.2 (continued)

Bread	Date	Shape	Weight (kg)	Crust	Crumb	Flavour	Ingredients	Primary fermentation	Resting time	Forming	Final proofing	References
"Pa de Pagès"	2012	Rounded loaf	0,5–1,0	Thick, brownish colour, cracked	White, irregular big cells	Slightly acidic, intense aroma and taste	W = 150–240, P/L = 0.4–0.6, 60–70% hydration, 1.8 g/100 g salt, 15–20% old sourdough, maximum 2% yeast, additives authorized	Minimum 15 min	Minimum 15 min at room temperature	Handmade	Minimum 3 h	Publication (2012/C 128/09) (2012)
"Pan de Alfacar"	2015	Variable (bun, ring-shaped, loaf)	0.08–1.0	Thick, golden, without flour, shinny and smooth	Flexible, soft, creamy white, irregular cells	Acidic aroma	W = 110–150, P/L = 0,3–0,6, spring waters, 55–62% hydration, min 10% old sourdough pH 4–6, max 3% yeast, 1.8 g/100 g salt	5–20 min	Minimum 15 min at room temperature	Handmade	1–2 h and no use of fermentation chambers	Publication (2012/C 128/09) (2012)

"Pan Gallego"	2019	Variable (loaf, ring-shaped, baguette, flat)	0.25–1.5	Golden to dark brown, thick, crusty and hard	Creamy white, spongy, irregular cells	Intense, aromatic, slightly acidic	Minimum 25% local wheat Callobre and Caaveiro, 75% soft water, 15% old sourdough, 1,5% yeast	Minimum 60 min, cold storage allowed	Optional	Handmade	Optional	Comission Implementing Decission (2019/C 243/03) (2019)

W flour strength index, *P/L* ratio resistance/extensibility, *RH* relative humidity, *n.d.* not declared

4.1.1 "PAN DE CEA"

The "Pan de Cea" (Fig. 16.2a, b) was the first bread to be included in the Spanish PGI breads, in 2005 (Publication (2004/C 98/09) 2004). This bread is specifically made in the village of San Cristovo de Cea (Galicia), in the north of Spain. This village has a long baker tradition, with the first document mentioning the bakeries of Cea dating from s.XIII describing the importance of the ovens and mills for the bread production process in this village and for centuries, the main activity of the village has been focused on producing flour, baking and distributing bread for the nearby population.

One of the peculiarities of this bread is the flour required to bake it, at least 50% of it must be Galician flour, with the characteristic of plain flour. Interestingly, it is also specified a maximum yeast level of 0.3% that is quite close to the level specified in the recent Spanish legislation for sourdough bread (RD 308/2019), even if

Fig. 16.2 "Pan de Cea". (**a**) detail of the loaves into the traditional oven while baking; (**b**) finished loaves. (Pictures courtesy of "Consello PGI Pan de Cea" 2020). (**c**) Traditional oven for baking "Pan de Cea"; 1: "capoeira" (roof), 2: "falsa cúpula" (false dome); 3: "capela" (chapel); 4: "Tornafumes", "chapilé" or "ucheira" (eave); 5: "Boca" (inlet); 6: "burato" (fire chamber); 7: "Lareira" (counter); 8: "Fornalleira" (ash deposit); 9: "Lar" or "lastro" (oven surface)

this PGI was published 14 years before. Leaving the dough also requires sourdough defined as "old dough".

The crumb is creamy coloured, with not very abundant irregular cells, fibrous and firm. The crust is about 1 mm, described as hard, laminated, golden to brownish colour and toasted taste. The shape of the bread must be double the length than the width, rounded, with a cross slash in the middle, named "fenda". The weight of the pieces can vary from 500 to 1000 g (Publication (2004/C 98/09) 2004).

The process to obtain the Pan de Cea is well described. All the steps have names in the local language, like "durmi-lo neno" (fermentation), "tasar" (division) or "tendas" (folding). It starts with a long kneading, from 45 to 60 min, followed by a first fermentation of the same duration, covered with a cotton cloth. Then, the dough is divided in the desired weight and folded several times to provide the dough with a better structure. This step is repeated 2 or 3 times depending on the characteristics of the dough, leaving the dough rest for 25–30 min between each fold, while fermenting. Before baking, a cross-cut must be done, creating the "fenda". The oven must be heated by plant-based combustible. Each loaf must be baked for a minimum of 120 min after the bread is finished, and cooled down at room temperature for at least 1 h.

The traditional ovens (Fig. 16.2c) are circular shaped, heated with wood and, made of granite, although it can be substituted by any refractory material that ensures the homogeneity of the temperature in all the inner volume of the oven. The dome of the oven is half-spherical, called "capilla" (chapel), should have a maximum diameter of 230 cm.

4.1.2 "PAN DE CRUZ"

The PGI "Pan de Cruz" (Fig. 16.3a) was published in 2007 (Publication (2008/C 324/12) 2008). This kind of bread is not linked to a single village, but a whole region in the inland of the country called Ciudad Real (Fig. 16.1). The baker tradition of this region is well documented especially in the nearby of the villages of Almagro, Carrión de Calatrava and Manzanares, and it was first mentioned in a document of 1273 by king Alfonso X. The importance of bread in this land is closely linked to the agriculture and production of cereals for animal feeding but, especially, wheat flour for bread making. Since this bread has a long shelf life, it was very appreciated among the rural population, that had to spend several days in the fields and mountains and bread was one of their main foods. Indeed, the Pan de Cruz is not only used as a side food but also as an ingredient for other elaborated dishes, as "migas" (a dish based in the crumb of bread) or "pellas" (a mixture of egg, spices and breadcrumbs) (Publication (2008/C 324/12) 2008).

The main ingredients for the production of this bread are well described (the strength of the flour (W index) must be between 140 and 200 and a ratio resistance/extensibility (P/L index) of 0.5–1.0), although the geographical origin of the flour is not specified, it must present a. This bread has a low hydration level, 45–50% (i.e., 40–50 L water for 100 kg of flour) and the leaving of the sough requires 15–25% of

Fig. 16.3 (**a**) "Pan de Cruz". (Picture courtesy of "Panaderos Artesanos" J. Sanchez 2020). (**b**) "Pa de Pagès". (Picture courtesy of G. Crespo from "Fleca Balmes" 2020)

sourdough and 1.8–2.2% yeast. The sourdough is defined as the "natural yeast" present in a piece of dough of the previous day. The additives in this PGI are authorized following good manufacturing practices. It worth to mention that the pH of the crumb of "Pan de Cruz" is detailed in its PGI and it must be between 5 and 7.

"Pan de Cruz" is shaped in a rounded loaf of various weights and sizes of the finished breads, from 115 g – 8 cm diameter the small bun to 850 g – 29 cm diameter the biggest loaf. Its crumb is light white, spongy and, soft, without big cells and cotton-like aspect. The crust is soft but crusty in mouth, with colour from golden to brown. The taste of this bread is toasted for the crust and slightly sweet and cereal flavour for the crumb. The loaves must be acceptable for consumption within 6 or 7 days after production.

One of its peculiarities is the low hydration of the dough, resulting dough is quite hard, and therefore the kneading has to be mechanical, followed by a refining process also called "sobado". The dough is forced to pass through two tight cylinders until the texture is fine and elastic and it is immediately divided into pieces according to the desired weight, from 150 to 1000 g of dough in the shape of a handmade rounded loaf, thicker in the centre. The pieces are then fermented for 80–140 min at room temperature and humidity (26–30 °C and 40–45% RH), in order to form a thin skin. Before baking the pieces, the baker cuts the surface in the shape of a cross that gives the bread its name. Additionally, the loaf is marked with several punctures in a shape of the traditional Calatrava cross. The baking must be done in a refractory oven in two phases, 15 min at 250 °C followed by 15–35 min at 200 °C (Publication (2008/C 324/12) 2008).

4.1.3 "PA DE PAGÈS"

The production of "Pa de Pagès" (Fig. 16.3b) refers to a whole region in the north-east of Spain, Catalonia. Its whole name is "pa de pagès català", meaning "Catalonian farmer's bread" making a clear reference to the traditional bread that was elaborated during centuries by the farmers and, people living and working in the field. The oldest historical reference of this bread is not written, but painted, representing these rounded big loaves in mural paints of Pia Almonia (Lleida, XIV–XV c.). Later, in the early twentieth century, some other written documents linked the production and commerce "Pa de pages" to the region of Catalonia. The traditional process of bread making of "pa de pagès" has been transmitted orally from generation to generation, until the publication of its PGI (Publication (2012/C 128/09) 2012).

Visually, this bread is a rustic rounded loaf, with a cracked brownish crust. The crust is crispy and toasted flavoured, whilst the crumb is white and presents big irregular cells. Their taste and aroma are intense and slightly acidic. The weight of the loaves ranges from 500 to 1000 g, with a natural opening in the top. The flour used for this bread must have a W and P/L indexes of 150–240 and 0.4–0.6 respectively and the hydration of the dough should be between 60% and 70%. For leavening the dough, 15–20% of sourdough and a maximum of 2% of bakery yeast (*S. cerevisiae*) are needed. The sourdough specified in the PGI corresponds to a piece of "old dough" from the production of the previous day, back slopped at least once before bread production with flour, fresh water and, optionally, salt. After kneading, it takes place the first fermentation of at least 15 min. This time can vary according to the know-how of the baker. The division and rounding of the dough can be made both manually or mechanically. Then the pieces rest at room conditions for 15 min to make the dough more manageable before the final shaping. It is specified that the last shaping step, also called "fruñido", has to be handmade. It consists of forming a ball having the folds in the lower side. The pieces are then fermented during at least 3 h. Right before introducing the bread into the oven, the loaves are turned upside down, leaving the folds in the top, where the bread will break the crust while increasing the volume. The bread should be baked in a refractory oven at temperatures ranging from 180 to 230 °C.

The finished loaves are presented to the final customer in non-portioned pieces, in paper bags or other sustainable or biodegradable material. Interestingly, the PGI specifies that the "pa de pagès" loaf can only be sliced if the customer requests and each bread slice receives the name of "llesca" (Publication (2012/C 128/09) 2012).

4.1.4 "PAN DE ALFACAR"

The "Pan de Alfacar" (Fig. 16.4a) PGI (Publication (2013/C 70/13) 2013), similarly to the "Pan de Cea", is limited to a small geographical area. In this case, the "Pan de Alfacar" bread is made near Granada, in the villages of Alfacar and Viznar (Andalusia) in the south of Spain. The bread industry of the region increased significantly after the conquest of the kingdom of Granada by the Catholic Kings. The

Fig. 16.4 (**a**) "Pan de Alfacar", different shapes. (Picture courtesy of J. R. Caballero from Alfacar Bakery 2020). (**b**) "Moña" (loaf) and "Rosca" (ring-shaped) formats of "Pan Gallego". (Picture courtesy of "O Pan de Leis" 2020); (**c**) Detail of the crumb of baguette-shaped "Pan Gallego". (Picture courtesy of G. Moscoso "panadería Da Moa" 2020)

increase of the catholic population together with the Muslims already established in the area resulted in a higher demand for food and bread as described in documents dated from 1571. The consumption of "Pan de Alfacar" in Granada continued being very popular with 7000 kg/day in 1950. To ensure this bread supply, in 1973, the bakers from Alfacar and Viznar created a cooperative society with 15 bread shops in Granada and at the moment of the publication of this PGI, the production of "Pan de Alfacar" was 2000 Tm of bread per year (ca. 5500 kg/day) (Publication (2013/C 70/13) 2013).

The "Pan de Alfacar" is strongly linked to the environment of the region as the most important ingredient described for its production is water from the spring of Alfacar. This spring is placed in the Natural Park of Sierra de Huétor (800–1500 m above sea level), close to Sierra Nevada. The geology of the zone provides the water with a specific mineral profile, described in the PGI document that contributes to the texture of the dough and the flavour of the bread. Moreover, the natural environment has its microbiota, that is transferred to the bread from the water, surfaces and bakers living in the region.

This bread can be presented in various shapes and weights: 80–250 g bun, 250–500 g ring-shaped or 250–1000 g loaf. Diameters of these shapes are also described in the PGI. The crust is thicker than 1.5 mm, glossy and golden, and the crumb is creamy white, flexible, soft, with abundant irregular cells, and slightly acidic aroma. As previously mentioned, the most relevant ingredient to bake "Pan de Alfacar" is water from the natural water spring of Alfacar described as hard water with contents of calcium ranging from 200 to 250 mg/L CO_3Ca. This water is added to the flour in a proportion of 55–62 L per 100 kg of flour, resulting in a semi-soft dough. The wheat flour used is weak (W 110–150) and extensible (P/L 0.3–0.6). For leavening the dough a maximum of 3% yeast (*S. cerevisiae*) and a minimum of 10–25% sourdough should be added. Similarly to other PGIs, the sourdough is a portion of the dough of the day before that must be also made with water from the spring of Alfacar. The backslopping of the sourdough receives the name of "recentao".

After the mechanical kneading, the dough rests for 5–20 min. Then it is divided and rounded either manually or mechanically, and rest for at least another 15 min. Next, each piece is hand shaped in bun, ring-shaped or loaf shape. The buns are tapered and its edges are known as "tetas". The ring-shaped or "roscos" are ellipsoidal, and sometimes they can show the junction, called "suegra". The loaves are rounded and flattened manually and show a squared mark or "pintao". Then the dough pieces are fermented for 1–2 h at room conditions. The use of proving cabinets is explicitly forbidden, therefore, the bread must be fermented in the bakery itself, choosing the better place according to its room temperature and climate conditions. The dough pieces can be covered by a cloth, called "lonas", to preserve the humidity. Once the dough is completely fermented, the baker applies some cuts in the surface. The cuts should be straight and deep to contribute to the correct volume development of the bread. A refractory oven must be used to bake the "Pan de Alfacar" bead, and it is recommended to bake it from the second batch of the refractory oven and not in the first one to ensure constant and homogeneous temperature conditions inside the oven. The baking time ranges from 25 min for the small buns to 50 min to bigger loaves, at temperatures from 200 to 230 °C (Publication (2013/C 70/13) 2013).

4.1.5 "PAN GALLEGO"

This PGI was registered in the European Commission in December 2019 (Comission Implementing Decission (2019/C 243/03) 2019), but the text describing its production conditions, described below was published in July 2020 (ORDEN 2020). Therefore, the date considered for the publication of the PGI "Pan Gallego" is 2019 (Table 16.2).

The "Pan Gallego" bread, also named "Pan Galego", can be found in the whole region of Galicia, in the north-west of Spain. Galicia is well known worldwide for its cultural heritage, especially, the "Camino de Santiago" (Way of St. James). The *Codex Calixtinus* is the oldest manuscript of the *Liber Sancti Jacobi* (twelfth century) that describes the life and acts of St. James and, it was used as a guide for pilgrims walking the “Camino de Santiago”. “Pan Gallego” is referenced in the *Codex Calixtinus* and some pilgrims cited this bread as part of the gastronomy of Galicia (Guillaume Manier, eighteenth century). “Pan Gallego” is represented in different paints of the nineteenth century as a good example of the importance of this bread in the region. Although initially, the “Pan Gallego” bread was elaborated with rye or corn, the bread described in the PGI is mostly baked with wheat flour. This change in the cereals of “Pan Gallego” was motivated for the higher status of white bread, especially after the civil war in Spain, and the fact that climate in Galicia favours special crops of wheat and will have an impact on the bread produced (Comission Implementing Decission (2019/C 243/03) 2019).

The shape of “Pan Gallego” is variable. It can be found in form of loaf, ring-shaped or baguette (Fig. 16.4b, c), at weights from 250 g, the smallest baguettes and ring-shaped, to 1500 g, the biggest loaves. The loaves present a typical “moño” or bun in the top, and ellipsoidal shape, but can be also rounded-flat. The ring-shaped breads are irregular, rustic and slightly flat. The baguette-shaped bread is quite wide compared to a French baguette, and length up to 60 cm. The crust is golden to dark brown, crispy, very thick (1–3 to 3–10 mm according to the format) and hard. The crumb is creamy white, spongy and irregular cells. It has an intense wheat flavour, very aromatic, and mildly acidic. As the crust is quite thick, it protects the crumb from dehydration and, therefore, the crumb remains tender for a long time, giving this bread a considerable long self-life as this bread is normally consumed 24–48 h after production.

As mentioned before, this bread is mainly made with wheat flour, but following the PGI indications, it must be used at least 25% of local wheat flours such as the varieties Callobre and Caaveiro. These flours are medium-weak, with W index of 100–200 and P/L of 0.25–0.7. The resting 75% of the flour can be from other wheat varieties or cereals and the water added must be weak, typical from Galicia. The hydration of the dough must be at least 75%, being the “Pan Gallego” and for leavening the dough, the sourdough, known as “formento” or “lévedo”, must be added in at least a concentration of 15% (15 kg of sourdough per 100 kg of flour). Similarly to the other bread PGI, the sourdough used is strictly a portion of the dough used the day before, backslopped with water and flour before baking the bread. No more controls are specified for the sourdough, as it happens in the current Spanish legislation. The dough kneading could be manual or mechanical, and after this step, the dough is fermented for at least 60 min. Then the dough is divided according to the desired weight, avoiding degassing the dough. Pieces are shaped manually and its fermentation is optional. Therefore, there are no specific guidelines for this step. “Pan Gallego” must be baked in refractory ovens, at temperatures of 180–270 °C using as a reference baking time 60 min for pieces of 1 kg (Comission Implementing Decission (2019/C 243/03) 2019).

5 Current Status and Future Trends of Spanish Bread Market

Spain is one of the European countries bathed by the Mediterranean Sea and, thus, during decades Mediterranean Diet (MD) has been the usual dietary pattern (Partearroyo et al. 2019). A high number of studies have demonstrated that MD is associated with reduced risk factors for cardiovascular disease and it is thus recognized by the World Health Organization (WHO) as a healthy and sustainable dietary pattern and as an intangible cultural asset by the United National Educational, Scientific and Cultural Organization (UNESCO) (Partearroyo et al. 2019). MD nutritional recommendations are given in the form of a pyramid, helping people to make good dietary choices. Within the food recommended by MD, bread and cereals are at the base of this pyramid representing one of the staple foods. In particular, dietary guidelines recommend eating 4–6 servings of cereals as bread, pasta, rice or couscous, preferably as whole grain (D'Alessandro et al. 2019).

Despite the benefits derived from following a MD and the linkage that this dietary pattern has to the Spanish country, several indexes point out dietary habits amongst the Spanish population seems to be inadequate and globally moving away from the traditional MD. Food habits and consumption in Spain have experienced a significant change in recent years, leading to a less varied food choice and a tendency towards an increasingly "westernized" diet with a higher intake of animal products instead of vegetal products, such as legumes, nuts, fruits, vegetables and cereals (Partearroyo et al. 2019). Reflecting this shift in dietary habits, a continuous decrease in bread consumption has been observed. According to the Spanish Ministry of Agriculture, Food and the Environment of Spain, from 2001 to 2019 bread intake has been reduced from 51 to 31 kg/person·year representing a drop in bread consumption by 40% approximately (MAPA 2018).

Several factors could be accountable for this drop. In the first place, as mentioned before, Spanish food habits have moved from MD to a more westernized diet reducing the intake of cereals among fruits, vegetables, legumes and nuts (Ruiz et al. 2015). In addition, there is increasing popularity of gluten-free diets and, therefore, bread-free diets (Kim et al. 2016). According to market research, consumers without celiac disease purchase the vast bulk of gluten-free products, because they perceive a gluten-free diet as healthier and helpful for weight loss, despite evidence as such (Reilly 2016). Moreover, there is a generally recognized idea that bread is a high energy food causing weight gain. Therefore, bread is one of the first food disappearing from the shopping cart when consumers decide to adhere to a losing weight diet. Finally, bread's nutritional and sensory quality has experienced a decrease in the last decades at the expense of higher production rates and lower production costs. Consequently, bread perception by Spanish consumers has been devalued and nowadays, bread is considered a dispensable side food rather than a basic component of the daily diet.

In an attempt to recover bread quality and consumption, the Spanish Government and baker guilds have taken several actions. Among them, PGI have been already described in the previous sections. Additionally, there are a recently approved bread quality legislation (RD 308/2019 2019) and a new vocational training degree in artisanal bakery and pastry (RD 482/2020 2020).

The high number of modifications in bread regulation together with the bread industry evolution and new market trends resulted in a new bread Technical-Health regulation passed by the Spanish Government on April 2019 (RD 308/2019 2019). The new regulation aims to create a framework of quality regarding the production of bread, adapting to the current market demands and giving greater security to the consumer by addressing the bread definitions according to their production processes. Therewith, this regulation seeks the promotion of bread with better nutritional attributes within a healthier dietary pattern. One of the main changes this regulation brings is the extension of the regular bread category. Regular bread is considered a staple food consumed on a day-to-day basis and, it is thus minimum taxed. Changes in consumer trends lead to include in this category bread manufactured not only with wheat but also with other cereals, including wholemeal cereals. Spanish Government aims, through this action, to increase bread consumption by reducing taxation to a wider range of bread. RD 308/2019 also regulates terms habitually used for advertising and highly valued by consumers as wholemeal bread or sourdough bread. The new definition of wholemeal bread includes bread elaborated exclusively with wholemeal flour, meanwhile, years ago wholemeal bread could be any bread with a percentage, high or low, of wholemeal flour in its recipe. Currently, a bread elaborated with a proportion of wholemeal flour should indicate the percentage of this flour contained in the bread. Therefore, this new definition clarifies to the consumers the characteristics of the bread they are consuming. It also pursues to promote the consumption of whole grains that have shown to play a beneficial role in the prevention of several diseases such as obesity, cardiovascular disease and certain types of cancer (Aune et al. 2016).

Sourdough bread popularity within Spanish consumers has increased in the last years. Sourdough bread is perceived as a more traditional bread of higher quality and more nutritional than bread elaborated with baker's yeast. Moreover, a quite large number of studies demonstrate that sourdough produces a better nutritional profile of bread since it lowers the glycaemic index by reducing starch digestibility, increases protein digestibility and reduces more efficiently phytate content in whole wheat bread (Corsetti 2013; D'Alessandro et al. 2019). Therefore, bakers use the term sourdough as a claim to highlight the quality of their bread. However, before RD 308/2019, most of the bread produced in Spain did not use natural sourdough as main fermentation agent and bread manufactured with inactivated sourdough or yeast dough were usually claimed as sourdough bread. Now, to be labelled as such, bread can only be fermented by Type I sourdough and its portion must not be below 5% of total weight and optional addition of baker's yeast in a proportion lower than 0.2%. In addition, bread before and after baking should have a pH below 4.8 as indicator of acidic fermentation by the sourdough , and the benefits derived from sourdough bread consumption (De Vuyst and Neysens 2005). Another important modification of the RD 308/2019 is the regulation the salt concentration in regular bread. Within the "Nutrition, Physical Activity and Obesity Prevention" framework from the Spanish Agency for Food Safety and Nutrition, this regulation limits the salt concentration to a maximum of 1.31 g or 1.66 g per 100 g of bread (value depending on the salt analysis method).

Evolution of the market, new production technologies and novel bread quality regulations trigger a more skilled baker. A large number of consumers demand, nowadays, a higher quality bread, more nutritious and with better sensory attributes. In consequence, the Spanish Government has approved a new vocational training degree in artisan bakery and pastry, that completes the existing degree in bakery and pastry (RD 482/2020 2020). This degree aims to quickly meet innovations in the production process and new market trends. More specifically, it involves a deeper knowledge in the production of traditional bread and pastry made with sourdough and/or pre-dough and different cereals and pseudocereals (RD 482/2020). Thanks to this new degree, bakers will be able to complete their training in order to meet the RD 308/2019 requirements regarding certain types of bread and, to offer better quality bakery products.

In addition to the Spanish Government commitment to promote the production and consumption of bread within a healthier MD diet, there is a clear endeavour to improve the sustainable development of the bread sector. Sustainability is one of the top-5 Food Trends in 2020 and 2021, hence Spanish consumers demand more and more frequently organic and local food that involves a smaller human print in the environment (Calicioglu et al. 2019). According to the Spanish Wheat Quality Survey 2019 (AIT 2020), in 2019 Spain produced and imported 4.63 and 6.4 T of wheat respectively. These data are in line with data from the Spanish Ministry of Agriculture, Fisheries and Food that show a clear cereal dependency from abroad in the last 8 years (MAPA 2020). Wheat and cereals imported generate a huge impact on the environment due to the CO_2 print. To turn this trend, the government, producers and consumers have started to investigate and innovate in order to improve agriculture practices and performance, including new fertilization techniques, soil management or Internet of Things (AETC 2020). Moreover, there is an increasing interest for recovering ancient and local wheat varieties and promote the use of other cereals in the bread production among other food products. Promoting local varieties involves crops adapted to the environment and thus more resistance to its changes, that usually results in fewer fertilizers and lower water consumption (Calicioglu et al. 2019). In addition, using a wider range of cereals foster crop biodiversity, an important point for agriculture sustainability (Calicioglu et al. 2019).

6 Conclusions

Bread in Spain is closely linked to its population subsistence and intimately connected to its tradition, social practices and religion. Bread summarizes different types of knowledge, from agricultural practices and technological processes to cultural heritage. Agricultural practices reveal the great cereal diversity and importance that these crops had and still have for the Spanish population. This is reflected by the more than 9000 varieties of cereals and pseudocereals registered in the CRF and probably used for bread production. On the other hand, the particular geographical characteristics, climate and crops available in each Spanish region have determined a high diversity of technological processes. These processes have been inherited across generations giving a great variety of breads from region to region made with different ingredients, mixtures and, forms. Going from the North to the South of the Peninsula it can be found breads with a soft and juicy crumb and a thick and crusty crust in the Atlantic area and the North Coast, such as “Gallego” bread, “Cea” Bread, “Bolla” or “Mollete de Santiago”, that differ from breads produced in the centre of the country that have a consistent crumb, like “Lechugino”, in Extremadura and “Pan de Cruz” in La Mancha. In the south, breads like “Mollete” from Antequera (Andalusia) are, by contrast, characterized by a juicy crumb with a soft crust. In addition to these specialities, in the Ebro Valley situated at the northeast of the Peninsula, breads are usually elaborated with an open and spongy crumb like “Taja” and “Cabezón” in Navarra, “Cinta Bread” and “Cañada” in Aragón and, “Pa de Pages”, “Llonguet”, and “Pa de Crostons” in Catalonia.

Despite the relevance bread has had trough Spanish tradition, several factors have contributed to a decline in bread diversity, quality and consumption. Bread-making mechanization reduced the cereal diversity substituted by bread wheat (*Triticum aestivum*) with good machining properties. Rural flight during twentieth century rapidly increased urban areas and hence, the need of high volumes of bread production at low operation costs. Both factors resulted in a shift from bread tradition in terms of less bread diversity and a loss of cultural heritage that impact, directly on bread quality and, indirectly on the progressive decline of bread consumption. In consequence, both, baker’s guilds and Spanish Administration, have launched several attempts to maintain and recover bread tradition and quality. PGIs and other regional trademarks like “C’Alial”, “Tierra de Sabor” or “Euskolabel” aim to promote and protect names of quality agricultural products and foodstuffs through the standardization and regulation of their production process. Spain has five PGIs regarding bread-making process approved from 2005 to 2019 that have a key role preserving the know-how inherited and promoting traditional breads. New bread technical-health regulation was recently approved on 2019 in order to adapt the bread production to the current market demands and give greater security to the consumer. This regulation addresses the bread definitions according to their production processes and establish bread requirements to offer products with better nutritional attributes. Therefore, the PGI breads and regional trademarks should adapt their texts to the current legislation, or at least, this should be considered in the next bread technical documents that may be published in future. Finally, to meet new market trends and production technologies Spanish Government has approved a new vocational training degree in artisan bakery and pastry that completes the existing degree in bakery and pastry offering bakers a deeper knowledge.

Summarizing, Spain has a long and rich bread tradition due to its geography, history and cultural heritage. However, lifestyle changes of Spanish population have shifted bread consumption to a more standardized bread, losing tradition and, gradually, bread consumption. In the attempt to recover and maintain this bread heritage, recent initiatives have been launched.

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Chapter 17
Traditional Turkish Bread, the "Tandır Ekmeği"

Raciye Meral, Yagmur Erim Kose, Elvan Ocak, and Fatih Ozogul

1 Introduction

Bread is an important part of a Turkish diet and it is considered sacred in Turkey. According to the Guinness world records book, as of 2000, Turkey has the largest per capita bread consumption with 199.6 kg (Boyaci Gündüz and Cengiz 2015). The breads produced by each region with their associated production techniques have strong cultural value. There are many different types of bread in Turkey (Büyükzeren 2019) and economic and cultural differences of people have an important role in the formation of different types of bread. The Anatolian people, whose economic activity is based on animal husbandry, with a nomadic or semi-nomadic lifestyle, consumed unleavened or leavened bread. Turkish bread can be classified into four major types according to: (1) type of flour: wheat bread, maize bread, etc. (2) method of baking: oven-baked, hot stone-baked, tandir baked, etc.; (3) Leavened or unleavened: lavaş, bazlama, yufka, etc. (4) shape of bread: loaf bread, pan bread, flat bread, etc. (Koca and Yazıcı 2014).

Flat bread is produced as in many countries of the world especially in Turkey, the Middle East, and North African countries (Hashmi 1996). Flat bread was the first baked grain product made and consumed at the beginning of human history and there are more than 60 types of flat bread in different countries around the World (Koocheki et al. 2009). Nowadays, flat breads are probably the most produced and

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consumed bread type in the world. Traditional flat bread is consumed by many people in the Middle East, North Africa, the Indian subcontinent, Central America, China, and Europe. Flat bread is an important food component in most of these countries. Today, 1.5 billion people consume traditional flat breads (Quail 2015) named as Tandir bread, Tandoori, Lavaş, Lahvosh, Lavas, Roti, Taftoon depending on the region of procedence (Hashmi 1996). Flat breads can be classified into 2 classes according to their shape as a single-layer and double-layer. Single-layer bread is classified into fermented and non-fermented sub-groups. According to this classification, the breads barbari, gomme, lavaş, tandoori, and pita are classified as single-layered flat bread; while yufka, and parotha unleavened single-layered flat bread (Kumar 2015).

TB is in the flat bread group and a traditional bread type produced and consumed in Turkey, especially in the Eastern (Van, Muş, Hakkari, Erzurum, Elazığ, Malatya) and Southeastern Anatolia Regions (Urfa, Diyarbakır). The product is a long, oval, and flat form and it has an elastic structure (Borlu 2009). The name of the bread relates to its baking process in a tandır (Hashmi 1996) a traditional bakery and cooking oven used for baking bread and cooking meals in Eastern and Southeastern Anatolia (Al et al. 2010; Akçay et al. 2008). Although the tradition of tandır cooking has a very long history and past in Eastern Anatolia, especially in the province of Van, the numbers of tandır have decreased due to the urbanization and industrialization of the country and the mechanization of this bread production The tradition of tandır cooking which has been moved from rural areas to the cities and the TB, which was previously produced and consumed only in rural areas, is now being produced and consumed in cities, being consumed in cafes and restaurants alongside the meals. There are several reasons for the increased consumption of TB: (1) as flours having a ash content are generally used in bread-making, TB is good sources dietary fibre, antioxidant sources and phenolic compounds (Jooyandeh 2009). (2) The handling of the TB dough is easier, as the gluten amount and gluten strength of flour used in TB making are lower than that of flour used in a loaf bread. (3) The production cost of TB is cheaper compared to the loaf and pan bread, as the formulation of TB is simple with few ingredients needed for its production. (4) mould spoilage in TB occurs at a lower rate than in loaf bread, thus TB can be stored for a longer period compared to loaf bread. (5) A higher bread volume is not necessary for TB. The addition of several fibre sources such as wheat bran, whole-wheat flour e.g to TB formulation does not cause any adverse effect on consumer acceptability. (6) The baking time of TB is very short. For all these reasons, there is an increased relevance of TB and thus, there is a need for reports detailing the economic and social importance of TB in the eastern Anatolian culture. Within this chapter, the main ingredients used in bread and detailed and illustrated production steps as well as importance of the tradition of tandır cooking and the significance of the socio-cultural of tandır are reviewed.

2 Brief Historical Overview

The archaeological excavations in Eastern and Southeastern Anatolia provide various information about the use of tandır ovens. It is claimed that the earliest information about the use of the tandır oven in Pulur (southwest of Erzurum city), where is showed that the tandır tradition has a history dating back to the Late Chalcolithic period (Kosklu 2005). However, some researchers have shown that there are not yet any data on the existence of the tandır ovens during the Late Chalcolithic and the Early Bronze Age periods (Çilingiroğlu et al. 2009). Archaeological studies in several excavation centres like Kenan Tepe and Salat Tepe in Diyarbakır stated that the tandır data started in the Middle and Late Bronze Age (Ökse 2015). Moroever, a tandır-like oven was also found in the Late Bronze Age at Türbe Höyük in the Siirt region (Sağlamtimur and Ozan 2007).

On the other hand, there is no data on the existence of tandır oven in the Eastern Anatolia until the Iron Age. Researches proved that ovens and furnaces were used more intensely than tandır ovens in the Middle Iron Age of the Van region. However, the tandır oven located in the outer city of both Erzincan Altıntepe and Van Ayanis proves that the Urartians used this type of tandır ovens (Erdem 2013; Karaosmanoglu and Yılmaz 2013). Archaeological excavations demonstrated that tandır is one of the permanent architectural elements of the Middle Ages in Eastern and Southeastern Anatolia. The tandır ovens belonging to this period were discovered in Pulur, Dilkaya, Erzurum, and Ayanıs regions in Van. Especially the tandır oven which was discovered in Ayanıs was dated back to the 10th century AD and was well preserved (Erdem 2013).

According to archaeological data, the tandır tradition continues from the Middle Ages until today. Even today, the use of similar tandır ovens in Anatolian geography shows that this culture still continues to date. Travellers passing through these regions have drawn attention to the clay ovens found in many villages and towns. Especially in traditional communities, tandır ovens are found in almost every street, gardens, and street corners (Parker 2011). The ovens can be two main types namely summer and winter tandır. Winter ovens are usually found in the room called 'tandır house' (Köşklü, and Tali 2007), are fired by burning cattle dung, wood, gas, diesel, or coal (Çinal and Barın 2020). TB has an important role in Anatolian culture, especially people is living in rural areas. Tandır house is also a kitchen for these people, which constitutes the most important part of the old Eastern Anatolian houses, is used for many purposes such as resting, sitting, cooking particularly in winter season (Fig. 17.1). The climate characteristics, geographical features, economic conditions, and social life of Eastern Anatolia are effective in the use of tandır houses (Erdem 2013). Summer ovens are mostly just in front of the tandır house or in the garden but close to the house. These ovens are especially used in the hot sunny days. Tandır house is also an important architectural structure in the Eastern Anatolia Region like Erzurum, Van, Kars, Ağrı, Iğdır, Elazığ, Malatya, Muş and Bitlis (Köşklü, and Tali 2007).

Fig. 17.1 Tandir house. (Şahbağı-Van. Photo: by Nihat Işık)

3 The Manufacture of Tandir Ovens

The tandir oven, which continue to be manufactured and used in many villages in the Eastern and Southeastern Anatolia regions of Turkey. The manufacturing of tandir oven is a long and tiring process (Erdogmus 2018), which is usually constructed the period from April to October when the warm and dry weather is conducive to sun drying (Parker 2011). Quality production of the oven is very important so the tandır dough will adhere to the oven wall easily. For this reason, not every soil is suitable for the tandır oven, it must have a clay soil structure (Koca 2019). Therefore, the first and most important step in tandır oven production is finding suitable soil areas and moving tandir soil (clay) to the village (Erdem 2013; Özgür 2019). Although tandır production is known as an activity performed only by women, young men of the village also help them at this stage. They gather the clay from this suitable location and, using a rented tractor, intermittently transport large quantities of clay to the village for processing (Parker 2011). After the clay is obtained, this soil is sieved by women with a sieve made of wire (especially steel) material and kneaded by adding water. The kneaded clay is crushed with their feet strongly and left to rest for 24 h allowing the water in the clay to be absorbed and create a viscous material. This process continues until the rested clay reaches the desired consistency (Kosklu 2005). The following day, various additives are mixed to the rested clay and kneaded and crushed again using their feet to obtain the molding clay with a strong structure (Parker 2011). These additives show regional and periodic differences. For example, straw is used in Erzurum Şık Village and Van Ayanis Village (Kosklu 2005), while goat hair and salt used together with straw in Diyarbakır Çarıklı Village (Parker and Uzel 2007). However, residents of Ayanis and Şık Villages stated that in the past, they used goat hair or cow tail that is one of the local plants, as additives for preventing crack of strong clay structure (Kosklu 2005). The following step is the shaping of the tandir oven. Although the way of production varies according to many regions, the ring strip technique is generally used for giving the shape of tandır ovens. According to this method, an average of one meter

Fig. 17.2 A tandir oven produced in Van. (Photo: by Raciye Meral)

long strips is made with molding clay (Erdem 2013), and the circular shape is given with these strips for generally depth of about 150 cm and a diameter of 60 cm (Çinal and Barın 2020) for a tandır oven. Finally, the rim of the tandır oven is shaped and the production of the oven is completed by opening the air hole (ash removal hole) at the bottom (Parker 2011), which is called *külve* by rural people (Fig. 17.2). After the oven is shaped, the oven is sun-dried for two more days thus this drying step generally requires the production of a tandır oven in the summer months. After the tandır oven is dried, the inside of the tandır is polished to make it slippery and shiny. Stones or glass bottles are widely used for the polishing process until a shiny surface is obtained (Erdogmus 2018; Köşklü 2005; Parker 2011). After the tandır oven is ready, it is placed in the hole that is the opening on the floor. The space between the oven and the hole it is filled with materials such as pebble or adobe. Finally, the filling surface is covered and plastered with mud (Erdem 2013; Köşklü 2005; Parker 2011).

For the oven to be ready to use, the fire is burned inside in the tandır oven. The fire should not be too strong and should increase gradually with copious amounts of dung, straw, and small sticks to avoid damaging the oven's quality and performance. Moreover, melted tail fat is applied to inner surface of the oven to increase its performance and longevity (Erdogmus 2018).

If tandır ovens are used frequently, they can usually last two to three years. An over-use of the oven may damage the oven walls as these may become brittle and the bread dough starts to stick less to the oven wall. In such case, the dilapidated old tandır oven is removed, the new oven is replaced in the same hole, and the space between the hole and the oven is filled up again with the aforementioned materials (Parker 2011).

4 Types of Tandır Ovens

Although the tandır ovens work on the same principle, their sizes and shapes vary from region to region during the construction. For example, in some regions, the tandır oven is completely buried in the floor, while in some regions it is seated halfway. In some rural areas, the oven is even placed above the ground. Generally buried ovens were found in the Eastern Anatolia Region like Van (Türkoğlu 1969), Elazig, and even Western Iran.. The ovens in the Bismil, Diyarbakır are completely different and the oven is placed on the floor with a certain inclination instead of being buried in the ground (Parker 2011; Tkâcovâ 2013).

5 Socio-cultural Relevance of Tandır Ovens

Tandır ovens are widely used to make TB in many parts of rural Anatolia. These breads are baked in large tandır ovens by the women in the tandır house every week or every 10 days. Locals generally prefer to consume TB rather than loaves of bread from a bakery as villagers perceive that TB tastes better and it is cheaper, even if it is laborious to make compared to other bakery breads. They also believe that consuming this bread is a ritual or tradition (Bal et al. 2013; Parker 2011). About 1 h before starting to bake TB, a fire is lit in the tandır oven and the oven is heated. The wood or dung is used as fuel for this process. The inhabitants of the village of Ayanis stated that the dung (especially cattle dung) was used more widely in the past, but it is not the preferred option nowadays due to its bad smell and smoke (Erdem 2013). After the oven is heated, the bread dough (small balls consists of flour, salt, water etc.) is placed on a circular pillow called "tandır pillow" (in local language *mezertge* or *rapata*) (Fig. 17.3) (Tekin and Ceylan 2017) and it is adhered to the wall of oven by the pillow (Erdem 2013; Özgür 2019). In some regions, the

Fig. 17.3 The vehicle is used to adhere the dough for wall of tandır. It is called as *mezertge* or *rapata*. The metal plate called as "sac" in Turkey. (Erciş-Van, İskele-Van: Photos: by Raciye Meral)

doughs adhere to the wall of the tandır oven by hand instead of the pillow. Baked breads are again quickly picked up by hand. Approximately ten to fifteen TB can be cooked simultaneously.

The baking process is usually conducted in the late afternoon and so the TB is fresh for the dinner. This process is also a time of socialization for village women, young girls, and children. Especially in cold winter days, long conversations are held near lit ovens, children play and get warm (Karpuz 1993; Parker 2011). In the past years when families lived more crowded, the tandır house was also used as a living room to warm up or bedroom for young single men of the house. In winter evenings, a chair was placed on the tandır oven, a blanket was laid on it, and family members would gather around this cover and warm-up (Çilingiroğlu, et al. 2009). The same tradition existed in Aliabad Village in Iran region where was noted that a wooden mechanism called “kursi” was placed on the oven of the living rooms, and the family members were warmed here by laying a blanket on it (Kramer 2014). It is also known “tandır evi” (tandir house) as a place where folk tales and epics were told, poems were read on the long cold nights (Köşklü and Tali 2007).

6 Types of Tandır Bread

Tandir ovens have been mostly used for baking bread namely TB. However, there are some minor differences such as shape, thickness, fat content in different varieties of this bread. Studies related to the Ethnographic field conducted in Van, Diyarbakır, and Erzurum revealed that these varieties also have different local names (lavaş, taptapa, etc.) (Erdem 2013). The different varieties, composition and names of TB are described in detail below.

6.1 Lavaş

Lavaş bread is one of the single-layer flat breads leavened with sourdough or yeast (Zolfaghari et al. 2017a). Lavaş is a traditional bread type that is more common in Turkey, especially in the Eastern and Southeastern Anatolia Region. The product is a long, oval, and flat form and has an elastic structure. The thickness and length of lavaş bread vary between 2–3 mm, 35–50 cm, respectively. Freshly baked lavaş bread is soft, elastic, and pliable ; although they may become stale and firm within a few hours when kept at room temperature (Koocheki et al. 2009). The shelf life the bread is longer than loaf bread and other tandır bread due to its the lower moisture content (5–7%) and thus, this bread can be stored for up to six months (Faridi et al. 1982). The typical lavaş bread produced in Van, Turkey can be seen in Fig. 17.3. In addition, lavaş is baked by the aid of a metal plate or “sac” in Turkey and “saj” in

Palestine, Jordan, Lebanon, Syria, and Iraq, "sadj" in Sudan and Ethiopia (Pasqualone 2018) that can be seen in Fig. 17.3.

Lavaş bread is used for wrapping foods such as "Van otlu cheese", tomatoes, and cooked meat in the Van province due to its flexible, thin, and flexible structure. Therefore, it is also considered as a snack food.

6.2 Taptapa

Taptapa is a flat bread type with a formulation and production similar to that described for lavaş, although there are some evident differences in the appearance of the bread. Bread thickness varies between 2–3 cm and between 15–20 cm length. The baking time of taptapa is longer than lavaş as this bread is thicker and thus, the baking time of taptapa varies between 13 and 15 min. Taptapa is a bread type that is generally consumed at breakfast. In the Van province, it can be consumed with *cacik* (a kind of strained yogurt containing chopped parsley and dill) which is one of the indispensable items of the famous Van breakfast. Cacık and taptapa are the favorite items of people who likes Van breakfast. The taste of taptapa is more preferred comparing to lavaş, however the shelf life of taptapa is shorter than lavaş.

6.3 Çöçe

Çöçe is a type of tandır bread that is produced less frequently than lavaş and taptapa. This bread contains margarine and milk (see image of these breads in Fig. 17.4). A comparison between lavaş, taptapa, & çöçe can be seen in Table 17.1.

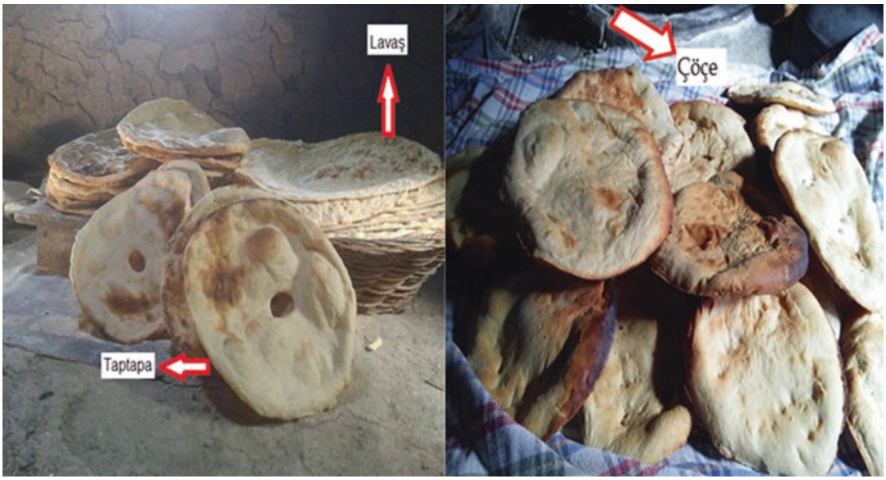

Fig. 17.4 Lavaş, taptapa and çöçe. (Şahbağı-Van. Photo: by Nihat Işık)

Table 17.1 The comparison of flat bread baked in Tandir

Bread type	Formulation	Size	Baking type	Baking time
Lavaş	Flour, water, yeast, and sodium chloride	Thickness: 2–3 mm Length: 20–30 cm	Tandir and sac	60–90 s
Taptapa	Flour, water, yeast, and sodium chloride	Thickness: 2–3 cm, Length: 15–20 cm	Tandir	13–15 min
Çöçe	Flour, water, yeast sodium chloride, fat, and milk	Thickness: 2–3 cm, Length: 15–20 cm	Tandir	13–15 min

Table 17.2 Basic TB formulation

Ingredients	Part (%) (based on flour weight)
Flour	100
Water	55–62
Active Yeast	2–3
Salt	1–1.5

In the old village weddings, when a man was getting married, breakfast was served to the guests to inform relatives and neighbours and Çöçe was one of the basic and unchangeable elements of this breakfast. A few days before the wedding, women would gather and burn the tandir and bake lots of çöçe. The process of Çöçe-making is a more complicated compared to that than lavaş and taptapa. There is fat in the çöçe formula and it is difficult for the dough to adhere to the wall of tandır due to its increased fat content. For this reason, especially çöçe-making is a job that requires more experience than lavaş and taptapa.

7 Ingredients for TB Formulation

Wheat flour, water, yeast, salt are used in traditional TB formulation. Also some of the additives used in the industrial bread-making process can be used in the TB-making. (Kamalabadi et al. 2019). Additionally, milk and margarine have been used in some tandir bread formulation such as çöçe. The formula for a typical tandir bread is summarised in Table 17.2.

7.1 Wheat Flour

Flour is a major ingredient in this bread formulation. It is a source of starch forming the bread structure together with gluten. Many chemical, biochemical and physical reactions occur during bread-making process and these transformations are significantly affected by the components of the flour (see Chap. 1 of this book). Besides, several additives are blended with wheat flour to produce the desired bread product (Goesaert et al. 2005).

Ash content (bran content) of flour is one of the important criteria determining the bread quality. TB is typically made from soft white wheat flour of high extraction rate (75–90%) or whole-wheat flours since these flours have higher bran content, white wheat is preferred for lighter color (Faridi et al. 1982). In the past, high extraction brown flour was used in the Van region (especially in the rural region) but later white flour was preferred by consumers. In other words, low extraction flour was used due to the preference of white flour to dark flour. However, increasing awareness of health has increased the usage of dark flour. As known whole wheat and wheat flour having high bran content are sources of dietary fiber consisting of indigestible cellulose, hemicellulose, lignin, gums, and mucilage, and high-fiber diets provide a variety of health benefits (Sudha et al. 2007). Normally, the addition of bran in bread formulation causes changes in organoleptic properties, such as a decrease in the softness of the bread and darkening of the colour. In addition, the volume of the bread is negatively affected due to the dilution of gluten after bran is added to bread formulation. The high water binding ability and interactions forming between flour components (mainly gluten) of the bran including phenolics, antioxidants, low molecular weight sulfhydryl compounds and enzymes play an important role in the negative effect of bran on bread volume (Hemdane et al. 2018; Meral and Erim Köse 2019; Meral and Doğan 2013; Meral and Sait Dogan 2013; Navrotskyi et al. 2019). However, the higher bread volume is not an essential requirement for TB, as it is flat and thin. Thus, TB made with wheat flour having a high extraction rate may be a good choice for people who willing to eat bread with added fibre. An important part of the population uses the lavaş bread by chopping it into meals that have high water content. This type of lavaş is preferred in these meals, since flours with a high extraction rate can bind more water, due to its higher bran content.

The flours used in bread making are generally produced from hard wheat with relatively high protein content. However, bread can also be made from soft wheat or durum wheat in different countries of the world. In Van region, the flour obtained from Tir wheat is used in TB making. The protein content of the flour is important in bread making. In practice, it is not possible to make good quality bread from flours with low protein (e.g., 8%) (Delcour and Hoseney 2010).

Gluten proteins, the dough-forming protein of wheat flour, are functional proteins found in wheat endosperm. They are defined as a rubbery mass that remains when wheat flour dough is washed with water including 2% NaCl. Gluten plays key roles in the formation of a viscoelastic structure during dough formation and gas retention during fermentation. Gluten also provides the cohesivity, viscosity, and elasticity on the dough (Wieser 2007). The quantity and quality of gluten proteins largely affect the dough mixing (Goesaert et al. 2005).

Less gluten and gluten strength are required for TB compared to pan and hearth bread as two reasons. First, a high gas holding capacity does not require because the bread is very thin, and second, most of these bread are made by hand and it is easy to knead and handle dough made from flours with weaker gluten (Morris et al. 2016).

Salehifar et al. (2010) investigated the effect of protein content and quality on the sensory attributes of Taftoon bread. Results indicated that high protein flours (more than 11.5%) are not able to sheet and expand during high temperature due to the short time conditions employed in the baking of Taftoon bread. They also demonstrated that low sensory scores gained the bread made from low protein flours and they have poor quality. Farvili et al. (1997) reported that high-quality TB was obtained from 85% extraction flour consisting of 11–13% protein. They also demonstrated that TB had a moderate protein level (11.2%).

The chemical formulation of flour used in lavaş bread was 10.3% moisture, 1.3% ash (%), 10.2% protein, 27% gluten and the pH was 6.5 (Movahhed et al. 2018).

As large amounts of TB are consumed daily in Turkey, there is great interest in the enrichment of TB to meet the nutritional awareness of consumers. Thus, TB is starting to be produced with blends of flours from other sources including whole wheat flour, flaxseed (Borlu 2009), whey protein isolates (Jooyandeh 2009) and triticale (Coşkuner and Karababa 2005). In addition, many tandir pieces of bread are made as gluten-free for celiac patients.

7.2 Water

Water is a basic component providing to the homogeneous mixing of the compounds, forming a desired viscoelastic structure. It helps to dissolve hydrophilic components including water, salt, and sugar. Water plays a critical role in the formation of the structural properties of gluten proteins together with flour. Water also contributes to the yeast activation, thus the hardness and temperature of the water used are important.

The amount of water used during TB-making depends on the water holding capacity of flour. The water holding capacity is directly related to the particle size of the flour and the amount of damaged starch, the particle size distribution of flour, ash and protein content. Approximately 50% of water needs to obtain optimum dough consistency (Kumar 2015; Elgün and Ertugay 1995). The temperature of the water used in bread making should be between 25 and 30 °C. Generally, tap water is used in TB production. However, in some cases, the water removed from $CaCO_3$ with a water purifier can be also used in bread making. Warm water is used in the winter months since the temperature of the water affects the dough and bread properties. Similarly, ice is added to the water in the summer months to reduce the temperature of water.

7.3 Salt

Salt is one of the four essential ingredients and plays an important role in the traditional formulation of TB. It is generally known as a flavour-enhancing, giving salty taste and masking metallic, bitter, or other off flavours (Doyle and Glass 2010; Liem et al. 2011). Salt also has many more functions, especially in bread-baking. Firstly, it helps to control the rate of yeast fermentation of dough (Miller and Hoseney 2008) by decreasing the rate of gas production. It is known that excessive fermentation problem occurs in the dough without salt or insufficient salt levels. As a result, over-fermented dough is too gassy to mold properly and a weak, uneven crumb structure with poor texture is common in the bread (Matz 1972). The salt also has a strengthening effect on the dough and supports the structure on the bread as it tightens the gluten structure. Therefore, the dough is less sticky and easy to handle. Due to the ability of sodium and chloride ions to relate to water molecules, the salt has a role in reducing water activity in foods (Albarracín et al. 2011). Thus, it is being used as a preservative to prevent microbial growth in bread baking and (Belz et al. 2012) consequently it extends the shelf life of bread (Quilez and Salas-Salvado 2012). The salt used in the bread formulation must be clean, bright, and white (good solubility), and it must not contain humidifiers.

7.4 Yeast

Baker's yeast (mostly strains of *Saccharomyces cerevisiae*) is a commercial preparation consisting of dried cells of the fungus (Ali et al. 2012). Bakers use yeast as a leavening agent, which converts the fermentable sugars present in the dough into the fermentation products like carbon dioxide and ethanol (Gabriela and Daniela 2010). A secondary function of yeast is to occur in flavouring and aroma. Baker's yeast is a high-volume, and low-value product that is produced on a global scale of 1574×10^6 kg per year.

In a study, lavaş bread was made using by bakery yeast and sodium bicarbonate, and the degree of staling and textural properties of this bread were examined. Results demonstrated that the best results are obtained in bread produced with a combination of baked yeast and sodium bicarbonate (Zolfaghari et al. 2017a, b).

7.5 Margarine and Milk

Many traditional baked products including TB contain significant levels of margarine. It plays a unique role in the TB dough like "shortness" as it lubricates or weakens the structure of food components to attain the desirable textural properties (Mamat and Hill 2014). These products modify the gluten structure (Baldwin et al.

1972). The margarine interacts with other ingredients and thus, the mould texture, mouthfeel, and an overall sensation of lubricity of the tandır bread are developed . In addition, nutritional value increases with 2.5–3% calorie energy in 1% fat.

Adding milk to the TB dough along with the essential ingredients improves the nutritional and sensory quality of TB (Delcour and Hoseney 2010).It also improves colour, increases water uptake, and shortens fermentation time (Shon et al. 2009). Margarine and milk are used in the production of çöçe. Generally, 100 g of margarine and 200–250 ml of milk are used for 1 kg of flour although there is no standard usage amount.

8 The Production Process of TB

8.1 Preparation of Tandır Oven

The flow chart of TB -making is in Fig. 17.5. The first process for the production of TB is the burning of the tandır. For this, wood and burning cattle dung are collected and brought to the tandır house. The walls of the tandır are wiped with a dry cloth. Burning cattle dungs are carefully placed in the tandir and are burned (Fig. 17.6).

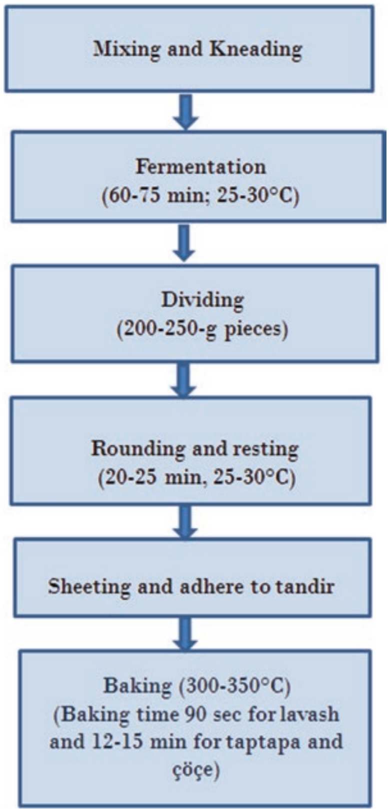

Fig. 17.5 Flow chart of TB-making

Fig. 17.6 Preparation of tandır. (İskele-Van, Şahbağı-Van. Photos: by Raciye Meral and Nihat Işık)

8.2 Mixing and Kneading

The ingredients described in Table 17.2 are combined and mixed. During dough kneading, water is absorbed by wheat flour and as a result of the energy input the gluten proteins are converted into a continuous cohesive visco-elastic gluten protein network (Goesaert et al. 2005). Nowadays the TB-making still a special ceremony for people living in rural areas. Early in the morning, women from neighbouring houses gather in the tandır house and they begin to knead the dough (Fig. 17.7). Dough kneading is a manual and a force-required job, thus women knead the dough in turn. The kneading process is continued until the surface of the dough becomes smooth. After kneading, the dough is kept at room temperature by covering it with a wet cloth. In winter, if necessary, the container found of the dough is wrapped with a blanket to keep it warm.

8.3 Fermentation

The purpose of this process is to convert the fermentable sugars into carbon dioxide (CO_2) and ethanol in the dough (Ali et al. 2012). With the fermentation process both the gluten network and the elasticity of the dough is improved and thus, CO_2 is being held efficiently (Sahlström et al. 2004). In traditional TB making, the fermentation is finished when dough height reaches to 2–3 times of initial dough height. In addition, the pore structure of dough is observed by detaching a piece from the dough. Enlarged pores indicate that the fermentation is finished. In industrial production, fermentation time is about 1.5–2 h. In a study conducted by Jooyandeh (2009) was revealed that sensory scores of lavaş samples fermented at different times increased with the increase in fermentation time.

Fig. 17.7 Dough kneading .The image shows the divided dough that is rolled by hand. (Şahbağı-Van. Photo:by Nihat Işık)

8.4 Dividing-Rounding-Sheeting

After the dough is fermented, the dough is divided into pieces of approximately 150–250 g by hand without weighing it. The divided dough is rolled by hand using some flour. These rolled doughs are called *künde* by rural people (Fig. 17.7). Then, these doughs are covered with a damp cloth and kept for 20–25 min. After this stage, the process of sheeting the dough is started. Depending on the type of TB, the dough is sheeted 2–10 mm thickness (Gocmen et al. 2009).

Doughs are sheeted onto the round wooden and there are 2 kinds of dough sheeting devices. The devices are called *merdane-kirdene* and *oklava*. The oklava is 70–80 cm long and 3 cm in diameter while the merdane 45–50 cm long and 12–15 cm in diameter (Fig. 17.8). These tools that are made of wood are used for the sheeting of dough.

The lavaş bread dough is first rolled with the merdane, then the oklava is used to make the dough thinner. The dough is spread on a pillow-like vehicle called *mezertge* or *rapata*. Mezertge allows the dough to be adhered to the wall of tandir (Fig. 17.9).

8.5 Baking

Baking is one important stage of the bread-making process. Bread quality is influenced by baking time and oven temperature (Ghanbari and Shahedi 2008). Ghanbari and Shahedi (2008) investigated the effect of baking time and temperature on the quality of taftoon (type of tandır bread) and its shelf life. They found that lower baking time and higher baking temperatures caused the lowest bread staling rates. In TB making, the tandır oven temperature is randomly controlled. When the tandır fire is red, the tandir is ready to be used (Fig. 17.10).

Fig. 17.8 Dough sheeting devices used in tandir bread: *merdane* and *oklava.* (İskele-Van. Photos: by Raciye Meral)

Fig. 17.9 Mezertge or rapata is covered with sheeted dough. (İskele-Van: Photos: by Raciye Meral)

Fig. 17.10 The tandır is ready for using and the dough adheres to tandir. (Şahbağı-Van. Photos: by Nihat Işık)

Before the sheeted doughs attach to the wall of tandir, the wall is cleaned with cleaning cloths. After the tandir is ready, the sheeted dough adheres to the wall of tandir. While lavaş dough adheres with the aid of mezertge (rapata) (Fig. 17.10), taptapa and çöçe can be adhered to it by hand.

This job is particularly stressful, since the intense heat affect near and underground the tandir. Unfortunately, there are some tragic stories about tandir burns (Akçay et al. 2008). While the baking process is between 60 and 90 s for lavaş, it takes 13–15 min for taptapa and çöçe. The bread that has been baked is taken from the wall of tandır with the aid of an iron stick or by hand (Fig. 17.11).

The TB that has just come out of the tandır is fragrant and one of the traditional-cooking rituals is to eat the bread with Van otlu cheese, tomato and cacik as soon as the bread is baked (Fig. 17.12). After baking, the tandır oven is still very hot thus it has to be placed with a pot in order to prevent accidental injuries. The pot is called a *kazan* that can be used meals cooking/warming for the evening (Fig. 17.12). After the baking process is finished, the *kazan* is placed on the tandır. Consequently, the cooking process of tandır is completed until next usage.

9 Conclusion

The tradition of tandır baking/cooking is an old part of Anatolian culture. TB, which dates back to ancient times, has formed an important part of the diets of people living in rural parts of Eastern Anatolia. TB-making has also become a tradition and ritual for the people who live in this region. The production of the tandır oven has been a source of livelihood for many people. In ancient ages, TB, consumed only by rural people, has become an indispensable taste for people living in urban areas. With industrialization, although traditional tandır houses replace with the modern

Fig. 17.11 Baking process. (İskele, Şahbağı-Van: Photos: by Nihat Işık and Raciye Meral)

Fig. 17.12 After baking (Şahbağı-Van)

tandır houses, the tradition of tandır cooking still has great importance. To preserve the tradition and to record the information about the production of TB, it is important both in terms of respect for the ancestors and the transmission of the traditions through generations. Therefore, more studies and records of these traditions will be needed in order to preserve these traditions associated to TB.

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Chapter 18
Traditional Ukrainian Bread Making

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1 Introduction

The cult of land, crop farming, grain and bread in Ukraine is known for a long time; traditions of grain production are the basis of life, folk culture, ethnicity and life of Ukrainians. Beginning of grain production in the territory of Ukraine dates back to 7000–6000 BC. It is associated with the Trypillian culture, and extension of the experience of growing hulled wheat, rye, barley, millet, as well as peas, flax, lentils (Pashkevych and Videiko 2006; Pashkevych and Bohuslavskyi 2019). It is thought that hull-less wheats (Fig. 18.1a) appeared in crops on the territory of Ukraine only in 1000 BC, initially on the limited area in the Northern Black Sea region, owing to the Greek colonists. Since that time, the value of hull-less wheat increases, and in the findings of the Ancient Rus (800–1000 AD) this wheat (together with spelt) already occupied a dominant place. Spelt in the territory of Ukraine had been grown since the Neolithic era (5000–3000 BC) and continued to exist until the late Middle Ages (Veremeichyk and Pashkevych 2004).

Grain crops were considered "the reliable bread", one of sustainable sources of energy and nutrients; they were used both for human consumption and for the feeding of livestock. Grain crops were used to make cereals for cooking porridges and soups, and also for making beer and vinegar. Various types of flour were obtained from one-grained and two-grained wheat, which differed significantly in color and technological properties, therefore the spheres of use, baked goods, and bread

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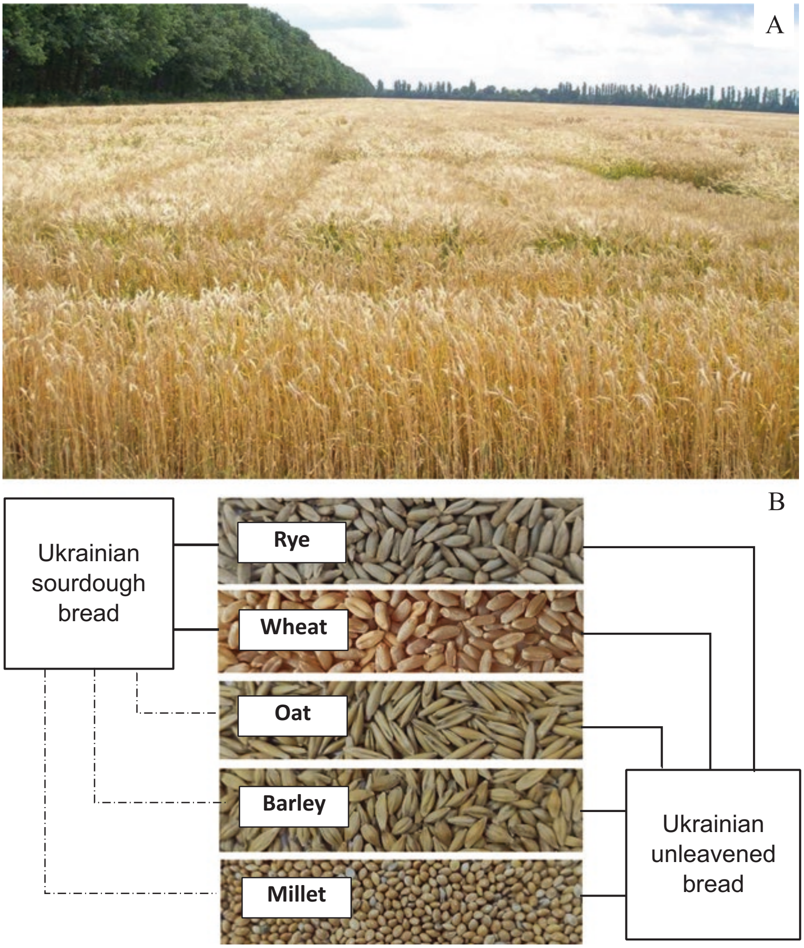

Fig. 18.1 Wheat field before harvesting, Dnipropetrovsk region (**a**); Cereals in Ukrainian bread making (**b**)

products made of them were also different. The ancestors of Ukrainians had the skills to bake unleavened bread since 4000 BC, which is evidenced by the clay models of loaves found in settlements on the territory of the modern Ukraine (Videiko 2011). There is no consensus among scientists with regard to the source of dough fermentation method in Ukraine, and the exact timeframe for the beginning of its use in bread making are not known as well. The time of appearance of sourdough bread is mentioned in various sources as 300–400 AD (Glushko 2012; Ziubrovskyi 2012). This opinion is explained by the borrowing of the term of Gothic origin for the name “hlaifs” of sourdough bread before 600–700 AD, which is confirmed by the findings of ritual clay loaves of white bread, imitating the baked bread, in the Slavic settlements. Although, taking into account the close links with the ancient Greece, indisputable existence of the Greek city-states of Tira, Olvia and others founded in 700–500 BC in the northern Black Sea region, it is worth noting that spreading of the tradition of sourdough bread making came much earlier and from that region, and the term "*khlib*" (bread in Ukrainian) can be derived from the ancient Greek word *clibanos* (the name of the conical pan for baking).

The first documented mentions of the sourdough bread making date back to the times of the Kyivan Rus, namely 1100 AD, which prove the use of various types of sourdough and recipes in Orthodox churches, monasteries and households (Artiukh 1977). It is believed that discovery of the sourdough bread is conditioned by the fact that the dough remaining in the uncleaned kitchenware began to ferment and turned into the leaven, which promoted fermentation in a new dough (Sumtsov 1885).

2 Role of Bread in the Life of Ukrainians

Bread was the most important food product of the ancient Ukrainians; that's why in the ideas and traditions it is closely connected with holiness, joy, happiness, health, well-being, cordiality, hospitality, the human life and magic power (Yarynchyna 2011). Bread and basic concepts about it remain one of the greatest materials and spiritual values for the population of Ukraine as heretofore. Its recipe, technology of production, appearance and quality contain the national and cultural information (Artiukh 1977).

Ukrainians have formed both the respect for bread as an essential food product, and the reverence for it as a Gift of Heaven. The Gift of Heaven in Slavic mythology is a Gift of Svarog, the Father of Heaven, Earth, and Sheaf. The sheaf is one of Svarog's names. Bread symbolized the life and therefore it was worshiped as the Sun. Since ancient times it was baked in the mold resembling a celestial body. The ritual bread *kruzhalo* (sweet bread of round shape) was made in the form of the Sun with rays in honor of its birth on Christmas Eve (Koliada). At a later time, the Nativity of Jesus and celebration of Christmas were timed to coincide with it, with the obligatory presence of Christmas *kalach* (a kind of fancy loaf) on the table. Furthermore, bread in the minds of people was a symbol of the Mother, Family and Kindred; in the ideas of the natives of Trypillia it meant fertility. Bread and grain became the center of ritual actions in the life of the ancestors, the basis of agrarian magic at the beginning and in the course of field works, the main attribute of celebrations that were supposed to bring happiness to the family (Tvorun 2006; Rusavska 2013). Everyday and ritual breads represented a quintessence of food, embodiment of wealth, affluence, hard work; they outlined the social status and authority of the family in the rural community.

The ritual bread is an essential companion of the calendar holidays such as Christmas, Annunciation, Easter, Ascension Day, St. Vasyl and Dmitry holidays etc. Besides, bread is an all-encompassing sign of charity, sincerity of feelings, and kindness. It was especially evident during the holidays. At Easter, wealthy peasants baked bread and brought it to the church together with the Easter foods so that all this would reach the poor. Extremely high status of bread is evidenced by the existence of an established set of regulations with regard to conditions of its baking. At the same time, bread was almost the only element maintaining the subtle connection between the world of the living and the world of the dead. Ukrainians believed that souls of the dead were fed and remembered by steam of bread, taken from the oven and especially – broken into pieces and laid out on the windows. The continuity of traditions, special attitude of Ukrainians to bread was ensured by the transmission of information orally through people's art – fairy tales, folk ballads, legends, myths, proverbs, songs, etc. (Boriak 2017).

From generation to generation, the people nurtured respect for the work of the grain grower and bread as a supporter of the family. The ancestors of Ukrainians saw the highest essence in a simple loaf of bread. That is why there are so many sayings about bread: "Bread is the staff of life", "No lunch without salt and bread", "All good is in bread", "With bread and water, there is no hunger", "Bread and water are Cossack foods", "Bread is the father, water is the mother", "Lack of bread means disaster", "It is half lunch without bread", "When there is bread, there is a reason", "When bread is on the table, the table is a throne, and if there is no piece of bread on the table, it is a bare board", "With bread the song is sweeter, and the house is warmer" etc. (Vivat 2016).

Associations of the type "baking cycle – human life cycle" in the Ukrainian folklore are most vividly reflected in Podilsky, Carpathian, Pokutsky, Polisky, and Slobozhansky fairy tales. They refer to so called "life and suffering of bread": personified bread talks about its tormented life (from "the birth" in the field/during leavening till "the death" when eating), thus driving away various demonological characters (devil or mermaid) or preventing crimes. Similar views are also reflected in the Ukrainian riddles: "I do not live or walk, but I know seven troubles and I die from a knife (bread is sown, threshed, milled, fermented, kneaded, baked and eaten)". Many popular beliefs and signs are connected with bread. It was forbidden to knock on bread in Boykivshchyna, as the people believed that bread was alive. According to behavior of the dough/pieces of dough during cooking, and quality of the ritual bread the features of the next year were predicted for the family. In the corner of a room, under the holy pictures, once there was a loaf of white bread covered with a towel (Tvorun 2006). In Ukraine, bread and femininity were identified in the structure of values: the woman crowned the results of work of grain growers by making bread for the family.

The attitude to bread as a sanctuary has the abundant reasons. It has been and remains a continuous and stable source of energy, a complex of vital nutrients for almost everyone throughout his/her life, it is not possible to be fed up with it, and it improves the digestion of other food products. The nature provided the grain with the ability to preserve its nutritional and biological value, as well as technological properties, for a long time, thus it has become a measure of well-being and national wealth (Iorgachova and Lebedenko 2015). In hard times, significance of this product grows, because due to its unique composition a person can sustain "by bread alone".

Ukrainians have always consumed a lot of bread. It is estimated that the Ukrainian peasant in the early twentieth century AD consumed about 1 kg of bread a day.

Owing to bread, the caloric content of the daily diet was supplemented, and proteins, carbohydrates, dietary fiber, vitamins, macro-, microelements, etc. were obtained. The content of nutrients and biologically active compounds, their digestibility largely depend on the flour, recipes and production technologies (Mykolenko et al. 2019). That is why the traditions and experience of bread making were kept in families and passed down from grandmothers and mothers; the process of baking was shrouded in mystery and required a special approach, allocation of time, place, clean environment, inspiration, household tools etc. Making bread for the family was exclusively an occupation for women; only when bakeries appeared, i.e. baking was done outside the homes, the right to bake bread began to pass to men.

In general, bakers and the process of breadmaking enjoyed a special honor in the mass consciousness of Ukrainians. Bread had a sacred meaning; as before, it is a mandatory attribute of Ukrainian rituals, everyday product representing an essential source of nutrients and physiologically valuable compounds.

3 Types of Traditional Ukrainian Bread

Ukrainian bread combines extremely wide variety of bread products; today their range includes more than 1.5 thousand items. The type of bread depends on many factors including: (1) type and grade of flour; (2) product recipe; (3) method for preparing of the dough; (4) method of baking; (5) shape of products; (6) purpose, time and place of consumption etc.

These factors have changed and modified over time, which affected the range and quality of bread products. For a long time, the priorities of Ukrainians, as well as humanity as a whole, were aimed at selecting the species and varieties of plants with higher yields, resistance to adverse soil and climatic conditions, and better technological properties to obtain nice and tasty bread products. Approaches to flour production and organization of breadmaking were aimed at facilitation, reduction of time and resources, stabilization of the fermentation process and achievement of the predicted product quality.

1. In the modern Ukrainian baked foods, bread products of white wheat flour prevail; however, the information about growth of pathological sensitivity of people to its components gives cause for concern and becomes a subject of research (Rybalka 2017). Therefore, the demand for rye flour products is growing, and whole-meal bread and flour of the ancient cereals, such as hulled einkorn and spelt, gain popularity (Mykolenko and Gez 2017). Besides, addition of flour made of barley, millet, oats, buckwheat, corn, soybeans, peas, beans, etc., and development of gluten-free products are in common practice. The experience of using different types and varieties of flour, valuable for bread making, is carefully preserved in the national traditions of the various regions of Ukraine (Glushko 2012; Ziubrovskyi 2016).

2. The formulation of bread determines to a large extent its quality, nutritional properties, and whether it is simple (made of flour, water and salt) or enriched bread (with dairy products, sugar, butter, oils and other ingredients added), possibly rich with high content of sugar, fats, and also eggs, raisins and other ingredients. It also defines mostly the purpose of the product (for fasting, holidays, everyday use, or rituals) (Tvorun 2006).
3. Traditionally, two methods of dough making and, accordingly, types of bread – unleavened and sourdough bread, existed in parallel in the territory of Ukraine (Fig. 18.1b). Making of dough and these types of bread, as well as symbolic properties and functions of each of them, have their own characteristics. The simplest and oldest way of breadmaking consisted in moistening of barley, wheat or rye flour with water and kneading of dough, which was baked in ash or on the hot stone. Archaeological findings testify to the older origin of unleavened bread (6000 BC) compared to the sourdough bread. Nevertheless, it was spread throughout Ukraine until the end of the nineteenth century AD. Today it is still found in the Carpathians territory as the ritual unleavened bread. To this day, *vertuta*, *palianychka* and many other baked goods are made here of unleavened dough. Earlier appearance and long-term preservation of traditions of unleavened bread *pechyvo* were promoted by simplicity, high speed, lower demands to quality of flour, conditions of dough making and baking process. Besides, the long history of unleavened bread in the territory of Ukrainian Carpathians and its relative diversity can be explained by the natural and climatic conditions, due to which it was necessary to plant frost-resistant crops, namely oats and barley. Recipe of unleavened bread of wheat flour is kept in the South of Ukraine, the development of which was significantly influenced by the Turkic-speaking ethnic group (Glushko 2012, Ziubrovskyi 2016). Making sour ("leavened", "yeasted") dough and fluffy bread is a long process, requiring wheat flour with the higher content of gluten or rye flour, introduction of the initiator of fermentation, special baking regimes and sanitary conditions in the room, as well as presence of clay ovens in combination with skill of the housewife (Ziubrovskyi 2012). However, such products are tasty, flavory, easier to digest, so they became widely spread.
4. Baking of unleavened and sourdough bread also depended on the method of heat treatment and technical and design features of a heating device (oven) (Fig. 18.2a). In the presence of the open flame, i.e. higher temperatures from the surface, flat unleavened cake *korzh* could be made only. Appearance of the ovens with half-closed flame in the early Slavic period and later on with the closed flame due to moderately high surface temperatures and hot air in the oven allowed baking of sourdough bread, which had sufficient volume and fluffy crumb (Siletskyi 2001; Petrauskas and Koval 2012). According to various estimates, sourdough bread was spreading in the central and northern regions of modern Ukraine in the seventh to eleventh centuries AD. At the same time, the basics of dough fermentation technology, views about this process, rituals and rites that accompanied it were formed. It is believed that appearance of clay ovens (with closed fire) and spreading of cereals suitable for baking (hull-less wheat, rye) contributed to the

Fig. 18.2 Clay oven. K. Sheptytskyi Museum of Folk Architecture and Everyday Life, Lemkivshchyna (**a**); Kneading trough with the lid (*vik*) for kneading of the sourdough (**b**); *Nochva* (*netska*) for kneading of unleavened dough (**c**); Bread peel and fire hook (**d**)

tradition of sourdough bread making in Ukraine (Ziubrovskyi 2016). Today in the rural areas of Ukraine you can find wood-fired stone ovens and clay-stone ones, which are used for heating, cooking and baking. There are also modern analogues of such ovens made of brick, stone or metal (cast iron) for baking at home or in mini-bakeries and restaurants.

5. Unleavened and flat cakes were baked in different ways: directly on the "bottom" of the open fire or traditional wood-fired clay oven; on the coals or in hot ash; on hot stones, clay or iron pans (Ziubrovskyi 2016). Sourdough bread products were made only in the clay oven directly on the bottom or in special molds, into which the dough pieces were placed with a shovel (peel), sprinkled with flour, if necessary.
6. The cult of bread in Ukraine and its continuous consumption led to the division of bread products into everyday and ritual bread, dedicated to calendar and family holidays.

   6.1 Ukrainians usually baked sourdough bread once a week. However, in the period of intensive labor activity they refused baking such sourdough bread completely or partially. Instead, they made bakery goods in a quick way. This bread was baked of partially fermented dough in the form of so called *palianytsa* during firing in the furnace. These products were made daily and usually consumed immediately or during the day. Traditional Ukrainian unleavened bread products were not fermented ones; they were more difficult to digest and assimilate. Therefore, they were often consumed with fermented milk products. As distinct from unleavened bread (*oshchypok*, *korzh*, *pechyvo* etc.), the dough for which was kneaded with water, milk or whey and gently rolled with a rolling pin, the technological process of sourdough making was much longer and more complicated.

   Everyday sourdough bread (*khlibyna*, *bokhanets*) was made in Ukraine mainly of wheat and rye flour. People living in the territory of Polissia, Volyn, Boykivshchyna, Lemkivshchyna and some other historical and ethnographic regions of Ukraine consumed mainly the bread made of rye flour. In the central and southern territories of the modern Ukraine, where mostly wheat was grown, more wheat sourdough bread was produced. In lean years, peasants added barley, buckwheat, pea, lentil flour, and from the nineteenth century AD – ground corn and mashed potatoes, to wheat and rye flour. Beets, boiled beans, bran, chaff, white goosefoot and even an acorn flour were added to the bread dough in the years of famine. Also, bread of the oatmeal was widely spread in the territory of Boykivshchyna and Lemkivshchyna, and corn meal bread was popular in Hutsulshchyna, Northern Bukovyna and lowland parts of Transcarpathia region (Ziubrovskyi 2010, 2013).

   6.2 Ritual breads (Figs. 18.3, 18.4 and 18.5) were baked for each holiday during the year; they differed in recipes, technologies, shapes of the product, and these traditions in each region of Ukraine have their own peculiar features. Breads for calendar holidays carry magic power, they were baked from the

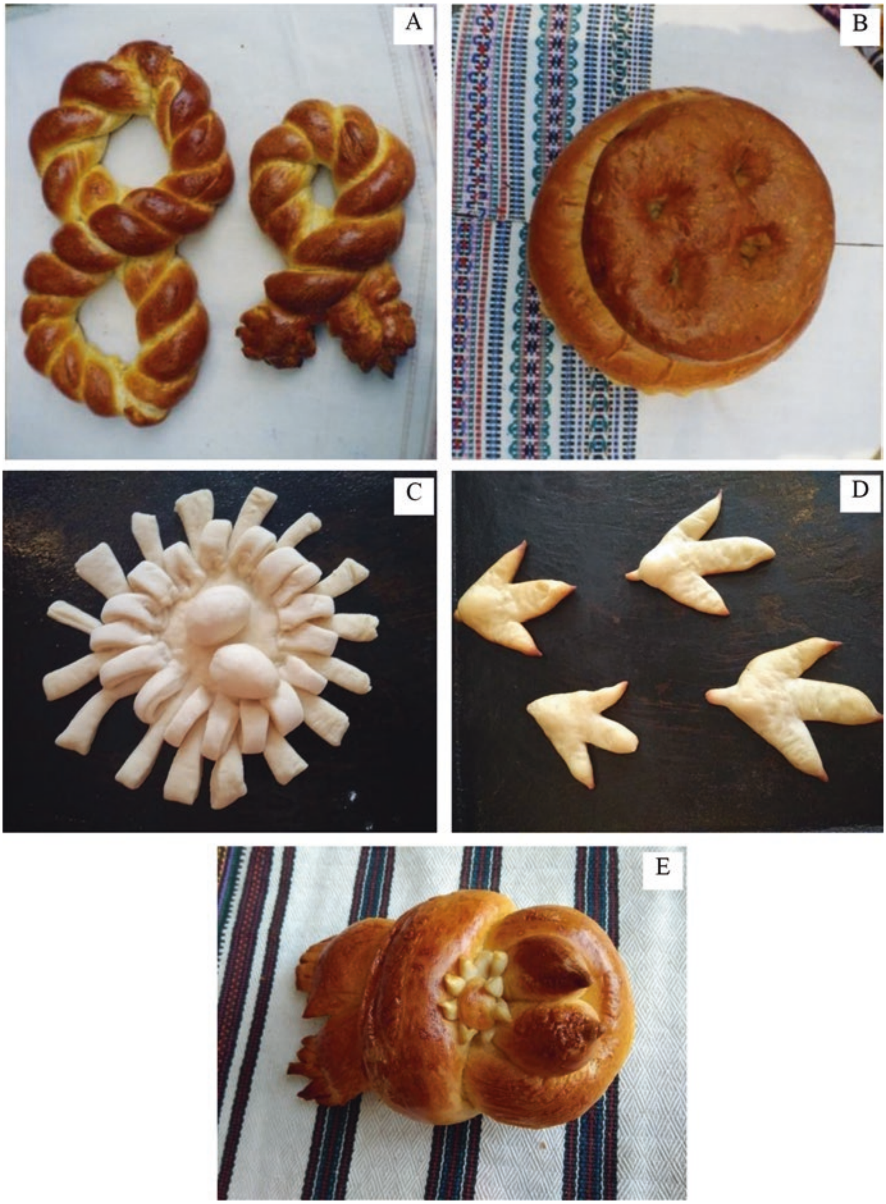

Fig. 18.3 Eight-shaped *rizdvianyks* (**a**); *knish* on Christmas (**b**); "Stork nests" (**c**); and "stork paws" (**d**); on the Annunciation Day. Wedding "geese" (**e**)

Fig. 18.4 *Korovay* bakers with the trough (**a**); *Korovay* to be handed out as a wedding invitation (**b**); *Korovay* bakers with rectangular *korovay* (**c**); *Korovay* of the god mother (**d**); *Korovay* of the bridegroom (**e**)

best raw materials in a certain atmosphere, in the endeavor to follow the rules and beliefs kept in each family (Ziubrovskyi 2014b, 2015a).

Ukrainians baked huge amounts of ritual bread, for example, for the winter holidays. Christmas is the first holiday of the year dedicated to the birth of Jesus. For Ukrainians, this holiday also referred to the end of winter solstice and the beginning of a new annual solar cycle, birth of the Sun. On the

Fig. 18.5 Meeting foreign guests with *korovay*, Vinnytsia (**a**); Girl with *obzhynok* (**b**)

eve of the Christmas time, there is a tradition to bake a variety of ritual breads (Tvorun 2006; Glushko 2012; Ziubrovskyi 2016; Konopka 2019). Christmas kalach *rozhestvo* of the sourdough is formed of two or more ropes and placed into a round mold, associated with the Sun, Dazhbog and Koliada holiday. For the fertility and large yields, *kalach* products were made eight shaped (Fig. 18.3a). Children-Christmas carolers were treated to small "doves". *Knish* (a kind of wheat bread) was made with the "small loaf" for the bodiless powers or soul as a symbol of unity of generations and patronage of ancestors (Fig. 18.3b). The Christmas Ukrainian bread "Tri-light Deity" consists of three ritual loaves which are placed on top of each other: the upper "master's" ("Holy Christmas") baked of rye flour; medium ("Vasyl") and under Jordanian kalach. This design symbolizes three biggest winter holidays – Christmas, Vasyl (the Old New Year) and the Epiphany Day, in this sequence the bread is eaten by the family on the appropriate holidays. It indicates that the rye "master's" bread supports life. "Vasyl" was baked of rich wheat dough in the form of a very beautiful and large New Year loaf (*korovay*) decorated with magical signs, such as "cross", "birds", "grass snakes" etc. "Vasyl" was given to boys-Christmas carolers as a treat. Jordan kalach made of wheat flour was brought to the church. Sometimes it was eaten by people present on the holiday or consecrated in the river (Tvorun & Tsvigun 2019).

Bread and other flour products accompany Ukrainians on the other holidays and calendar events as well. "Honey cakes" of unleavened dough were baked on the Candlemass Day, *varenyky*, *mlyntsi* (pancakes, "rolls") – on the Pre-Lenten festival; *zhylianyks* or *duzhyks* of unleavened dough – during the first week of the Lent, *khresty* (“cross-like” cookies) – during the fourth week of the Lent, “larks”, “doves” or “nightingales” – on the Forty Martyrs Day, “stork nests”, “stork paws” (Fig. 18.3c, d) or *gallepy* of unleavened dough – on the Annunciation Day; *paska* (*baba*) of rich dough – on the Easter Day. *Mykolaichyks* of unleavened dough were made on the St Nicolas Day (in spring and in winter), *palianytsia* (*manzar*) – on the Holy Trinity, of yeast or sourdough with fillings, *knish*, *mandryk*, *perevertanyk* (*pampushka*) on St Peter and Paul’s Day; *korzh* of unleavened dough – on the Maccabees; Savior’s loaves, *pampushkas* – on the Savior Day. Holiday *kalach*, *vertutas*, *verguns*, and “family” pastries were baked for the celebration of the Dedication Day; *kalyta* (*korzh* with a round hole) or *malais* made of unleavened dough, sometimes with the lovage, – on the Andriy’s day etc. (Tvorun 2006; Glushko 2012).

From the dawn of time, Ukrainians did not have a single family holiday without bread. When a baby is born, this event is celebrated with bread, and the giving of “christening” *kalach* is the most solemn moment of the baby’s Baptism. A child was sent to school with bread, and a married couple is blessed for their life together with bread. *Korovay*, *karachun*, *kalach*, *shyshka*, “dove”, “geese”, (Fig. 18.3e) accompanied the wedding (Tvorun 2006; Zuber 2017; Petrova 1998).

Korovay is a high round or rectangular bread decorated on its top with flowers, cones, cross, birds, and green snakes (Fig. 18.4). The quality of the *korovay* baking determines how the young couple would live together. *Korovay* is the crowning dish that stands out among others and becomes a cult symbol having the magical properties (Tvorun & Tsvigun 2019). Ukrainians most often baked *korovay* in the houses of the bridegroom and bride on Thursday before the wedding. Only these two *korovays* were needed at the wedding, but guests could also bring their own. Some *korovays* were a part of the gift, and sometimes they replaced it completely. Two main wedding *korovays* were subject to the most stringent requirements. Mainly, they were made of refined wheat flour of the best quality. Unlike the ordinary sourdough bread, *korovay* was a multi-recipe product including eggs, butter, and milk. Such ingredients were brought for making of a *korovay* by specially invited women, i.e., *korovay* bakers (Fig. 18.4a). They were in the even number, from four to eight, in order to ensure a happy life for the married couple. *Korovay* bakers were chosen according to the certain criteria: they could be married women of childbearing age, happily married. Widows, pregnant women and “divorcees” were not invited (Ziubrovskyi 2010). Children were invited to prepare sponge for the *korovay* to ensure the fertility of the young couple. After that, the dough was blessed: the father crossed it with a whip, and the mother poured a glass of horilka. *Korovay* was kneaded by the *korovay* bakers, who accompanied this process with songs (Petrova 1998). During processing of the dough, a special cone was made in the center of the *korovay*, where money was baked. Besides, spliced rye spikelets were baked in it, symbolizing “a couple”. Together with the *korovay*, the bakers also made the "cones" – pieces of twisted rich dough, resembling the cut top of a cone in their shape. In addition to the apron or kerchief that the mother of the bride or bridegroom tied to the baker's hand, were a kind of payment for the baking. Although the *korovay* ritual in Ukraine no longer contains all the traditional stages, *korovay* remains an integral part of the Ukrainian wedding in the twenty-first century AD as well (Tvorun & Tsvigun 2019).

Ukrainians also welcome their distinguished foreign guests with a *korovay* on the special embroidered towel *rushnyk* (Fig. 18.5a). Meeting guests with *korovay* is an expression of good intentions and respect of the host party. In order to demonstrate their good intentions and respect for Ukrainians, guests should bow to the bread and kiss it. It is not necessary to break off pieces of the *korovay*, to bite and chew them. After kissing, the people just take it away and taste at a time convenient to them; one can bring the gift *korovay* to his/her country as an edible souvenir (Tvorun & Tsvigun 2019).

Traditionally, bread as a sacred thing and the God's Gift, a magical product for the good harvest, was used as a ritual object, accompanying the peasants in the grain growing process – when sowing, visiting the grain field, during the harvesting, harvest festival (*obzhynok*, Fig. 18.5b) etc. (Tvorun 2006).

Types of traditional Ukrainian bread are rather diverse; they are the property of Ukrainians and means of their national identity. They are symbols of fertility of the Ukrainian land, centuries-old culture, wisdom and skill of people inhabiting the territory of Ukraine.

4 Grain and Flour in the Traditional Ukrainian Bread Making

Today, hull-less wheat flour plays an important role in the traditional Ukrainian breadmaking. In terms of its nutritional value and bakery properties, wheat meets the requirements of farmers and bakers and is the result of creative work and talents of many generations in scientific selection and developments in bread production (Pashkevych and Bohuslavskyi 2019). However, in recent decades a heated public debate broke out with regard to safety and immunoreactivity of the wheat gluten, sensitivity of the human body to its components, and its possible negative impact on the health (Pashkevych and Bohuslavskyi 2019). Therefore, attention is returned to flour made of alternative types of cereals, genetically close to Ukrainians, and other types of cereals, as well as less refined flours.

So, at present time one- and two-grained hulled wheat deserves attention, first of all, for making bread products for the dietetic and healthy nutrition. They were the first crops grown by the natives of Trypillia (from 6300… 5500 BC), together with hulled and hull-less barley, peas and lentils. One-grained wheat flour is of yellow or brown color; the bread made of it is of dark-brown color. Flour of two-grained wheat (einkorn) is of white color and more valuable by its chemical composition, compared to the modern wheat varieties. Bread products of such flour are tasty, flavory, and nutritious; they are easily digested, contain more proteins, unsaturated fatty acids, vitamins and minerals (Babenko et al. 2017; Mykolenko and Omelchenko 2020). Besides, Trypillian people were growing spelt on their fields, as recorded in the materials from the territory of Dniester-Prut interfluve in 5000 BC. Replacement of hulled wheats by hull-less wheats in the territory of Ukraine occurred at the turn of 1000 and 2000 AD from the Northern Black Sea region, where hull-less wheats cultivation began at the end of 1000 BC (Pashkevych 2005). Numerous traces of spelt were discovered in the paleobotanic findings of the Carpathian mounds (200–400 AD), and the materials of hull-less wheat and spelt prevail in the findings of the Ancient Rus (800–1000 AD). Both spring hull-less wheat and winter hull-less wheat were cultivated in Ukraine in the tenth to thirteenth centuries AD; the first variety was found in the northern regions, and the other one in the south of the modern Ukraine. From the thirteenth century AD, hull-less wheat already dominated among the cereals in some regions of the modern Ukraine (Middle Dnipro basin), which contributed to the spread of sourdough bread making. In the late nineteenth century AD, spelt was one of the main plants of Bessarabia. In the early twentieth century AD the crops of hulled wheats due to their good adaptation to temperature fluctuations and depleted soils preserved in the Crimea and Subcarpathia (Veremeichyk and Pashkevych 2004). Flour of hulled wheats, despite the technological difficulties in their growing, obtaining of flour and products, is considered a promising raw material for bread, because it has a combination of amino acids and composition of nutrients and biologically active compounds valuable for the human body; they are less reactive as well (Rybalka 2017).

Rye and oats, well known in our time as cultivated plants, appeared in Ukraine quite late; they were considered for a long time as contaminants of wheat and barley. It is known that findings of oats, which contaminated the wheat crops, date back to 2000 BC. However, farmers of that time already knew its taste and fodder properties. The earliest findings of the cultural form of oats refer to 700–500 BC in the Western region and 100 AD in the Southern regions of Ukraine (Pashkevych and Bohuslavskyi 2019). In the Ancient Rus, according to the chronicles of 997 AD, oats were grown together with wheat and used mainly as a fodder, but also as food ingredient, for example, for the alcoholic beverages production. Use of oats for making of unleavened bread products was the most common in the mountainous territory of Ukraine, i.e. in the Carpathians and Subcarpathia regions (Ziubrovskyi 2016).

Increase in findings of the rye was recorded in the monuments of the Scythian period (900–300 BC). The first mentions of rye growing in the chronicles of the Ancient Rus date back to 1056–1115 AD. According to paleobotanic studies in the Middle and Northern Dnipro basins, rye and hull-less wheats were primarily grown there in the tenth to fourteenth century AD (Veremeichyk and Pashkevych 2004). Apparently, rye, which accompanied wheat in crops in the northern regions, has gained an advantage due to higher frost resistance. Winter and spring rye not demanding with regard to soils and climatic conditions and having high biological value occupied up to 50–60% of the sown area in some regions of Ukraine in the early twentieth century AD.

Barley also played an important role in the diet of Ukrainians for thousands of years. It was used to prepare porridge, products of unleavened dough, *korzh*, *yashnik*, oat-barley cakes, and also mixed with wheat or rye flour into sourdough. Its sown area in 1900 AD only in the southern regions of Ukraine was about 25%. Barley was grown in rather large quantities since it was used in making beer and horilka. Besides, barley, as the wheat, was the commercial crop exported abroad in large volumes (Artiukh 1977).

Archaeological and written sources indicate the long history of cultivation of the millet in the territory of Ukraine. Millet grains were found during excavations of settlements of the Trypillia culture. According to archaeologists, millet was one of the most characteristic cereal plants of the Scythian era. Scythian farm workers were making flat cakes of millet, which was pre-moistened, dried and pounded in mortars. Millet became especially popular in the era of the Kyivan Rus. Its crops were found throughout Ukraine (Pashkevych 2014; Gorbanenko 2015). It is known that before the twentieth century AD millet was used for the production of bread as an additional ingredient.

Species and varietal composition of flour used by Ukrainians differed depending on the region. For example, people in Volyn and Polissia traditionally made bread of rye or rye-wheat flour; in Podillia, Middle Dnipro basin, Slobozhanshchyna – of wheat or wheat-rye flour; in the Ukrainian Carpathians (Boykivshchyna, Lemkivshchyna, Hutsulshchyna) – of the oatmeal, barley and corn flour in Hutsulshchyna. Consumption of unleavened bread of the oats, barley or corn was typical not only for mountain regions, but also for certain foothills (Pokuttia, Pidhirya) and plain (lowland Transcarpathia, plains of Bukovyna) territories of Ukraine. Numerous recent studies approved the expediency reviving the national experience of using different types of cereals in bread making to balance the daily diet (Arsenieva and Arsynenko 2009). Usually, everyday sourdough bread was made of whole-meal flour. White or refined wheat flour was chosen for the festive ritual bread. A mixture of two or more types of flour was often used for bread making (Ziubrovskyi 2016; Glushko 2012).

Grain for baking flour was ground on the manual rotary millstones, horse-drawn millstones, wind-powered mills or water mills. The technical support of grain milling depended on the time, territorial features and wealth of Ukrainians. Most often, Ukrainian peasants were grinding the grain at home using simple rotary millstones. After grinding, the grain was screened on sieves to remove inorganic inclusions and large peripheral particles of the grain (flower and seed shells, germ), which were poorly ground due to high content of food fiber and fat. Thick-walled wooden containers were used to store the flour to prevent the appearance and reproduction of pests in the flour.

5 Technical and Auxiliary Means and Accessories for the Production of Traditional Ukrainian Bread

Ukrainians have long believed that the house is kept by three things: kneading trough, oven and *pokut* ("corner of honor") (Boyan-Gladka 2017). The kneading trough was the central component of the process of traditional Ukrainian bread making (Fig. 18.2b), which was used to make sourdough. Unleavened dough was kneaded in a wooden trough (*netska*, *nochva*) (Fig. 18.2c), which was also used in making of the sourdough for ritual breads (Ziubrovskyi 2014c). Bread trough was cone-shaped or cylindrical cooper's product with a push-in bottom and removable cover *vik*. Obtaining the active spontaneous sourdough was directly associated with the design of the trough, since there were gaps between its individual segments. In between there were pieces of dough that accumulated microbiota productive for baking (yeast and lactic acid bacteria). Accordingly, prevention of drying of the kneading trough was a necessary precondition for the fermentation process (Ziubrovskyi 2012; 2016).

The rivets for the trough were made of tree species such as pine, spruce, linden, maple, sycamore, fir, oak and beech. The choice of such wood species was conditioned by the need to ensure the functional strength and water resistance of the trough. Its bottom was usually made of oak because this tree is the strongest one, which contributed to better preservation of the product. The trough was often made with mixed (oak and pine) rivets, which, according to Ukrainians, contributed to better fermentation of the dough (Ziubrovskyi 2015b). The trough was covered with a *vik*, i.e. round lid made of thin boards, sometimes connected at the ends in a lock, or a linen towel was used to cover it. Besides, the necessary precondition for the rapid and successful maturation of the sponge and dough in the trough was considered to be correct location of the rivets: they should be placed similarly to the direction of growth of the tree of which they were made.

Ukrainians preferred the old trough, the surface of which contained a potential supply of microbiota formed by long use of the trough. The use of a new trough required prior preparations. Such trough was pre-soaked for a day with water at room temperature with buckwheat straw, or chaff and buckwheat straw, to eliminate the natural smell of wood. Only then, the first leaven was made or a piece of dry bread was poured over, and the mixture was placed into the trough. Sometimes the trough was lit by burning a handful of flour in the closed trough for a few minutes.

The trough was treated with care and respect. The trough filled with dough was placed on the table or bench under the holy images in the corner of honor and covered with towels. Sometimes the trough was placed on a bench by the bed. The trough was usually not thrown away. Even if the trough was completely worn out, it was believed that it could not be used for anything other than storing bread. The trough was more often scraped than washed in order to preserve the microbiota useful for baking. However, if the Ukrainians washed the trough, they rubbed the walls of it with onions and salt.

Almost in all territory of Ukraine, except the Ukrainian Carpathians, sponge was prepared using a wooden spoon or paddle-shaped peel (often made of oak or pear), named *kopystka*, *kopistchynka*, *kopystochka*. *Kopystka* as a sacral object of the bread making was used exclusively for this purpose. Leavens with spontaneous microflora inherent in the traditional bread baking of Ukrainians were unstable, especially at the early stage of fermentation. It was believed that the use of *kopystka* in the kneading of dough prevents the introduction of microflora from the hands into the dough and the associated deterioration of the sponge fermentation.

Oven in the houses of Ukrainians (Fig. 18.2a) was used for cooking and heating purposes (Babenko 1905; Veremeichyk and Pashkevych 2004; Petrauskas and Koval 2012). The oven was an integral attribute of a traditional Ukrainian house which played an important economic and magic role. With its help, the food was prepared, and also various ritual actions were performed relating to the cleaning function of fire. With the improvement of human habitation, the clay oven changed its shape and location, while retaining the original ritual significance (Boyan-Gladka 2017). In a perfectly designed clay over housewives could effectively use the heat energy, because the oven was heated by hot bottom, walls, hot air and thermal radiation. It usually took up to 2 h to heat the oven to the temperature required for baking bread (Shcherban 2016). Maximum amount of bread that could be baked in the oven depended on its size, and ranged from 8 to 10 loaves.

The base of the oven was most often made of clay straw, in the houses of Polissya and Carpathians the oven edges were primarily made of wood, in the south and Transcarpathia – of natural stone. In the Dnipro basin the base of the oven was made of clay straw, sometimes with the addition of stone, or made of brick (Petrauskas and Koval 2012; Yevseieva & Petrenko 2018). Clay oven consisted of the oven itself, with the lower part named *komin* (exhaust pipe), roof or jaws and a hearth with fireplace to extract smoke into the chimney. The space between the oven and the wall was arranged for keeping the cooking utensils. From the fireplace, the hole led to the chimney (*bovdur*) (Babenko 1905). The oven bottom was paved with broken clay, and broken glass or clay fragments were added to it. The bottom was not only the lower part of the oven where firewood was burning, but also a place for baking bread and cooking (Yevseieva and Petrenko 2018). Semicircular jaws arranged in the front wall of the heating device were the only opening through which the products for heating, in particular unleavened or sourdough bread, as well as fuel and air, entered the oven (Glushko 2012).

To obtain high-quality bread, the oven was well heated. For this purpose, the people tried to use the firewood of hard low-smoke wood species: oak, hornbeam, birch, ash, beech, hazel, alder, maple, and acacia. Hornbeam firewood was considered to be the most optimal for housewives with regard to baking sourdough bread. It burned quickly, and generated a significant amount of heat, while heating the bottom well. Wood with various congenital and acquired defects was considered unsuitable as a fuel for the clay oven, for example, it was forbidden to use the wood of trees turned by roots under the action of wind. The people tried not to use willows, pines, spruces, and aspens for heating of the oven while baking bread, because they generated a lot of smoke and soot when burning. However, willow sprouts consecrated in the church on Palm Sunday were burned in the oven during baking of the ritual products, such as Easter cake (*paska*). It was believed that in this way these products were baked better and their crust acquired the brown color inherent in the baked bread.

The quantity and quality of fuel depended on the type of bread baked (unleavened or sourdough bread). For successful baking of sourdough bread, it should be subjected to long-term heat treatment. Unleavened products, as a rule, had a disc shape and small diameter, compared to sourdough bread, and also they could be baked on the plate, without using an oven bottom. Therefore, baking of sourdough bread represented more energy consuming process (Ziubrovskyi 2014a).

Bread was put into the oven and taken out of it with the help of a special peel made of a wide board (Fig. 18.2d). This peel had a round, semicircular or oblong blade, depending on the type of bread product. The peel for loading of the ritual bread (*korovay*) had very large dimensions of the working surface. The handle of the peel was usually long, because of the size of the oven and the heat from it. The bread peel should be made very carefully and smoothly. For operations with the fire and heat and for "moving" of the bread in the oven, the people used *kotsyuba* (fire hook), hoe-shaped or sword-shaped tool made of wood or iron. Using *kotsyuba*, it was possible to check the readiness of the oven for putting bread into it: the people scraped the surface of the bottom and if sparks bounced, the oven was considered hot enough to load the bread.

In the traditional baking, Ukrainians paid special attention to the use of various leaves – cabbage leaves or leaves of trees – as a bedding when baking bread. Usage of leaves prevented burning and contamination of the bread base. The loaves baked on the leaves were considered especially delicious. Cabbage leaves were most often used as a leaf bedding. The leaves were laid out on the working surface of the bread peel, on top of which a dough piece was placed and put with the use of the peel on the oven bottom. Before use, cabbage leaves were pretreated by cutting off thick veins and stalks. In addition to cabbage leaves, the leaves of oak, maple, linden, sycamore, walnut, and grape were often used as a bedding for bread. In autumn, the leaves of trees for baking were harvested for the winter in large quantities. The leaves collected in the forest were tied into a bunch (*kalytka*, *vinok*), or strung on vine twigs and hung under the ceiling in the pantry or in the house. Before baking, these leaves were scalded with boiling water to straighten them.

Thus, all items related to bread making a priori acquired the high semiotic status, magic power and, accordingly, a special attitude in the Ukrainian family (Borenko 2017).

6 Technological Processes of Ukrainian Bread Making

6.1 Making of Unleavened Bread as a Valuable Experience of Using Different Cereals

Unleavened dough, due to its simple preparation and lower demands to the quality of flour, remains quite popular in various historical and ethnographic regions of Ukraine; it is considered by the modern science of nutrition as a means of diversifying the diet and increasing its balance by including flour made of different types of cereals.

For the making of *khlib* (*korzh*, *pechyvo*) of unleavened dough in the wooden trough (*netska*, *nochva*) water was mixed with salt and flour. Sometimes milk, whey, and fermented milk products were used instead of water; these products contributed to the partial fermentation of the dough, and by adding baking soda as a baking powder. The dough was rolled out with a rolling pin on the tabletop (square plate made of boards with a narrow bar on the one side or around the perimeter), on the table or surface of the chest. After the dough was formed ("laid out into *pliatsky*"), the indentations ("hollows") were made in it with a spoon, or the dough was "pecked" on top with a knife and put onto the pan, or sometimes directly on the oven bottom. Water vapor formed inside the product during baking could come out freely without forming voids inside the loaf, thus securing its uniform baking (Artiukh 1977).

To this day, the following types and names of the unleavened baked products are known: in Transcarpathia, corn *malysnyk*; in Lemkivshchyna, Boykivshchyna *oshchypok* (from the word "peck", meaning the method of consumption), *uglianka*, *palenia* (as they were baked in hot wood ash or in front of a fire) of the oatmeal, barley, corn flour or their mixes; in Hutsulshchyna *malai* of corn flour and *korzh* of oatmeal; in Pokuttia *malai* of barley-corn flour and corn-potato *mandeburchenyk*, *korzh* of wheat, barley and rye flour; in Podillia, wheat *zhylnyk* and *korzh* of corn, *lemishka*, *hrechanyk* of buckwheat, *matrotennyk* of peas; in Volyn, rye or wheat *korzh*, wheat *palianytsia*, barley *yashnik*; in the Middle Dnipro basin wheat *shulyk* and rye or wheat *palianytsia*; in the South the wheat *plachynda*, as well as *pita*, *chorek* in the Budzhatsky Steppe (Yatsenko and Kovtiuk 2011; Ziubrovskyi 2016,). Ukrainians also make *verguns*, *vertutas*, pies with different fillings (cheese, potatoes, cabbage, pumpkin, poppy seeds, cracklings, fruits and berries) of thin-rolled unleavened dough (Artiukh 1977).

6.2 Sourdough Bread Combining the Values of Cereals, Power of Microorganisms, Labor and Skill of the Housewife

Making of sourdough bread is a long and complex process. It requires the use of ingredients which chemical and microbiological composition can ensure long-term fermentation and obtain of fluffy bread of high volume, nice shape, bright taste and flavor, which can be preserved longer and digested easier. The emergence of such technology was made possible owing to the accumulation of experience and development of ideas about the basics of fermentation, the first approaches to its regulation and stabilization, the rules of dough processing and baking bread, carefully preserved in families and passed from mother to daughter. These are clear practical recommendations on the choice of ingredients, recipes, time, sanitary and hygienic, temperature conditions, arrangement and equipment of premises, which are intertwined with folk beliefs, magic rituals, legends, etc. (Ziubrovskyi 2015a).

Multi-phase dough making was the traditional process: sourdough, sponge and dough were prepared for wheat bread, and sourdough and dough for rye bread, sometimes using autolyze.

The most difficult and responsible process is the making of spontaneous sourdough or starter; in Ukrainians, it was associated with conception. The process of the fermentation took place precisely due to the presence of active wild yeast and lactic acid bacteria in the sourdough. Their development significantly affected the quality of bread and depended on many factors. Microorganisms were getting into the starter with the ingredients, and as a result of contact with the trough where the batch was made. Along with wild yeast, the accompanying microflora entered into the starter, which could negatively affect the taste and flavor characteristics of the bread, causing its rapid deterioration. Because of instability of sourdough, it is known that bread made in two adjacent households, even by one housewife, could be radically different in its characteristics. Therefore, special respect was enjoyed by women who could make sourdough bread well, i.e. who possessed special secrets and skills.

Such secrets include the following. Housewives began to make bread early, before sunrise, or in the evening. The trough (washed rarely) was rubbed with salt, mixed with the remains of leaven. Then water was poured into the trough, and a piece of dough from the previous baking process (mother-dough) was placed as a carrier of the active fermentation microbiota. They could be called as: *rossh(z)chyna*, *pidroshchyna*, *rozchynka* – Volyn; somewhat differently in the territory of Halytsky Volyn – "*kvasne* dough", locally in the western part of Volyn – *gushcha*, in the central part – *kisla*; Polissia – *zakvaska* (Eastern Polissia), *testo*, *kisto*, *rashchyna* (Central and Western Polissia); Pokuttia – *kvasne* dough; Boykivshchyna – *rozkvas*, *kvas*; Lemkivshchyna – *kvasok*; Middle Dnipro basin – *roshchyny*. In Poltava region, bread was made using *rozkryshka* (a kind of dry leaven). In Podillia Transnistria and Dnipro regions, the people used "homemade yeast" (*pliatsok*), the dried sourdough kept till the right time. Sometimes bread was made with the fermented steamed bran or water-flour mixture, which was prefermented for several days (Fig. 18.6).

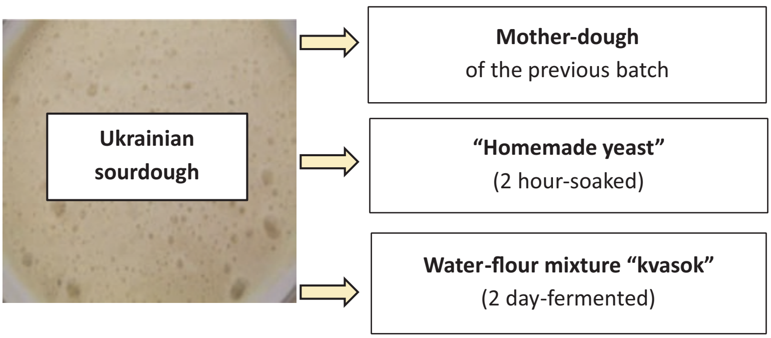

Fig. 18.6 Types of Ukrainian mother-dough in breadmaking

The sourdough was mixed with warm water adding flour to the consistency of thick sour cream and mixed thoroughly. The trough was covered and the mixture was left in a warm place for fermentation. Sometimes this process was running overnight. The sponge of creamy semi-thick consistency, being thinner than the ordinary dough consistency, was considered to be the most favorable substrate for the reproduction of wild yeasts and lactic acid bacteria. This consistency also contributed to the accumulation of acids and aromatic compounds, further improving the proofing of the dough pieces and organoleptic properties of the bread. Thorough mixing of soluble dough, water and flour with a *kopystka* provided the uniform distribution of microorganisms and nutrients required for their nutrition in the sponge (Artiukh 1977; Ziubrovskyi 2010; Glushko 2012). When the sponge completed fermentation and began to settle, it was kneaded, with the addition of the main flour.

For wheat dough a sponge was prepared first, which was fermented. In some regions, for example, in Volyn, it was called *pidkolot* or *pidmolot*; it was used to knead the dough. Wheat dough was kneaded for a long time (from half an hour to 2 h), until it began to detach from the walls of the trough and from the hands. Rye dough of less elasticity did not require long kneading. However, the achievement of specified physical properties was important for both types of the dough. In some places, it was believed that wheat dough should be kneaded until bubbles appear on the surface, indicating a new activation of the fermentation process (Ziubrovskyi, 2018). After that, the dough was left in the trough to rise, kneaded again, then flavoring ingredients, such as dill, fennelflower, salt were added, and the bread was made. The loaves were left to rise, and then baked on the cabbage leaves or oak leaves or directly on the oven bottom. For baking of sourdough bread, oven was well heated, swept with a wet broom and the bread was put using the peel. Bread was baked slowly, mostly for an hour and a half. Then the housewife took out one loaf of bread, put its vertically in her left hand and, knocking from the bottom, determined the readiness of the bread, which was to "ring like a tambourine". After the bread was removed from the oven, its surface was sprinkled with water and the loaves duly stacked were covered with a linen cloth (Artiukh 1977; Ziubrovskyi 2010).

Most often, the remains of the dough in the form of a spherical piece of the future mother-dough were stored directly in the trough between baking cycles. In Volyn the trough with remains of the dough during longer storage (for more than 2 weeks) was taken to a cool place, such as a pantry, and in Slobozhanshchyna they were stored in a cellar or in any other cold place. Since the spherical lump of the leaven was formed by scraping the remnants of the dough from the trough, it was sometimes called *poshkrabanets*, *shkrabanets* (Volyn), *poshkribtushka* or *poshkrebukha* (Western Polissia). In the Transcarpathian Boykivshchyna, where bread was baked less often, the leaven was wrapped in cloth and put into flour. The people also wrapped the dough residues after kneading into a cabbage leaf and further stored such wrapped leaven in the cellar. In order to prevent the leaven from covering with mildew and drying out during storage in the trough, it was sprinkled with salt or flour on the top, and the hop cones extract was used for sponge preparation. Although it is known that the leaven formed of the remains of the dough almost never spoiled.

6.3 Recommendations for Ensuring of Proper Quality Bread Formation

Ritual actions related to preparation of the starter, sponge, dough, and baking of bread included crossing over of the trough, dough piece, bread, and preliminary saying of the verbal formulas of the Christian and religious content, maintenance of cleanliness, silence in the room, the prohibition of slander.

The housewife engaged in baking, during her long practice, in addition to wisdom and knowledge from her mother, accumulated a significant empirical knowledge about the rules of dough and bread making, the required ratio of ingredients, especially liquid and flour, the influence of temperature conditions, inclusion of the other raw material components, additional operations etc.

It was fair to pay attention to the temperature of water during kneading, as it affected the quality of sponge fermentation. A liquid at room temperature (lukewarm liquid corresponding to the temperature of the human body) was considered optimal for the sponge preparation. Failure to comply with the traditional rules regarding the temperature of the soluble liquid caused negative consequences for the dough fermentation and corresponding deterioration in the quality of sourdough bread.

During fermentation of the sponge lasting from 6 to 12 h, the trough was placed near the oven, on the hearth, on a bench near the oven, or even on the bed. In order to provide the additional heat, Ukrainians covered the oven with warm clothes (like a casing) or laid the clothes under the trough, insulating it from the cold floor and retaining the heat released during fermentation. Pillows or duvets were sometimes used for thermal insulation.

In addition, it was forbidden to use hot water for kneading of the sponge, which led to formation of sticky bread crumbs and destruction of the microbiota of the inner surface of the trough. In the opinion of housewives, the sourdough from overheated trough did not work in the future. Hot water sterilized both sponge and all working surface of the trough, on the walls of which, covered with the remains of the dough, colonies of yeast and lactic acid bacteria settled as well. It was believed that various irrational actions could have the negative impact on the dough fermentation in the kneading trough. For example, in Volyn it was considered that the soudough in the trough would not work well if it was maleficiated, if a cat jumped over the trough, if the housewife baked bread on Friday (Ternopil region) etc.

6.4 Traditional dough fermentation Improvers and Hop Bread Making

In the traditional bread making, Ukrainians used various ingredients of the plant and animal origin, improving the fermentation process. In order to accelerate and properly regulate the process of obtaining a sourdough and accumulation of the fermentation microflora, Ukrainian housewives used the following techniques:

1. creation of more balanced composition of the nutrient medium by steaming a part of the flour, its autolyze, additional inclusion of fermented milk products, whey, honey, sugar, boiled potatoes and beans;
2. introduction of previously prepared "homemade yeast" as a source of fermentation microflora, which could be different in various regions ("hopped yeast" – everywhere in Ukraine; "brewer's yeast" of dried beer foam in the Western regions; "wine yeast" of wine foam and wort in the south of Ukraine);
3. use of ingredients with the selective antiseptic properties, i.e. active towards foreign microflora at the relative stability of yeasts and lactic acid bacteria (LAB) (extracts of hop, yarrow etc.) (Lebedenko & Kozhevnikova 2019; Lebedenko et al. 2017).

In spite of the fact that potatoes appeared in the territory of Ukraine only in the eighteenth century AD, they were actively grown already at the end of the nineteenth century AD. Since then, peasants use this vegetable crop in the traditional bread making. Most often, boiled potatoes were added to sponge as a filler or substitute for the flour. Beans were also used as a flour substitute, for example, in Volyn. Usage of these additives was especially relevant in the war and postwar periods. Boiled potatoes were used to adjust the consistency of erroneously steamed sponge which reduced the dilution of semi-finished product during fermentation. Boiled potatoes also allowed getting softer bread.

The traditional Ukrainian bread making was characterized by the use of various fermented milk products (sour milk, whey, residues after mechanical separation of sour cream). However, use of steamed milk to make dough was uncommon for Ukrainians; it was used only occasionally instead of water in making of sponge for wheat bread. In general, the use of fermented milk products contributed to rapid maturation of the sponge and increase of the dough during fermentation due to the presence of amino acids, minerals and addition of lactic acid, which facilitated reproduction of the microbiota. Sourdough bread made with the use of fermented milk products had better porosity and volume yield. For example, whey bread was considered tastier than bread made with water. Rather often, use of fermented milk products corrected low baking qualities of flour made of sprouted grain, as it inhibited the enzymes activated during sprouting and improved structural and mechanical properties of the dough.

Preparation of special "homemade yeast" was common in the traditional Ukrainian bread making. Throughout Ukraine, its main components were brews or mashes of hop cones, to which dried leaves of this plant, steamed grain bran, boiled potatoes and flour could be added. For making homemade yeast, various combinations of these substances were mixed with flour and water, and left for fermentation for 0.5–3 days. Enzymatically active homemade yeast was added to the sponge during kneading.

The process of making "homemade yeast" in Podillia Transnistria and Dnipro regions was rather complex. It was made of the fermented mixture of bran and flour in the hop extract, which were kneaded into a firm dough, to form a *palianytsa*. This sour dough for long-term storage was dried in the sun and received *pliatsok*, *maglai*, *grysyk*.

The technological process for production of the traditional Ukrainian sourdough bread using hop *grysyk* was divided into several stages such as: preparation of raw materials and auxiliary means; making of fermented bran; obtaining of hop *grysyk*; activation of hop *grysyk*; preparation of liquid sponge; dough making; dough processing; baking of dough pieces; bread cooling and storage (Fig. 18.7, Table 18.1).

At the preliminary stage, the flour was sieved, and firewood was prepared to fire the oven up. After that, fresh or pre-dried hop cones were poured with water and heated to boiling in a clay pot (Shcherban, 2016). Hop cones were boiled on the low heat during 10–15 min to release the extracting compounds. 2–3 tablespoons of sugar or honey were added to the obtained hop extract of brown color and cooled. The cooled solution was filtered through a cloth, and wheat or rye bran was added thereto in the amount required to form semi-finished product with the consistency of a thick sour cream. The resulting semi-finished product was left in the container not tightly closed for fermentation in a warm place, for example, in the hearth for one day. During this time, the semi-finished product was punched two or three times to evenly distribute the spontaneous microbiota and more efficiently feed microorganisms with available sugars that have accumulated due to the high enzymatic activity of the bran.

The next stage was obtaining of the hop *grysyk*. To do this, the fermented bran was ground with wheat or rye flour using *kopystka* in the wooden trough until bean-sized balls were formed. This semi-dry mixture was spread in a layer of 5–7 mm thick on the cloth and dried under indirect sunlight in summer or near the oven in winter. Obtained homemade yeast or hop *grysyk* was placed into linen bags, which were tied and stored suspended for a long time in a dry room, using as needed for breadmaking. Hop *grysyk* was used to prepare a sponge instead of mother-dough from the previous baking batch (Fig. 18.6).

It is known that in Poltava region *palianychka* bread, mixed with the fermented mixture of bran and flour in the hop extract, was baked in the oven to obtain *rozkryshka*. Respectively, *grysyk* and *rozkryshka* had different enzymatic activity: most of microorganisms remained in *grysyk*, while *rozkryshka* served only as an additional nutrient substrate for yeast and lactic acid bacteria.

Then the bread was made using the sponge with activation of hop *grysyk*. For this purpose, it was poured with warm water in the ratio of 1:2–2.5 and kept in water for 2 h; after that, the linen bag was pressed out to transfer the soluble substances and microbiota of "homemade yeast" to the aqueous medium. Flour was added to the obtained activated liquid leaven of spontaneous fermentation, and the liquid sponge with the consistency of thick sour cream was kneaded. The sponge was left in a warm place to ferment for 1–1.5 h. After dropping of the sponge, salt, sugar or honey, as well as wheat flour, were added to it to knead the dough. The dough was kneaded by hand for a long time (sometimes up to 1 h). The resulting dough was subjected to fermentation, followed by dividing the dough into pieces and moulding round dough pieces. As the moulds, wicker baskets, clay plates, or cabbage leaves were used. After maturation in the mold, dough pieces were placed into preheated oven and baked for 1–1.5 h. Obtained products were cooled, and covered with a towel. Duration of consumption of such bread was about 1–1.5 weeks.

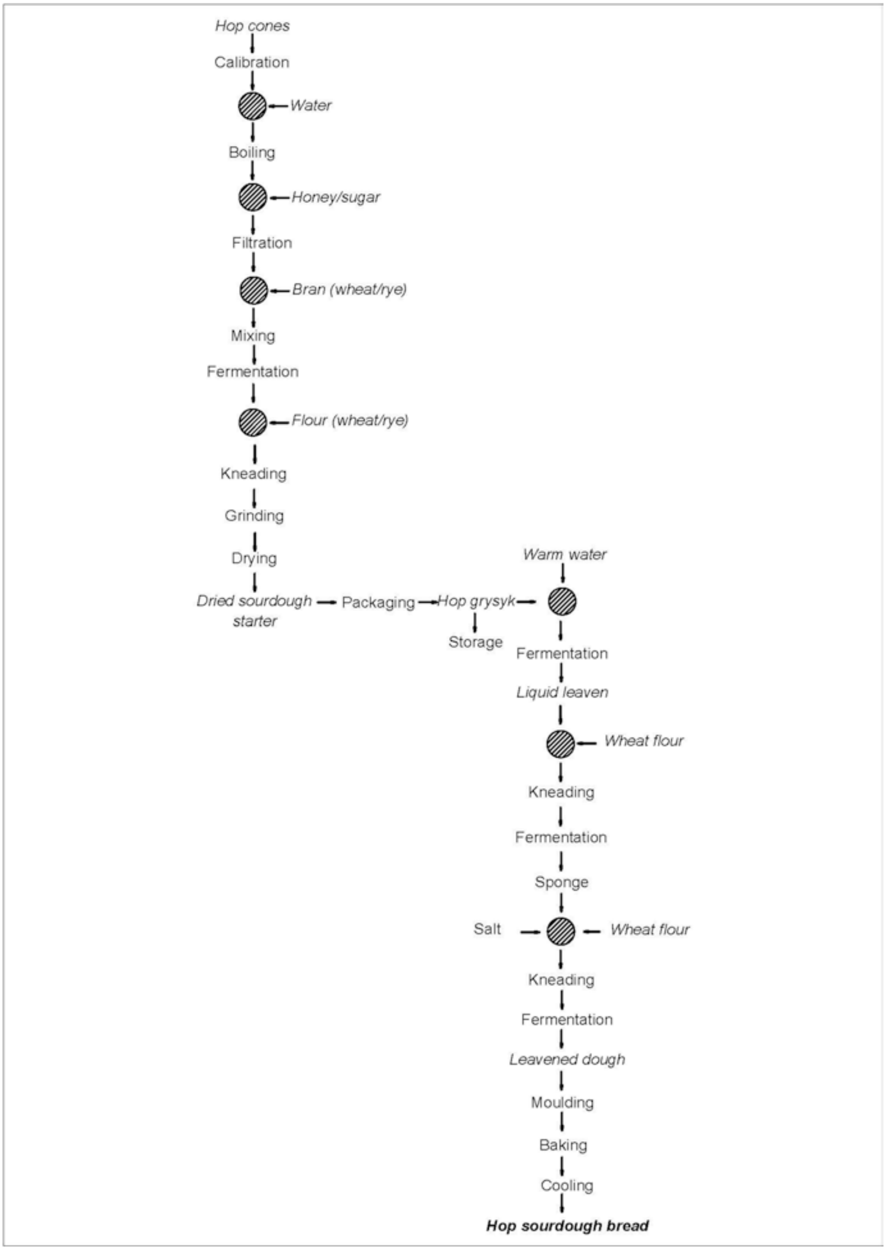

Fig. 18.7 Flowchart of the Ukrainian hop sourdough bread making

Table 18.1 Technological modes of hop sourdough bread making

Bread baking stage	Input raw materials and semi-products	Operation	Output product
Raw materials preparation	Flour	Sieving	Hop extract
	Water	Heating	
	Hop cones	Calibration	
		Extraction of hop cones at hydro-module of 1:100 by boiling for 10–15 min	
Preparation of fermented bran	Hop extract	Dissolution of sugar/honey in the hop extract	Fermented bran
	Sugar/honey		
		Natural cooling of the solution	
	Wheat/rye bran	Kneading of the dough with the consistency of thick sour cream	
		Fermentation for 24 h with 2–3 punching operations	
Obtaining of hop *grysyk*	Fermented bran	Kneading of tight dough	Hop *grysyk* in the bag for storage
	Wheat/rye flour		
		Rubbing of the dough	
		Drying of the dough in a layer of 5–7 mm thick at the temperature of 30–40 °C to the moisture level of 11–13%	
		Packing in round linen bags of 12–13 cm in diameter	
Activation of hop *grysyk*	Hop *grysyk* in the bag	Keeping of hop *grysyk* in a bag in water at hydro- module of 1: 2–2.5 for 2 h	Liquid leaven
	Warm water		
		Pressing out of the linen bag	
Sponge making	Liquid leaven	Kneading of liquid sponge with the consistency of thick sour cream	Liquid sponge
	Wheat flour		
		Fermentation of the sponge for 1–1.5 h	
Dough making	Liquid sponge	Kneading of the dough for 1 h	Fermented dough
	Flour		
	Sugar /Honey		
	Salt		
		Fermentation of the dough for 1–1.5 h	
Dough processing	Fermented dough	Dividing the dough into pieces	Proofed dough pieces
		Molding the dough pieces	
		Proofing the dough pieces	
Baking of dough pieces	Proofed dough pieces	Baking in the oven at 220–280 °C for 1–1.5 h	Hot hop sourdough bread
Cooling and storage of bread	Hot hop sourdough bread	Cooling of bread	Hop sourdough bread
		Covering with a towel	
		Storage at room temperature for 1–1.5 weeks	

Hop was known as one of the most common improvers of sourdough fermentation in Ukraine (Artiukh 2014). Hop is a unique plant, due to chemical composition of hop cones. Hop contains vitamins C, E, B_1, B_3, B6, H, PP, necessary for the activation of enzymes involved in the metabolism of yeast cells and fermentation at all. A significant part of the nitrogenous substances of hop is asparagine, which is an effective stimulant of yeast activity. Besides, hop is rich in macro- and microelements, required for the viability and development of yeast cells. Moreover, a complex of specific compounds is found in hop cones. Hop cone resins represent a mixture of phenols, resin acids and neutral resins, which includes more than 90 compounds, 20 of which are not found in other plants. Quantitative content of phenols and resin acids determines the marketable value of a specific hop variety. The main component of the bitter substances of hop is humulone (the carrier of its bitter taste), lupulone and their derivatives, which have the selective fungicidal and broad bactericidal action (Lebedenko & Kozhevnikova 2019). However, lactic acid bacteria and yeast are resistant to their impact. It allows hop extracts to stabilize the microbiological composition of spontaneous fermentation yeasts, inhibiting the development of pathogenic microorganisms (Lebedenko et al. 2014; Yurchak et al. 2009). In addition, hop extracts improve the biological value of bread, enriching it with polyphenolic compounds. The healing properties of hop are well known to Ukrainians: hops tinctures were used in folk medicine to treat colds, diseases of the genitourinary system, etc.

In bread making use of aromatic and fine-aromatic hop varieties is known to be more appropriate than bitter, brewer's ones. When using bitter hop with the high content of alpha acids, the bread acquires a bitter taste, especially with the introduction of crushed hop during the preparation of the sponge. For example, in Volyn dry mixture of hop leaves and bran was sometimes added directly to the sponge to improve the dough fermentation, but it significantly affected the taste of bread. However, in the traditional Ukrainian bread making, use of hop cones, rather than its leaves, was the most widespread. At the same time, a significant change in the taste of bread, its deterioration occurred only under short duration of fermentation of the dough made with hop extract. So, the use of hop cones at the initial stages of long-term bread making has a positive effect on the dough preparation, quality of the traditional Ukrainian sourdough bread and its nutritional value.

7 Conclusion

Ukrainian breadmaking traditions are the cultural heritage of the Ukrainian people growing grain from ancient times. Together with the Ukrainian towels' patterns, folklore and art, customs and way of life, they make up the genetic code of the Ukrainian ethnos, distinguishing it from other nations. Authentic technologies and local products represent an inexhaustible source of development of the modern food industry and models of healthy nutrition. It is an invaluable treasure, which should be deeply studied and reproduced in our times.

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