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# Production of Traditional Mediterranean Meat Products

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# Production of Traditional Mediterranean Meat Products

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# Preface

The meat industry is a sector with great importance worldwide. At present, the repercussions of the diet on the health and well-being of consumers condition their attitude towards certain foods. Taking into account that both meat and meat products are important constituents of the diet, the degree to which these foods are perceived as healthy determines their image, as well as the purchase intention of consumers. In addition, not only healthy products but high-quality products are increasingly demanded, made in a traditional way, a specific region, with a specific species or breeds and with added value (e.g., protected with quality marks).

This book arises from the collaboration between different institutions and centers at an international level, which include members of the Healthy Meat network, funded by CYTED (ref. 119RT0568). The Healthy Meat network aims to create a wide Ibero-American network within the food sector for the production of healthier meat products through different strategies and interventions that have an impact on reducing the consumption of some nutrients, and with nutritional and health benefits for the consumers. Therefore, each research group contributes its local and specific scientific-technological knowledge and is transferred to the other groups of the Network in order to catalyze the discovery or development of new ideas or solutions adapted to the specificities of each region and oriented to obtain healthier meat products.

The publication of this book about Mediterranean meat products responds to the need to inventory and characterize traditional meat products within each geographic region and with high economic and social interest. In turn, this book will also facilitate the creation of complementary work groups, taking into account essential aspects such as the scientific knowledge they possess, the similarity of the type of products they intend to study, and the lines of research and areas of knowledge. Finally, the publication of this book is a very useful tool in order to standardize the manufacturing process of the main Mediterranean traditional meat products, since there are several variations between manufacturers or regions.

Therefore, the current book examines the techniques, processing conditions, and ingredients used for meat products manufacture. A complete and comprehensive description of the materials and processing conditions used is made so that each meat product can be manufactured by other researchers or industries. In addition, each book chapter includes explanatory notes and elucidates the possible specific points to take into account for the correct manufacture. The ultimate goal is to support the scientific community, professionals, industries, and food companies in their aim to study and/or manufacture the main Mediterranean meat products. The book consists of 21 chapters.

Chapter 1 provides the complete manufacture description of one of the most popular dry-ripened sausages, the Spanish chorizo. Moreover, the elaboration process of Chouriça de carne, a very similar Portuguese sausage, is also described in Chapter 19.

Chapter 2 discusses the ingredients and processing conditions for the elaboration of Sobrasada, a traditional meat product from the Balearic Islands (Spain).

Chapter 3 provides the necessary information for the elaboration of Botifarra, a typical sausage from Catalonia, Aragón, Murcia, and Comunidad Valenciana (Spain). This sausage is also known as Longaniza or Llonganiza.

The complete processing conditions of Morcilla de Burgos, a blood sausage from the Burgos region, in the north of Spain, are shown in Chapter 4.

In Chapter 5, all manufacturing steps and ingredients for the elaboration of Salchichón, another important Spanish sausage, are explained.

Chapter 6 deals with the composition, ingredients, manufacturing steps, and characteristics of Androlla and Botillo, two similar sausages from Galicia, the North-west of Spain.

In addition to the sausages, in the present book also dry-cured meat products elaborated with whole pieces are covered. Thus, in Chapter 7, a comprehensive explanation about the processing of one of the most important meat products worldwide dry-cured ham is provided.

Another appreciated meat product with similar processing steps to ham is the Lacón. This product is typical of Galicia (Spain). Chapter 8 focuses on the manufacturing steps and the main dry-curing conditions of Lacón.

Chapter 9 provides a complete description of the ingredients, spices, materials, and processing conditions for the elaboration of dry-cured loin. This product is produced worldwide but is typical in Spanish. A similar dry-cured meat product is Coppa, a traditional product from Italy, which is fully described in Chapter 14.

Chapter 10 explains the main steps in the Cecina manufacture. This product is typical of the "León" region in Spain. Cecina is a traditional product similar to Italian Bresaola (which is fully described in Chapter 12) and Turkish Pastırma (which is fully described in Chapter 17).

The description of the comprehensive procedure for the elaboration of Salame Felino, a traditional salame produced in Northern Italy, is provided in Chapter 11.

Chapter 13 provides a complete description of the manufacturing process of pepperoni, an important dry sausage worldwide, but traditionally elaborated in Italy.

Chapter 15 provides an overview of specific ingredients and processing conditions for the elaboration of Lukanka, a popular meat product in Bulgaria, the Balkan Peninsula, and South-East Europe, and widely appreciated for its gastronomical qualities.

Sucuk, a traditional Turkish dry-fermented sausage, is widely produced and consumed in Turkey. Chapter 16 explains in a comprehensive way the main processing steps and conditions for its manufacture.

Alheira is a typical Portuguese sausage whose main ingredients are poultry meat, bread, olive oil, lard, garlic, and paprika. The full manufacturing process is shown in Chapter 18.

The formulation and the different stages of manufacturing of the Portuguese meat-based products Paia de Toucinho and Entremeada are described in detail in Chapter 20.

Finally, the full processing conditions for the elaboration of Salpicão (a traditional meat product from the north region of Portugal) and Paio (a traditional meat product from the south region of Portugal) are covered in Chapter 21. These products have a long tradition of manufacturing and are highly valued by the consumers due to their exquisite sensory characteristics and attractive nutritional value.

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# Chapter 1

# Dry-Ripened Chorizo

Irma Caro, Félix Fernández-Soto, and Javier Mateo

## Abstract

Spanish dry-ripened chorizos are highly seasoned red-colored intermediate-moisture, shelf-stable, and ready-to-eat sausages widespread throughout Spain. The characteristic nonmeat ingredients in the chorizo formulation are salt, paprika, garlic, and oregano. This study gathers information from scientific literature describing the characteristics of different types of chorizo and the effects of relevant factors on chorizo quality, technical specifications from national standards regarding chorizo formulation and making process and knowledge and information obtained from the producers. Many chorizo varieties are produced with differences depending on the region and the technology used in their making process. Traditional chorizos are spontaneously fermented, low-acid, and slow-ripened sausages with aw <0.9, while some industrial chorizos are highly fermented and commercialized with higher aw. Chorizos are categorized according to their composition (extra o average), or by the pig breed from which the pork is obtained. Other relevant differences in chorizos are they are the possibility of dry-smoking or mold covering, the amount or type of paprika used and sausage shape and size.

**Key words** Traditional meat products, Intermediate-moisture meats, Dry-cured sausages, Dry-fermented sausages, Spanish chorizo

## 1 Introduction

Spanish dry-ripened chorizos are a group of highly seasoned, generally red in color, intermediate-moisture, shelf-stable, and ready-to-eat sausages produced throughout Spain [1]. These dry-ripened sausages are usually made from pork, air-dried varying from weeks to months, and characterized by the use as ingredients of Spanish paprika (*Capsicum annuum* subsp. *cerasiforme* and subsp. *longum* fruits), called "*pimentón*" and garlic (*Allium sativum*) [2–4]. A variety of chorizo specialties are normally linked to specific Spanish regions, such as *Cantimpalos*, *Riojano*, *de Pamplona*, *de Requena*, to mention but a few, with some of them being granted international or regional quality labels. Variability in chorizos results from the quality and quantity of the raw materials used and variations in the making process conditions. In some regions, particular varieties

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of these sausages are named "*longaniza,*" "*chistorra,*" or "*morcón*" instead of chorizos, and there is a variety of chorizo "*chorizo blanco,*" which does not contain paprika [5]. Chorizo consumption in Spain is almost one million kg per year. Although there are still homemade productions in the rural area, most chorizos are produced in the meat industry.

Several studies describing the quality characteristics of dry-ripened chorizos and critical factors affecting their quality can be found in the international literature from over the last three decades. Chorizo chemical composition were reported by Gimeno et al. [6], Ansorena et al. [7], and Menéndez et al. [8], and other studies focused on the microbial population involved in chorizo fermentation and ripening [9–11]. The effects of nonmeat ingredients such as paprika [12, 13] or the use of phosphates [14] Fonseca et al. on the chorizo drying rate, texture, color, and oxidative stability have also been evaluated. Other studies have described the differences between homemade and industrial chorizos in volatile and taste compounds [15, 16] or the effect of the use of starter or flavor-produced cultures in the chorizo sensory properties [17–19]. Moreover, the effect of storage conditions, mainly packaging type or temperature, on the time-related changes in chorizo quality traits and sensory properties has been the subject of other studies [20–22].

With regard to microbial hazards associated with chorizo consumption, the growth possibilities of *Staphyloccocus aureus* during the drying conditions as a function of temperature-time combination and the behavior of *Listeria monocytogenes* on sliced chorizo during storage [23–25] have been studied. *Listeria monocytogenes* could survive in chorizo or even grow if the levels of the hurdles to control its growth (pH, aw, nitrites, microbial composition, storage temperature) are not sufficiently achieved by producers.

With regards to chemical hazards, various studies have evaluated the effect of different factors affecting the biogenic amine concentration in chorizo such as water activity [26], size [27], the use of starters [28], or the storage conditions in sliced chorizo [29]. The studies by Lorenzo et al. [30] and Ledesma et al. [31] also evaluated the presence polycyclic aromatic hydrocarbons in smoked chorizos.

This chapter aims at describing in detail the formulation and making process of chorizo by considering the information from scientific and technical literature, national regulations and standards regarding chorizo quality, and the producers' knowledge and information.

## 2 Materials

Dry-ripened chorizos are usually prepared with lean pork cuts, i.e., neck, shoulder, fatty meat cuts such as belly and lean and fatty trimmings. The typical muscle to fat ratio in chorizo formulation is from 70/30 to 80/20, resulting in 30–40% fat content in the final (Table 1); a lower amount of fat would produce less succulence, fast drying and hardness, while higher amounts can downgrade the commercial quality type of chorizo (*see* **Note 1**).

Among dry-ripened chorizos, the greater part is prepared from pork from the Duroc, Landrace and Large White pig breeds. However, approximately 15% of the chorizos commercialized in Spain are prepared from the meat of pure Iberian breed pigs (*see* **Note 2**) or Iberian x Duroc (up to 50%) crossbreeding pig [32]. These chorizos are named "*chorizos ibéricos*" and are usually more expensive than normal ones and considered high-quality ones. On the other hand, a few chorizo varieties, usually lower in quality, include blood, offal or boiled rinds [4, 33]. Furthermore, some specialties are made from beef or game meat together with pork backfat [34].

The most characteristic nonmeat ingredients in the chorizo formulation are salt, paprika, garlic, and oregano, used at c.a. 1.7–2%, 2–3.5%, 0.5–2%, 0–0.5 g/kg of the sausage mixture [4]. The relevance of paprika, which tends to be the most abundant nonmeat ingredient in chorizo formulation, on chorizo quality is explained in **Note 3**. Other spices or condiments such as pepper, white wine, or olive oil are also used in some chorizo varieties [4, 35]. Most homemade and some industrial chorizos have no other ingredients in their formulations [36]. However, it is common in industrial chorizo to use nonmeat proteins such as milk proteins and dextrin, to improve cohesiveness, and the additives nitrite, nitrate, and ascorbate.

Traditional chorizos are low-acid fermented sausages with a long and slow ripening at low temperatures [37], with a final pH of 5.5–6.2 and aw $<0.9$. However, some industrial chorizos are formulated with sugars, dextrose or lactate, and microbial cultures composed of lactic acid bacteria and *Staphylococcus xylosus* or *S. carnosus* in order to intensify the fermentation process, reduce the final pH and increase the presence of lipolytic and proteolytic activity [17, 38].

The greater majority of chorizos have a red color characteristic because of the paprika (Fig. 1), a highly seasoned flavoring, and a 20–30%-moisture range. The weights of chorizo sausage pieces are usually between 0.4 and 1 kg, and their shapes depend on the casing used for stuffing. Chorizos can be few-cm diameter horseshoe-shaped, named "*sarta*" or "*herradura*" or different diameter stick-shaped (named "*vela*" and "*cular*"). *Cular* chorizos are stuffed into the pig rectum. Dry-ripened chorizos are generally

**Table 1**
**Dry-ripened chorizo composition (protein, fat and salt expressed as percentage of chorizo and SFA, MUFA and PUFA as percentage of total fatty acids)**

| | |
|---|---|
| Moisture | 29–44 |
| Protein | 14–27 |
| Fat | 30–37 |
| Salt | 2.1–3.5 |
| SFA | 40 |
| MUFA | 46 |
| PUFA | 14 |

*SFA* saturated fatty acids, *MUFA* Monounsaturated fatty acids, *PUFA* polyunsaturated fatty acids, Adapted from [5, 6, 16, 33]

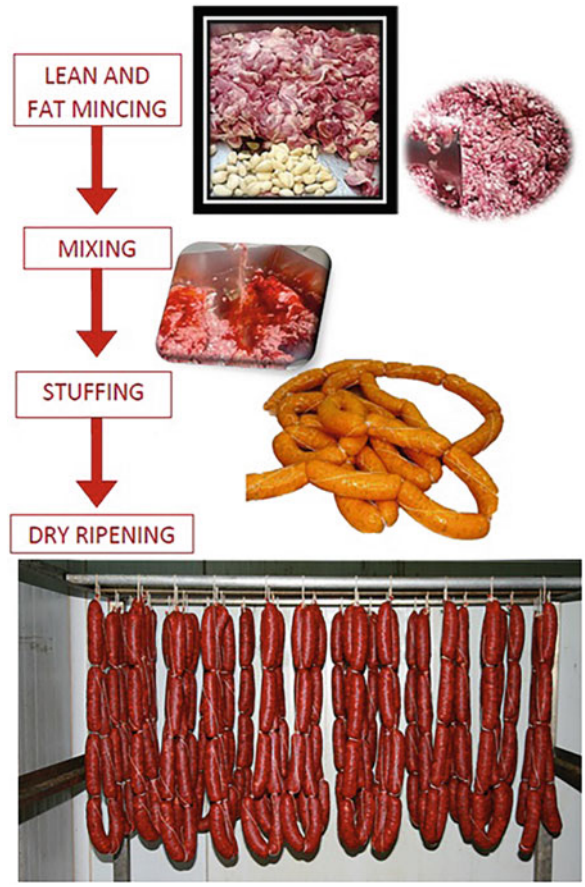


**Fig. 1** Different types of dry-ripened chorizos and a mixture of paprika and oregano in the center of the image

consumed raw, sliced, in baguettes ("*bocadillos*") or tapas. Approximately 60% of commercialized chorizo is distributed in the market in sliced presentations and the rest as whole sausage pieces [32]. Slices are normally vacuum packaged or packaged under anoxic modified atmospheres.

## 3 Methods

The different steps in the dry-ripened chorizo making process include meat and fat mincing, mixing the ingredients to prepare the batter, resting of the batter for 24–48 h (optional), stuffing, and ripening (Fig. 2):

1. Lean and fatty cuts are cut into chunks, and the chunks and trimmings usually minced in a single step by running them through 6–18 mm sieve plates [4].
2. The minced meat and fat are mixed with the nonmeat ingredients for some minutes using paddle mixers, preferably under vacuum, until a homogeneous and cohesive mass is formed.
3. In homemade sausages or small-scale plants where the mixing does not work under vacuum, the batter is compacted and kept into containers for 24–48 h under refrigeration [1], which contribute to a reduction in the batter redox potential before stuffing.
4. The batter is stuffed into 30–60 mm diameter pig, or beef casings [1, 35] or artificial collagen casings and the sausages obtained are tied with thread or metal clips.
5. The ripening in homemade and small-scale industries is performed in conditioned non-automatized rooms, opening and closing of windows depending on the weather conditions to maintain appropriate air moisture, temperature, and air ventilation inside. However, in many industries, ripening is carried out in ripening chambers with automatic control of the air conditions. Traditional chorizos are typically slowly ripened at temperatures under 15 °C for weeks of months, depending on the ripening conditions, sausage composition, such as fat content, and diameter. On the other hand, industrial chorizos can be ripened faster and, in these cases, the ripening includes a one-to-three day fermentation step under high air moisture and temperature (90% and 18–25 °C) to foster the growth of lactic acid bacteria. The ripening process involves the loss of moisture and the development of microbial and enzymatic processes contributing to the flavor and texture of the sausage. Dry-ripened chorizos can be considered as shelf-stable sausages (*see* **Note 4**).

**Fig. 2** Diagram of the dry-ripened chorizo making process

6. Optionally and generally, in the regions of Spain with more humid climates chorizos are smoked during the ripening, e.g., chorizo *de León* variety (Fig. 3), using oak firewood, with temperatures ranging from 10 to 40 °C for some days and a few hours per day. Smoking increases the oxidative stability of chorizos and prevents the growth of molds (*see* **Note 5**).

## 4 Notes

1. According to Spanish chorizo standards, there are two quality commercial types: extra "*extra*" and average "*normal*" depending on chorizo formulation and composition. *Extra* chorizos must have a fat content in dry matter lower than 57%, except for Pamplona chorizo and Iberian chorizo varieties, which can have up to 65%. Moreover, *extra* chorizos should have more than 30% protein-in-dry matter, a ratio collagen/total protein lower than 0.16, and less than 2% carbohydrates, with all these limits being more permissible for *Pamplona* and Iberian chorizo. Finally, extra chorizos only allow for less than 1% added proteins (nonmeat proteins, such as milk proteins) [35].
2. Iberian breed pigs "*cerdos ibéricos*" are out-door and slow-growing animals, traditionally reared in the Mediterranean *Dehesa* ecosystem, following extensive ("*de bellota*") or semi-extensive ("*de cebo de campo*") production systems [39]. Some of the Iberian pigs are also fed on commercial feed concentrates

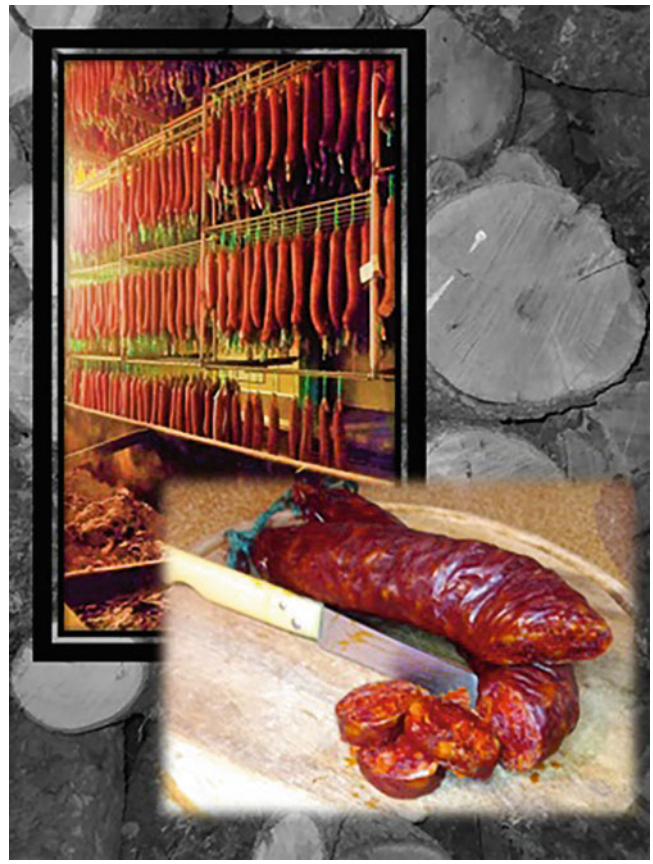

**Fig. 3** Dry-ripened smoked "*chorizo de León*"

and legumes under intensive systems (these are named "*de cebo ibérico*").

Iberian breed pigs or their Duroc crossbreeds are heavier and older at slaughter than standard white pigs, and the pork from these animals has greater subcutaneous and intramuscular fat contents and is associated with superior eating quality.

3. The powdered paprika used in Spain can be prepared from dried-smoked, oven-dried or sun-dried *C. annuum* fruits, and is mainly produced in the regions of Extremadura and Murcia [40]. Their flavor can be sweet, semi-hot "*okal*" or hot, only being used in hot chorizo "*chorizo picante*" varieties. Paprika exerts a relevant effect on the chorizo drying and ripening process [16, 41] since it is a source of fermentable sugars (1–2 g/kg of sausage mix), minerals, natural antioxidants and fiber. Paprika is also mainly responsible for both the characteristic chorizo flavor and redness. Spanish paprika is highly colored, i.e., more than 100 ASTA units [12], and this result in a high redness and yellowness in chorizo, i.e., a* and b* color values from 14 to 24, and 9 to 18, respectively [6, 42].

4. The quality of non-packaged chorizos during storage can deteriorate due to either undesirable growth of molds and yeast on the surface or sausage hardening or crust formation, depending on whether the air humidity is too high or too low, respectively. Autoxidation, resulting in rancid flavor development and/or in discoloration, can also limit the chorizo shelf-life. The chorizo color stability depends, to a great extent, on the paprika characteristics, such as levels of antioxidant compounds or whether it is used raw or previously heated paprika [12, 13].
5. Some varieties of traditional chorizos, such as *Cantimpalos* or *Zamorano* chorizo, which are non-smoked and slow-ripened, show a spontaneously-formed homogeneous and white mold covering, dominated by *Penicillium* spp. [9]. On the other hand, the presence of molds on the chorizo surface is usually not desirable, and then different approaches to prevent their growth are used by producers: the use of pimaricin on the chorizo surface, disinfection of facilities to reduce the level of spores in the air, or lowering temperature and air moisture during the ripening.

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### References

1. Ordoñez JA, de la Hoz L (2007) Mediterranean products. In: Toldrá F (ed) Handbook of fermented meat and poultry, vol 32. Willey-Blackwell, Iowa, pp 333–347. https://doi.org/10.1002/9780470376430
2. Mateo J, Aguirrezábal MM, Domínguez MC et al (1997) Volatile compounds in Spanish paprika. J Food Compos Anal 10:225–230. https://doi.org/10.1006/jfca.1997.0535
3. Aguirrezábal MM, Mateo J, Domínguez MC et al (1998) Spanish paprika and garlic as sources of compounds of technological interest for the production of dry fermented sausages. Sci Aliments 18:409–414
4. Martín-Bejarano S (2001) Enciclopedia de la carne y los productos cárnicos. Martín & Macías Plasencia, Cáceres
5. MAPA (2021) Carne y Productos Cárnicos. In: Características nutricionales de los principales alimentos de nuestra dieta. The Ministerio de Agricultura, Pesca y Alimentación. Available via Plataforma de conocimiento para el medio rural y pesquero. https://www.mapa.gob.es/es/ministerio/servicios/informacion/plataforma-de-conocimiento-para-el-medio-rural-y-pesquero/observatorio-de-buenas-practicas/buenas-practicas-sobre-alimentacion/caract-nutricionales.aspx. Accessed 15 Jul 2021
6. Gimeno O, Ansorena D, Astiasarán O et al (2000) Characterization of chorizo de Pamplona: instrumental measurements of colour and texture. Food Chem 69:195–200. https://doi.org/10.1016/S0308-8146(99)00239-3
7. Ansorena D, Gimeno O, Astiasaran I et al (2001) Analysis of volatile compounds by GC-MS of a dry fermented sausage: chorizo de Pamplona. Food Res Int 34:67–75. https://doi.org/10.1016/S0963-9969(00)00133-2
8. Menéndez RA, Rendueles E, Sánz JJ et al (2018) Physicochemical and microbiological characteristics of diverse Spanish cured meat

products. CyTA—J Food 16(1):199–204. https://doi.org/10.1080/19476337.2017.1379560

9. López-Díaz TM, Santos JA, García-López ML et al (2001) Surface mycoflora of a Spanish fermented meat sausage and toxigenicity of *Penicillium* isolates. Int J Food Microbiol 68:69–67. https://doi.org/10.1016/s0168-1605(01)00472-x
10. Aymerich T, Martín B, Garriga M et al (2006) Safety properties and molecular strain typing of lactic acid bacteria from slightly fermented sausages. J Appl Microbiol 100:40–49. https://doi.org/10.1111/j.1365-2672.2005.02772.x
11. Quijada NM, de Filippis F, Sanz JJ et al (2018) Different *lactobacillus* populations dominate in "chorizo de León" manufacturing performed in different production plants. Food Microbiol 70:94–102. https://doi.org/10.1016/j.fm.2017.09.009
12. Gómez R, Álvarez-Orti M, Pardo JE (2008) Influence of the paprika type on redness loss in red line meat products. Meat Sci 80:823–828. https://doi.org/10.1016/j.meatsci.2008.03.031
13. Pereira C, Córdoba MG, Aranda E et al (2019) Type of paprika as a critical quality factor in Iberian chorizo sausage manufacture. CyTA—J Food 17(1):907–916. https://doi.org/10.1080/19476337.2019.1668861
14. Fonseca B, Kuri V, Zumalacárregui JM et al (2011) Effect of the use of a commercial phosphate mixture on selected quality characteristics of 2 Spanish-style dry-ripened sausages. J Food Sci 76(5):S300–S305. https://doi.org/10.1111/j.1750-3841.2011.02199.x
15. Mateo J, Zumalacárregui JM (1996a) Volatile compounds in chorizo and their changes during ripening. Meat Sci 44:255–273. https://doi.org/10.1016/S0309-1740(96)00028-9
16. Mateo J, Domínguez MC, Aguirrezábal MM et al (1996b) Taste compounds in chorizo and their changes during ripening. Meat Sci 44(4):255–254. https://doi.org/10.1016/s0309-1740(96)00098-8
17. González-Fernández C, Santos EM, Jaime I et al (1997) Use of starter cultures in dry-fermented sausage (chorizo) and their influence on the sensory properties. Food Sci Technol Int 3(1):31–42. https://doi.org/10.1177/108201329700300104
18. Fonseca S, Cachaldora A, Gómez M et al (2013) Effect of different autochthonous starter cultures on the volatile compounds profile and sensory properties of Galician chorizo, a traditional Spanish dry fermented sausage. Food Control 33:6–14. https://doi.org/10.1016/j.foodcont.2013.01.040
19. Ansorena D, Astiasarán I, Bello J (2000) Changes in volatile compounds during ripening of chorizo de Pamplona elaborated with *lactobacillus plantarum* and *Staphylococcus carnosus*. Food Sci Technol Int 6:439–447. https://doi.org/10.1177/108201320000600602
20. Fernández-Fernández E, Vázquez-Odériz ML, Romero-Rodriguez MA (2002) Sensory characteristics of Galician chorizo sausage packed under vacuum and under modified atmospheres. Meat Sci 62:67–67. https://doi.org/10.1016/S0309-1740(01)00229-7
21. García-Torres S, Contador R, Ortiz A et al (2021) Physico-chemical and sensory characterization of sliced Iberian chorizo from raw material of three commercial categories and stability during refrigerated storage packaged under vacuum and modified atmospheres. Food Chem 354:129490. https://doi.org/10.1016/j.foodchem.2021.129490
22. Trejo A, Martín MJ, Gómez-Quintana A et al (2021) Effect of high-pressure treatment and storage temperature on top-quality (Montanera) Iberian dry-cured pork sausages (chorizo). J Food Sci 86:1963–1978. https://doi.org/10.1111/1750-3841.15698
23. González-Fandos ME, Sierra M, García-López ML et al (1999) The influence of manufacturing and drying conditions on the survival and toxinogenesis of *Staphylococcus aureus* in two Spanish dry sausages (chorizo and salchichón). Meat Sci 52:411–419. https://doi.org/10.1016/s0309-1740(99)00023-6
24. Menéndez RA, Rendueles E, Sánz JJ et al (2015) Behavior of *listeria monocytogenes* in sliced ready-to-eat meat products packaged under vacuum or modified atmosphere conditions. J Food Prot 78:1891–1895. https://doi.org/10.4315/0362-028X.JFP-15-103
25. Gonzalez-Fandos E, Vazquez de Castro M, Martinez-Laorden A et al (2021) Behavior of *listeria monocytogenes* and other microorganisms in sliced Riojano chorizo (Spanish dry-cured sausage) during storage under modified atmospheres. Microorganisms 9(7):1384. https://doi.org/10.3390/microorganisms9071384
26. González-Tenorio R, Fonseca B, Caro I et al (2013) Changes in biogenic amine levels during storage of Mexican-style soft and Spanish-style fry-ripened sausages with different $a_w$ values under modified atmosphere. Meat Sci 94:369–375. https://doi.org/10.1016/j.meatsci.2013.03.017

27. Miguélez-Arrizado J, Bover-Cid S, Latorre-Moratalla ML et al (2005) Biogenic amines in Spanish fermented sausages as a function of diameter and artisanal or industrial origin. J Sci Food Agric 86(49):549–557. https://doi.org/10.1002/jsfa.2385
28. González-Fernández C, Santos EM, Rovira J (2003) Influence of starter cultures and sugar concentrations on biogenic amine contents in chorizo dry sausage. Food Microbiol 20: 275–284. https://doi.org/10.1016/S0740-0020(02)00157-0
29. Ruiz-Capillas C, Pintado T, Jiménez-Colmenero F (2012) Biogenic amine formation in refrigerated fresh sausage "chorizo" keeps in modified atmosphere. J Food Biochem 36: 449–457. https://doi.org/10.1111/j.1745-4514.2011.00550.x
30. Lorenzo JM, Purriños L, Bermúdez R et al (2011) Polycyclic aromatic hydrocarbons (PAHs) in two Spanish traditional smoked sausage varieties: "chorizo gallego" and "chorizo de Cebolla". Meat Sci 89:105–109. https://doi.org/10.1016/j.meatsci.2011.03.017
31. Ledesma E, Rendueles M, Díaz M (2014) Benzo(a)pyrene penetration on a smoked meat product during smoking time. Food Addit Contam Part A Chem Anal Control Expo Risk Assess 31(10):1688–1698. https://doi.org/10.1080/19440049.2014.949875
32. MERCASA (2021) Alimentación en España, Produción, Industria, Distribución y Consumo, 23ª edición, 2020/2021. MERCASA – Distribución y Consumo. https://www.mercasa.es/media/publicaciones/281/AEE_2020_web.pdf. Accessed. 15 Jul 2021
33. Salgado A, García-Fontan M, Franco I et al (2006) Effect of the type of manufacture (homemade or industrial) on the biochemical characteristics of chorizo de Cebolla (a Spanish traditional sausage). Food Control 17: 213–221. https://doi.org/10.1016/j.foodcont.2004.10.003
34. Soriano A, Cruz B, Gómez L et al (2006) Proteolysis, physicochemical characteristics and free fatty acid composition of dry sausages made with deer (*Cervus elaphus*) or wild boar (*Sus scrofa*) meat: a preliminary study. Food Chem 96:173–184. https://doi.org/10.1016/j.foodchem.2005.02.019
35. BOE (2014) REAL DECRETO 474/2014, de 13 de junio, por el que se aprueba la norma de calidad de derivados cárnicos
36. Roncalés P (2007) Additives. In: Toldrá F (ed) Handbook of fermented meat and poultry, vol 32. Willey-Blackwell, Iowa, pp 77–86. https://doi.org/10.1002/9780470376430
37. Flores J (1997) Mediterranean vs northern European meat products. Processing technologies and main differences. Food Chem 4: 505–510. https://doi.org/10.1016/S0308-8146(97)00011-3
38. Bañón S, Martínez A, López AM (2011) Maduración de chorizo y salchichón de Chato Murciano con diferentes cultivos iniciadores (bacterias ácido-lácticas y estafilococos). An Vet Murcia 27:101–108. https://doi.org/10.6018/j/160191
39. López-Bote CJ (1998) Sustained utilization of the Iberian pig breed. Meat Sci 49(s 1): S17–S27. https://doi.org/10.1016/S0309-1740(98)90036-5
40. Palacios-Morillo A, Jurado JM, Alcázar A et al (2014) Geographical characterization of Spanish PDO paprika by multivariate analysis of multielement content. Talanta 128:15–22. https://doi.org/10.1016/j.talanta.2014.04.025
41. Aguirrezábal MM, Mateo J, Domínguez MC et al (2000) The effect of paprika, garlic and salt on rancidity in dry sausages. Meat Sci 54: 77–81. https://doi.org/10.1016/S0309-1740(99)00074-1
42. Pagán-Moreno MJ, Gago-Gago MA, Pérez-Álvarez JA et al (1998) The evolution of colour parameters during chorizo processing. Fleischwirtschaft 78:987–989

# Chapter 2

# Sobrasada

Gema Nieto, Gaspar Ros, Rocío Peñalver, Rubén Domínguez, José Angel Pérez-Alvarez, Alfredo Teixeira, and José Manuel Lorenzo

## Abstract

Sobrasada is a product arises from the need to store food during long periods of time, using salting techniques to stuff meat chopped. The origin of its name is in Sicily, where a technique known as sopressa, which means, "minced," applied to meat to stuff. From this area, it passed to the Iberian Peninsula thanks to maritime trade, and from Valencia it expanded to Mallorca, where it sees its greatest development from sixteenth century. Although in the initial formula of sobrasada the pork is the main ingredient, soon after introduces the use of paprika as a distinctive sign for the conservation of food, since the meat acquires its characteristic red color. With the passing of time the elaboration process was perfected, and in 1993 the Balearic Government recognizes the Specific Designation for "Sobrasada of Mallorca." In 1996, the European Union granted it the Indication Geographic, which establishes the processing and formulation conditions and the minimum characteristics that guarantee the quality of sobrasada. The present chapter describes in detail the formulation and the different stages of elaboration of Sobrasada.

**Key words** Traditional meat products, Pork sausage, Dry-cured products, Dry-fermented sausages, Manufacture process

## 1 Introduction

Sobrasada is a raw cured sausage, made from meat selected from pork, seasoned with salt, paprika, and black pepper. It is stuffed into the animal gut and has a slow maturation. This product is traditional from the Balearic Islands, and is protected with the geographical indication. In traditional Mallorcan cuisine, sobrasada is consumed in various ways: toasted in winter, or spread on bread and raw in summer. To avoid the great heterogeneity in the products manufactured by each company and try to standardize these meat products while protecting their quality and characteristics, sobrasada is protected by Geographical Indication, which sets minimum criteria for formulation and processing steps that ensure the correct quality of the final product.

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The first historical reference to the name sobrasada is found in a document dated 1403 from Sicily, where a shipment of food is described and, among these meats, sobrasadas are explicitly mentioned. This could place in Italy the possible origin of the name of this sausage, although without any doubt we can affirm that of that sausage from which it inherited the name, it has little to do with the one currently known, since until the arrival from American lands of the paprika no acquired the current characteristics. From the seventeenth century, multiple references using sobrasada in gastronomy are found, acquiring great gastronomic importance from this time and relegating its role as a system for the preservation of meat products. In the twentieth century, processors incorporated new equipment and technology to the sobrasada production process to ensure the quality of the product, while preserving the characteristics and typical presentations of sobrasadas traditionally made in family slaughterhouses. At the end of 1993, the Government of the Balearic Islands recognized the Specific Denomination of Sobrasada de Mallorca and, in early 1996, the European Union protected the Sobrasada de Mallorca denomination with the quality denomination: Protected Geographical Indication, which extends the protection initially granted in Spain, the entire territory of the European Union. The Protected Geographical Indication Sobrasada de Mallorca protects two types of sobrasada: sobrasada de Mallorca: made with pork. Sobrasada de Mallorca de Cerdo Negro: made exclusively with Mallorcan black pork meat and stuffed in natural casings. Pigs are raised and fed on the island of Mallorca according to traditional practices.

Sobrasada is manufactured using lean pork meat (30–60%) and white fat (40–70%). The mixture (lean pork meat, white fat, paprika, and salt) is filled into casings and ripened for several weeks at 12–16 °C and a relative humidity between 60% and 85% [1]. The fermentation process depends on such parameters as the proportions and quality of the raw material, use of starters, temperature and relative humidity, loss of water and microbial flora [2]. During fermentation there is a simultaneous loss of water and a decrease in water activity. Lipolysis and proteolysis, as in similar meat products, are key processes during ripening of sobrasada [3]. These biochemical events may originate from endogenous muscle enzymes or from bacterial enzymes [4]. Lipid degrading phenomena, implying the release of free fatty acids (FFA) and carbonyl compounds, and denaturation and partial fragmentation of proteins, are important in the development of the characteristic taste and flavor of the final product.

In general, the production process consists of two well-differentiated phases. The first is the production of the sausage itself, which consists of the stages of mincing the raw materials, mixing these with the other ingredients and the sausage in the casings and a second phase, in which the maturation takes place

and drying of the product. The chopping of the raw materials is carried out mechanically with a crushing machine in order to achieve a particle size of less than 6 mm (usually between 3 and 5 mm in diameter). During this operation, the muscular structure is destroyed to a greater or lesser degree and in this way the contact of the different ingredients is facilitated. In this stage, the development of enzymatic activities and microorganisms is favored, due to the incorporation of oxygen and the partial destruction of the structures. Then the meats are mixed with the spices and salt. Next, the dough is stuffed into casings and the curing phase begins in the dryers, where the controlled temperature and humidity produce a series of changes in the physical-chemical and microbiological characteristics of the product. These transformations provide sobrasada with the peculiar characteristics of aroma, flavor, consistency, color, and stability. The maturation stage of sobrasada de Mallorca is carried out at temperatures between 14 and 16 °C and with a relative humidity of between 70% and 85% and the duration of the process depends on the size of the piece. During this stage, there are basically two phenomena: one physical, drying, and the other biochemical, the result of fermentation.

After curing, the Sobrasada de Mallorca will present the following sensory characteristics. Irregular cylindrical shape, determined by the morphology of the gut. Dark red surface, smooth or slightly rough, with the absence of molds. Soft, nonelastic, adherent, cohesive, unctuous, and not very fibrous pasta. When cut, its delicate red marble appearance is observed.

On the palate it is characterized by high deformability, adhesiveness, and granularity. A high insoluble portion is detected. It has a very unctuous, cohesive texture and characteristic flavor and aroma, with a clear perception of paprika.

In addition to the above characteristics, Mallorca sobrasada must meet one of the following conditions: “pH less than 4.5” or “aw less than 0.91” or “aw less than or equal to 0.95 if the pH is less than or equal to 5.2.”

The studies carried out on sobrasada products are very scarce. In fact, the few studies carried out in this regard focus on the chemical, physicochemical, and microbiological characterization. Mendoza et al., [5] studied low fat, dry-fermented sausages with different percentages of inulin and found that the addition of inulin (up to 11.5%) improved the sensory characteristics of the product. Further, García et al., [6] manufactured batches of dry-fermented sausage by adding either cereal DF (wheat and oat) or fruit DF (peach, apple, and orange), at concentrations of 1.5% and 3% (w/w). Acceptable results were obtained for sausages containing 1.5% orange DF. Additionally, and taking into account that the fermentation and ripening process of sausages involves several proteolytic and lipolytic reactions, responsible for the typical organoleptic characteristic of sobrasada, the study of the proteolytic and

lipolytic were analyzed. In this sense, Simal et al. [7] reported during ripening the microbiological, biochemical, and physical phenomena that taken place are responsible for health quality and safety. These phenomena such as the proteolysis and lipolysis reaction, the decrease in pH and growth of lactic bacteria, the water activity and moisture content and [8] have a great influence on the final sensory properties of the sobrasada, such as formation of aroma precursors, changes in color and texture and characteristics. More recent studies reported the inclusion of carrot dietary fiber into sobrasada and the effects on physicochemical modifications during the ripening of sobrasada, with and without the addition of carrot dietary fiber [9].

In others "sobrasada" studied, the breeds, feeding and casings used in the Balearic Islands were employed. The evolution of different groups of microorganisms also was studied: mesophylic aerobic microorganisms, lactic acid bacteria, *Enterobacteriaceae*, yeasts and molds, group D *Streptococcus*, proteolytic microorganisms and lipolytic microorganisms. It was found that the predominant flora, from the beginning to the end, was made up of lactic acid bacteria. Conversely, *Enterobacteriaceae* disappeared as ripening went on, and the rest of the microbial groups studied underwent little variation along the process. An important characteristic of the product is the fast fall of pH, from values near 6.0 to values around 5.3, in the first week. Different microbial communities throughout the process of maturation of Mallorcan sobrasada, noting a predominance of bacteria from the lactic acid between 7 and 9 days maduration which presented values of $10^9$ cfu/g and catalase-positive gram-positive cocci with values of $10^6$ cfu/g. In general, the objective of these studies is better understanding the role of microorganisms in the release of compounds that play a vital role in the development of the aroma and flavor of these products [5–9].

## 2 Materials

According to the regulations of the Protected Geographical Indication, for the elaboration of the Sobrasada de Mallorca, the following ingredients must be used and in the proportions established in the regulations of the Protected Geographical Indication.

Sobrasada is made with pork meat consisting of a homogeneous paste of meat and fat with small pieces of meat, easily distinguishable. They are mixed with seasonings and have paprika as a typical ingredient, spices, ingredients and additives authorized, stuffed in natural or synthetic casings, which have undergone a process of ripening-drying, without smoking, and characterized by its red color and its aroma and typical tastes (Order of February 27, 1980; BOE 3/21/80).

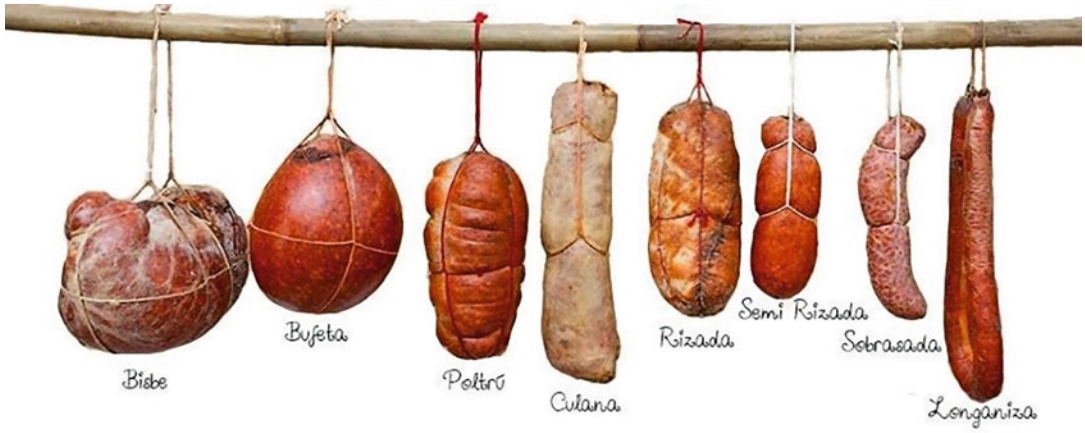


**Fig. 1** Characteristics of the casing or the container used for following presentations of sobrasada

The characteristics of the product covered by the protected geographical indication are the following (Fig. 1).

1. Lean pork: between 30% and 60%. Pork fat: between 40 and 70% (*see* **Notes 1–3**).
2. Paprika (*Capsicum annuum* L. and / or *C. longum* D.O.): between 4% and 7% (*see* **Note 4**).
3. Salt: between 1.8% and 2.8% (*see* **Note 5**).
4. Spices and / or natural aromas: pepper, hot paprika, rosemary, thyme, and oregano (*see* **Note 5**).
5. The use of colorants is expressly prohibited.
6. The casings can be natural or made of collagen fiber, the latter for pieces of less than 500 g (*see* **Note 6**).
7. Given its high fat content, the initial aw values are low (0.93) and at the end of the process decrease to 0.88–0.83 (*see* **Note 7**).

With these ingredients and following a production process duly specified in the PGI regulations, a sobrasada of the highest quality is obtained, keeping intact the traditional aspects that characterize and distinguish it.

Regarding the characteristics of the casing or the container used, the following presentations of sobrasada are distinguished (Fig. 1):

**Pasta**: Presented in tubs or by weight, it consists of uncured raw dough. It is mainly used in kitchen, although it is also consumed on bread. It does not have as intense a flavor as cured sobrasada.

**Tarrina**: Sobrasada tub differs from pasta in that it has been previously cured in the gut, to then be extracted and presented in a tub.

**Longaniza**: Stuffed in the small intestine. It is the thinnest presentation within the sausages. Have a very fast healing process, making it the first to be consumed.

**Semirrizada**: Stuffed in the large intestine in its finest parts, so it usually has a size half. It is the most common presentation after the sausage.

**Rizada**: Stuffed in the large intestine in its thick parts, so it usually has a larger size than semi-curly.

**Medio cular**: Made with the first piece of the last end of the large intestine. It is large, being able get to weigh 3 kg. It is eaten raw.

**Cular**: Embedded in the last end of the large intestine, acquiring a characteristic curved shape. It is big size.

**Poltrú**: Stuffed in the first end of the large intestine, the cecum.

**Bufeta**: Stuffed into the urinary bladder. It can weigh 8 kg. It is eaten raw or stewed.

**Bisbe**: From the Catalan Obispo, stuffed in the stomach. It is the largest of all sausages.

## 3 Preparation of Fermented Sausages

The general production process as well as the main stages will be discussed in the following sections of this chapter.

The process consists of two different phases. In the first, the own sausage, which consists of the stages of mincing the pork, mixed with the other ingredients and the sausage in the guts. In the second, the maturation and drying of the product. The traditional chopping is done by hand but with the improvement of the production performed mechanically, with a crushing machine programmed to achieve particles smaller than 6 mm. Afterwards, the meat is seasoned and the spices are added. The dough is stuffed into the guts, and undergoes a process of curing in the drying rooms.

The basis of the wide variety of fermented cured raw sausages that exist in the market is based on flexible manufacturing technology that enables many modifications as long as adequate reductions in pH and aw are maintained. Obtaining a quality fermented sausage requires a fermentation process in which produces a decrease in pH and a maturation stage in which the typical aroma and texture as a result of numerous chemical and enzymatic processes that take place. The subsequent drying phase is also essential, since in it there is a reduction in aw which, in combination with the decrease in pH, causes the sausage acquires its preservation capacity, in addition to the appropriate consistency.

## 4 Methods

The different phases of the manufacturing process must be carried out in accordance with the traditional knowledge of the producers, in order to obtain a product of the highest quality. The elaboration process of sobrasada consists of a series of steps, including meat selection, mincing, mixing, macerating, stuffing, and curing, which will be carried out as described below (Fig. 2):

1. **Chopping the meat and fat Fermented cured raw sausages** can have a varying degree of mince (fine, medium or thick). The chopping operation influences the locking of the dough and the proper consistency when cutting the final product. If the pasta gets too hot from refrigeration insufficient or insufficient freezing of the raw material, the fat particles are disposed of around the lean meat and the sausage remains excessively soft because the meat particles have not been properly locked. Likewise, it is the transfer of water to the outside during the drying phase is greatly impaired, since the fat is distributed as a film around the entire sausage.
2. **Mixed with the rest of ingredients** and additives. In addition to meat and fat, fermented sausages contain or may contain a series of additives that fulfill various functions during the manufacturing process and that they participate in the characteristics of the final product.

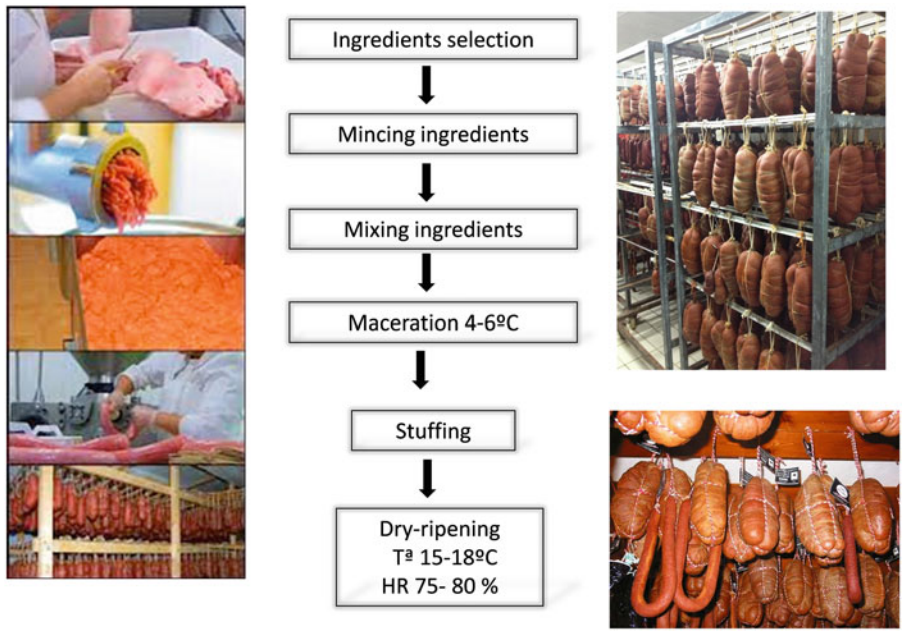


**Fig. 2** Diagram of the different stages of the manufacturing process of sobrasada

3. **The addition of salt** is essential for the production of cured raw sausages. Salt improves flavor, and its technological importance is due in its influence on multiple reactions of the ripening and drying processes. Salt plays an essential role in the binding of the pasta, since it intervenes in the solubilization of meat proteins, allowing that form an adhesive film that allows the meat particles to intercalate between the fat particles. The amount of salt added depends on the type of sausage and usually varies between 2% and 3% in the final product.
4. **The addition of spices**, that are plant ingredients with an aromatic character that are used usually in small quantities to give certain flavors, aromas, and colors to meat products.
5. **Spices, additives, sugar, and salt** are often added to the basic meat dough and minced fat, the mixture is homogenized by the action of a kneading machine to obtain proper distribution of all components. The aw of the mass is reduced from 0.99 to 0.96 due to the presence of salt, curing agents and sugars and nitrate and / or nitrite exert its inhibitory effect.
6. **After mixing all the ingredients**, the pasta must be introduced into the guts to constitute the pieces of sausage. The casings must be permeable to water vapor and they can be natural or artificial (fibrous, collagen).
7. **Fermentation**: Once the fermentation stage is finished, the sausages are placed in the curing, where the ripening process begins and, simultaneously, the drying of the product. This stage involves the maintenance of the sausages for variable periods of time in controlled temperatures and humidity conditions being the most common procedure 5–10 days at 18–22 °C and relative humidity between 80% and 90% fifteen and, subsequently, they are kept at 12–15 °C and a relative humidity of 65–80%. The duration of this last curing period is variable, depending on the type of product and its diameter, but usually ranges from about 20 (fast curing) to 90 (traditional process) days. Proteolysis, started during fermentation, now continues with action of exopeptidases, both endogenous and of microbial origin, which release small free peptides and amino acids. Lipolysis, initiated during fermentation, continues in this maturation phase. In addition, the free fatty acids generated undergo various oxidative reactions that lead to the appearance of volatile and nonvolatile substances that contribute to the flavor and aroma of the sausage. Finally, during this phase the complete reduction of the residual nitrite of the fermentation, with which the final values are usually below 10 mg / Kg of product.

   The chemical composition of the final products (after the drying-ripening period), are specified in Table 1. Sobrasada is commercialized in independent units. Sobrasada may be

**Table 1**
**Proximate composition (%) and pH, Aw of dry-ripening sobrasada**

| Maximum% | Sobrasada de Mallorca | Sobrasada de Mallorca black pork |
|---|---|---|
| Moisture | 35 | 30 |
| Protein | 8 | 13 |
| Fat | 85 | 80 |
| Carbohydrates | 2.5 | 2.5 |
| Collagen/total protein × 100 | 30 | 20 |
| pH | <4.5 | <4.5 |
| Aw | <0.91 | <0.91 |
| Aw<0.95 if pH is ≤5.2 | | |

authorized to be sold vacuum packed, raw or after cooking, or in a modified atmosphere, provided that their quality and prestige are not impaired.

## 5 Notes

1. The raw material will come from castrated males or females. Animals used for reproduction cannot be used to obtain sobrasada covered by the protected geographical indication.
2. Lean pork: between 30% and 60%.
3. Pork fat: between 40% and 70%.
4. Paprika (*Capsicum annuum* L. and / or *C. longum* D.O.): between 4% and 7%.
5. Salt: between 1.8% and 2.8%. Spices: pepper, hot paprika. The use of colorants is expressly prohibited.
6. The casings can be natural or made of collagen fiber, the latter for pieces of less than 500 g.
7. The meats, minced and mixed with spices, are left to rest for a few hours after slaughter, and are then stuffed into the guts of the same pig, where they will be cured. During this phase there is a slow transformation of the product that consists of the fermentation of the dough, which loses part of the initial moisture, which gives the sausage its typical texture and flavor.

## Acknowledgments

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## References

1. Llull P, Simal S, Benedito J et al (2002) Evaluation of textural properties of meat-based product (sobrassada) using ultrasonic techniques. J Food Eng 53:279–285
2. Rosselló C, Barbas JI, Berna A et al (1995) Microbial and chemical changes in Sobrasada during ripening. Meat Sci 40:379–385
3. Martín L, Córdoba JJ, Antequera T et al (1998) Effect of salt and temperature on proteolysis during ripening of Iberian ham. Meat Sci 49: 145–153
4. Molly K, Demeyer D, Johansson G et al (1997) The importance of meat enzymes in ripening and flavour generation in dry fermented sausages. First results of a European project. Food Chem 59:539–545
5. Mendoza E, García ML, Casas C et al (2001) Inulin as fat substitute in low fat, dry fermented sausages. Meat Sci 57:387–393
6. García ML, Dominguez R, Galvez MD et al (2002) Utilization of cereal and fruit fibres in low fat dry fermented sausages. Meat Sci 60: 227–236
7. Simal S, Femenia A, Garcia-Pascual P et al (2003) Simulation of the drying curves of a meat-based product: effect of the external resistance to mass transfer. J Food Eng 58:193–199
8. Olivares A, Navarro JL, Flores M (2011) Effect of fat content on aroma generation during processing of dry fermented sausages. Meat Sci 87: 264–273
9. Eim VS, Simal S, Rosselló C et al (2008) Effects of addition of carrot dietary fibre on the ripening process of a dry fermented sausage (sobrassada). Meat Sci 80:173–182

# Chapter 3

# Botifarra

Jacint Arnau, Josep Dolcet, and Maria Dolors Guàrdia

## Abstract

*Botifarra (pl. botifarres)* comprises a great variety of traditional meat derivatives including cooked, with incomplete thermal treatment, aired or not submitted to any treatment, always stuffed in casings. In this chapter, only the meat derivatives not submitted to any treatment ("fresh botifarra") will be addressed, which, in consequence, are classified as meat preparations. The product is presented in various forms and receives different names such as *llonganissa*, *llangonissa*, or *tastet* in some parts of Catalonia, and as *llonganissa fresca* or *longaniza* in other Autonomous Communities of Spain. The composition and elaboration process are different depending on whether they are made in domestic, artisanal, or industrial conditions.

This chapter aims to describe the composition and stages of the manufacturing process in fresh *botifarres* and the main characteristics of these types of products.

**Key words** *Botifarra*, *Butifarra*, *Llonganissa*, *Longaniza*, Fresh sausage, Ingredients, Processing, Preservation

## 1 Introduction

*Botifarres* (in Catalan) or *butifarras* (in Spanish) comprise a great variety of traditional meat derivatives including cooked, with incomplete thermal treatment, aired ("oreados") or not submitted to any treatment, always stuffed in casings [1]. However, in this chapter we will only address meat derivatives that have not been submitted to any treatment ("fresh *botifarra*"), which consequently should be considered as meat preparations because they have undergone processes insufficient to modify the internal muscle fiber structure of the meat and thus to eliminate the characteristics of fresh meat [2]. Fresh *botifarres* have a shiny casing appearance when freshly produced. They have a cherry red color typical of bloomed meat (which tends to brown due to the natural oxidation process), and small pieces of fat and other added ingredients are easily distinguished (Fig. 1). The texture is granular when is fresh and after cooking. The product is presented in several forms,

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**Fig. 1** General appearance of several types of *botifarra (pl. botifarres)*

**Fig. 2** Rolled *botifarra*

including rolled pieces prepared for barbecue (Fig. 2). *Botifarras* are named as *llonganissa*, *llangonissa* or *tastet* in some parts of Catalonia, and as *llonganissa fresca* or *longaniza* in other autonomous communities of Spain such as Aragón, Murcia and Comunidad Valenciana.

Despite the importance of these types of products, the research literature is limited and focused mainly on food safety [3–5]. Information related to processing is mainly related to traditional production methods [7, 8].

Considering the available information, the main objective of this chapter is to describe the composition and stages of the manufacturing process in fresh *botifarres* and the main characteristics of these types of products.

## 2 Materials

The fresh *botifarra* is a meat derivative (meat preparation), resulting from the mixture of minced meat (mostly pork), ingredients, additives [8] stuffed mainly in natural casings, which is cooked before consumption.

The shape is defined by the shape of the casing, with its own texture and roughness. The appearance depends on the type of casing, grinding size, amount of fat, degree of blooming and possible use of colorants. After cooking it is slightly brownish on the surface due to the formation of Maillard reaction products. The weight is variable and ranges from 100 to 120 g per serving. The consistency is soft before cooking, but firm and adhering well to the casing after cooking. The grains are easily separated during chewing. The aroma is typical of grilled meat, including spicy notes and a balanced sweet/salt ratio. The texture is granular and juicy.

The traditional ingredients used are meat (including ham, shoulder, belly, and jowl), casings, salt, and spices (mainly pepper, black and/or white) in Catalonia. In other parts of Spain, some of the following spices are also included: anise, fennel, nutmeg, garlic, cinnamon, and paprika for red *longaniza*. To increase shelf life, sodium sulfite (E-221) or potassium metabisulfite (E-224) are allowed [8] and often used. Some of the sugars (e.g., sugar, dextrose, dextrin, lactose) are sometimes included to facilitate preservation and browning during cooking. Sodium ascorbate (E-301), citrate (E-331) and spice extracts are sometimes included to improve color and slow down oxidation. Starch and fibers are sometimes used to reduce water losses during cooking. In some areas, colorants such as cochineal carmine (E-120) are used to adequate the color to consumer preferences [8]. Water is sometimes used to facilitate ingredient distribution and to increase juiciness. Other ingredients such as mushrooms, *escalivada* (grilled pepper, onion, and aubergine), etc. are used for some specialties [7], and sugar for *botifarra dolça* [9] (*see* **Note 1**) (Fig. 3).

## 3 Methods

Manufacturing is different if it is done at a domestic, artisanal, or industrial level. But, in general, it consists of the selection of the meat, mincing, mixing, stuffing, and packaging which will be carried out as described below (Fig. 4, flow diagram):

**Fig. 3** *Botifarra dolça* (sweet sausage). (Source: Gremi de Carnissers i Xarcuters Artesans de les Comarques Gironines)

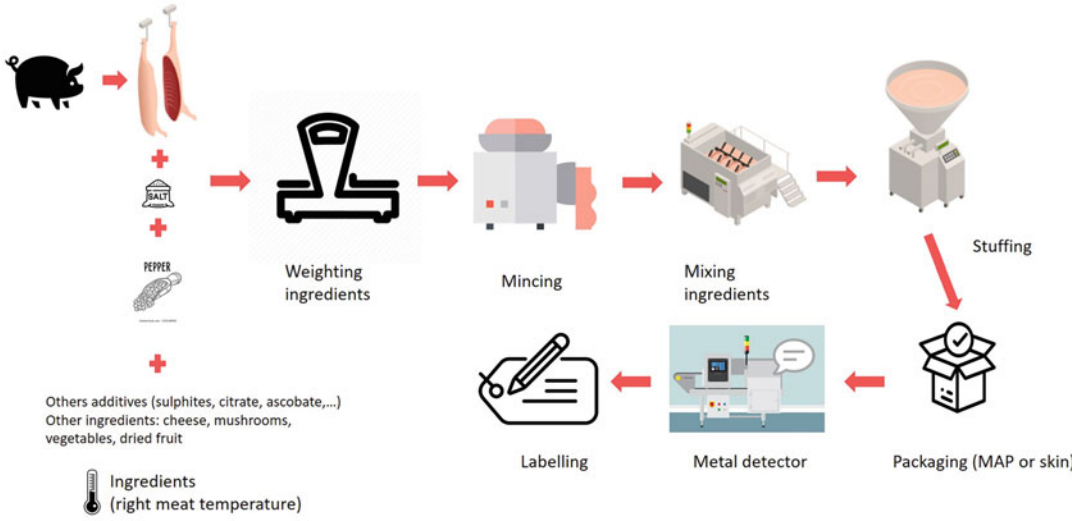


**Fig. 4** Flowchart of the different stages of the manufacturing process of *botifarra* under industrial conditions

1. The selection of the meat is carried out at a maximum temperature of 7 °C. However, a temperature close to the freezing point of meat is much better to improve grinding quality, shelf life, and to avoid smearing (*see* **Note 2**). The most common grinding size is 5–6 mm.
2. The mixing of the "meat" ingredients with water, salt, sugars, additives, and species is made just to obtain a homogeneous

**Fig. 5** Traditional dish based on grilled or fried *botifarra* with beans

mixture. Long mixing periods are not desired because the product becomes too gummy after cooking.

3. Then, the dough is stuffed into natural pork or sheep casings (*see* **Note 3**). The stuffing method used should avoid the formation of air pockets in the meat mass and the breakage of the casing. Vacuum stuffers are used for industrial products, including sometimes in-line grinding systems, while non-vacuum stuffers are used in artisanal production.
4. The products are then packaged according to the expected use. Industrial products are packaged in a modified atmosphere including $O_2$, $CO_2$, and $N_2$ gases (*see* **Note 4**).
5. The product is consumed grilled or fried together with beans (Fig. 5), French fries, salads, and in a sandwich or in traditional cuisine recipes, but it could also be consumed directly after drying (*see* **Note 5**).

## 4 Notes

1. *Botifarra dolça* is a typical *botifarra* made in the Girona area that includes only lean meat, sugar (40–45%), salt (0–2%), lemon zest and cinnamon (Fig. 3). It is cooked slowly to facilitate browning of the sugar/meat (Fig. 6), sometimes including apple slices. The product can also be consumed raw after drying.
2. Smearing occurs when the fat cells break down and the fat covers the meat particles. This produces a fatty appearance, reduces the stability of the color and the adhesion of the meat to the casing during cooking.

**Fig. 6** Traditional dish based on *botifarra* dolça with apple. (Source: Gremi de Carnissers i Xarcuters Artesans de les Comarques Gironines)

3. The natural casings give the *botifarra* an appearance close to traditional products. The casings must be carefully cleaned, free of strange odors or other defects, and can be pre-tubed ready to stuff.
4. In modified atmosphere packaging, $CO_2$ is used to slow down the growth of spoilage microorganisms and can be absorbed by both meat and fat. The function of oxygen is to make myoglobin bloom to obtain the desired bright cherry red color. And finally, nitrogen is just an inert gas that does not react with the components of the meat and acts as a filler.
5. Traditionally the product was consumed cooked, but when it was moderately dried it became a *somalla*, which was consumed raw, and then it continued the fermentation and drying process until it met consumer requirements. Depending on the drying conditions, it can become a product without any mold growth, named *secallona*, or when there is mold growth on the surface, it becomes a *fuet*.

## References

1. Real Decreto 474/2014. Real Decreto 474/2014, de 13 de junio, por el que se aprueba la norma de calidad de derivados cárnicos
2. Regulation 853/2004. Regulation (EC) no 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for on the hygiene of foodstuffs
3. Flores J (1981) El dióxido de azufre. Aspectos toxicológicos y problemática de su utilización en los productos cárnicos. Rev Agroquímica y Tecnología de Alimentos 21(4):471–474
4. Banks JG, Board RG (1982) Sulfite-inhibition of *Enterobacteriaceae* including *salmonella* in British fresh sausage and in culture systems. J Food Prot 45:1292–1297
5. Wedzicha BL (1984) Chemistry of sulphur dioxide in foods. Elsevier Applied Science Publishers Ltd., Amsterdam

6. Regulation 1333/2008. Regulation (EC) no 1333/2008 of the European Parliament and of the council of 16 December 2008 on food additives
7. Dolcet J, Reina F (1999) El llibre de les botifarres crues. Fundació Oficis de la Carn, Barcelona
8. Dolcet J, Pons I (2010) Els embotits de Catalunya. DAAAR. Generalitat de Catalunya. Edicions 62. Barcelona
9. Arnau J, Matas J (2004) La botifarra dolça y el fuet dolç: sistemas de elaboración y formas de consumo. Eur Secur 126:129–131

# Chapter 4

# Morcilla de Burgos

Eva María Santos, Ana Díez, Isabel Jaime, Rafael González, and Jordi Rovira

## Abstract

Blood sausages elaboration is intimately linked to the slaughter process, which has been done throughout the Spanish geography for centuries. These products, known as *morcillas*, have gone from local consumption to gaining popularity and splendor, in response to a growing consumer demand for traditional and quality products.

In these products, blood from the slaughtering process is mixed with different ingredients, depending on the availability of the area, stuffed in natural casings and subjected to a thermal treatment. The enormous variety of ingredients considered in its composition offers a wide range of textures, flavors, and tastes. *Morcilla de Burgos* is one of the most famous and known *morcillas*. This product, with onion and rice in its composition, has recently obtained a protected geographical indication (PGI), in an attempt to protect their origin and elaboration process. In this chapter these aspects are described.

**Key words** Traditional meat products, Blood sausages, Morcilla de Burgos, PGI

## 1 Introduction

*Morcilla de Burgos* is a blood sausage traditionally associated to the homemade pig slaughtering process in different villages of Burgos region, in the north of Spain. During the slaughtering process carried out during autumn–winter months (generally from November to February), blood from the slaughtered pig was collected, and mixed with other ingredients like onion, lard, rice, salt, and spices [1].

Blood sausages have been made from animal blood for thousands of years around the world although unlike other meat products they have deserved less fame. In general, blood sausages have been locally distributed and consumed but their recognition was demerited in favor of other meat products like dry-cured ham, salami, or chorizo. However, in the last decades there has been a growing trend by consumers endorsed by authorities to recover traditional products and processes with accredited quality. In this

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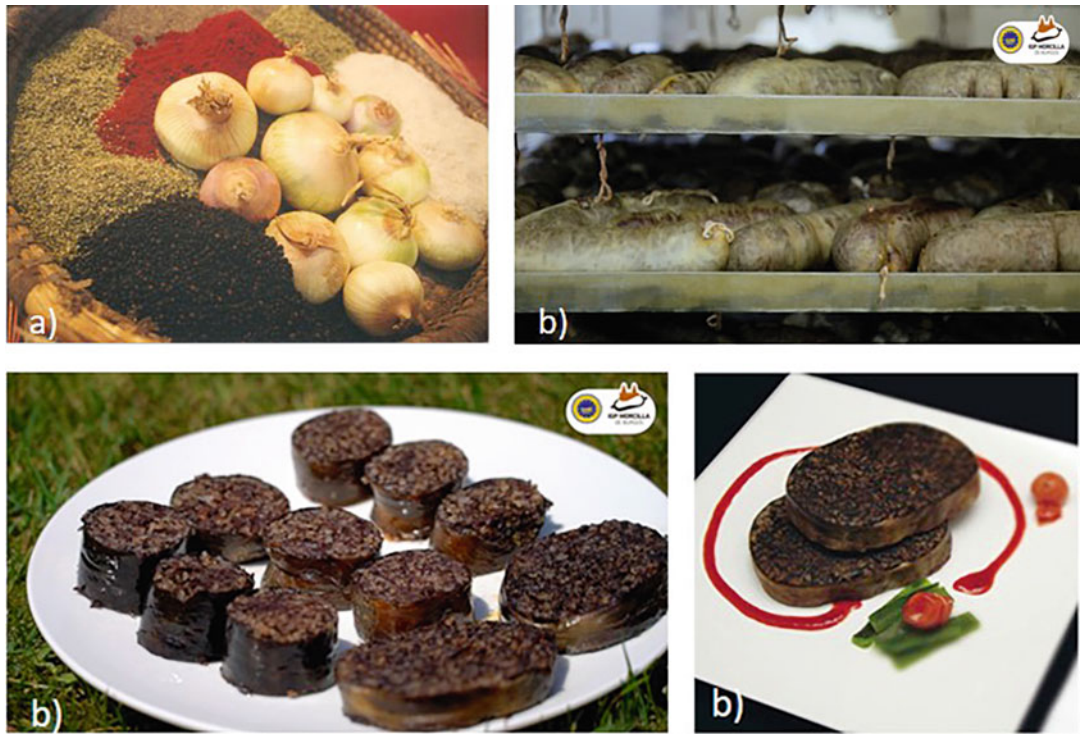


**Fig. 1** (**a**) Some of the ingredients of Morcilla de Burgos (**b**) Typical images of Morcilla de Burgos (PGI morcilla de Burgos, www.cardeñafood.es)

sense, food quality labels like Protected Geographical Indication (PGI) or Protected Designation of Origin (PDO) were the tools established by the European Union to promote and protect traditional agrifoods as a common cultural heritage of the European population. Since the promulgation of these regulations, PGI and PDO have given visibility and relevance to many traditional products, allowing the transition of hand-made productions to industrial ones, with standardized protocols and supporting the inhabitants of rural areas [2].

*Morcilla de Burgos* have been the first Spanish blood sausage in receiving a Protected Geographical Indication (PGI) in August the 29th of 2018, in the class 1.2 (Fig. 1). Meat products [3]. The first written references about this product date back to the beginning of the last century where the authors Arán in 1914 [4] and Sanz Egaña in 1928 [5], describe a blood sausage elaborated in the north of Spain with the inclusion of rice and onion. In fact, onion plays a significant role in the elaboration of *Morcilla de Burgos*. According to the oral tradition, the best onion to elaborate this *morcilla* is the regional variety called *Horcal* or *horco*, even *matancera* or *matanza*, due to the close relationship with the slaughtering activity or *matanza*. This onion has been generally grown in the autumn–winter months in the hydrographic basins of the main rivers that

flow through the region of Burgos, when slaughtering process was mainly done. Its bulb is white, juicy, and with a better yielding rate comparing to other onion varieties. The higher content of sugars of this onion gives mild sweet notes and has been the differentiating characteristic of *Morcilla de Burgos* [1], comparing to other *morcillas* elaborated in Spain, where other vegetable ingredients are considered [6].

Finally, lard (some producers include also tallow) is the last of the main ingredients, together with different spices like black pepper and paprika or cumin among others, which give the peculiar and unique flavor and taste to this product. Although the scientific information about this product is limited, from the interest of the producers to protect this product, several studies were developed about physicochemical characterization [1], but also about preservation by conventional techniques (vacuum, modified atmosphere) [7] or even high processing pressure and organic acids addition have been studied to extend the shelf life [8, 9]. The study of the spoilage lactic acid bacteria of this product has been also a topic of interest since the presence of several lactic acid bacteria are the responsible of reducing the shelf life of this product [10–12].

## 2 Materials

According to the requirements established by the PGI [13], *Morcilla de Burgos* a meat product obtained by stuffing a sausage and then cooking it. It is made from the following basic ingredients: onions from the *Horcal* variety, lard or tallow, rice, blood, spices, and salt. The IGP established several limits to the proportions of main ingredients. *Horcal* onion presence must be higher than 35%, rice from 15% to 30%, blood over 12% and lard or tallow in the 10–22% range.

The characteristics of the product covered by the protected geographical indication are the following [13]:

1. Shape and external appearance: is cylindrical in shape, between 30 and 100 mm in diameter, varying between 150 and 350 mm in length and occasionally curved, depending on the shape of the intestine used (*see* **Note 1**). The sausage is firm and compact to the touch.
2. Appearance in the cut: the predominant aspects of the sausage's appearance are white flecks owing to the presence of rice and the even distribution of the ingredients. Occasionally, small pieces of lard can be seen. Although some variations can be observed depending on the color of the binder, the basic color presents various shades of brown in all cases.

**Table 1**
**Physicochemical specifications in final product for Morcilla de Burgos**

| Physicochemical parameter | Specifications |
|---|---|
| pH | 6–7 |
| Moisture | 54–67% |
| Fat | 15–25%[a] |
| Total sugars | ≥3.5%[a] |
| Fiber | ≥2.7%[a] |
| Salt | 0.5–2% |

[a]Expressed in dry matter

3. Texture: the sausage has a crumbly texture in the mouth, where the presence of onion and grains of rice are noticeable, although it should not be tough. It has also slightly fatty sensation because of the fat source added.
4. Aroma and flavor: the aromas and flavors of onion and the various spices should be perceptible.

The PGI also establish some values for physicochemical parameters in the final product (Table 1).

As it was previously mentioned only onion variety allowed is *Horcal* variety (*Allium cepa* L.) (*see* **Note 2**). In the case of rice, dry, whole grained of short- grained Japanese varieties such as "*Bahía*" or "*Bomba*" can be used, but always belonging to the "Extra" class and stored in hygienic conditions (*see* **Note 3**). In the case of fat source, lard or tallow can be used, even a mixture of them (*see* **Note 4**). Related to the blood, although pig and cow are the traditional source, sheep's blood is also allowed in the formulation.

Regarding the spices, the use of black pepper is essential, while other species like paprika, oregano, cumin, cloves, garlic, cinnamon, caraway, parsley, and aniseed are optional according to the habitual producer recipe.

## 3 Methods

The elaboration of *Morcilla de Burgos* is relatively simple considering that five main steps can be distinguished: raw material preparation, mixing of the ingredients, stuffing, thermal treatment, and air cooling (Fig. 2).

These steps are usually done in the same day, since ingredients of this product, especially the use of blood, make *morcilla* a very sensitive product to spoilage if cooking process is not done immediately after mixing.

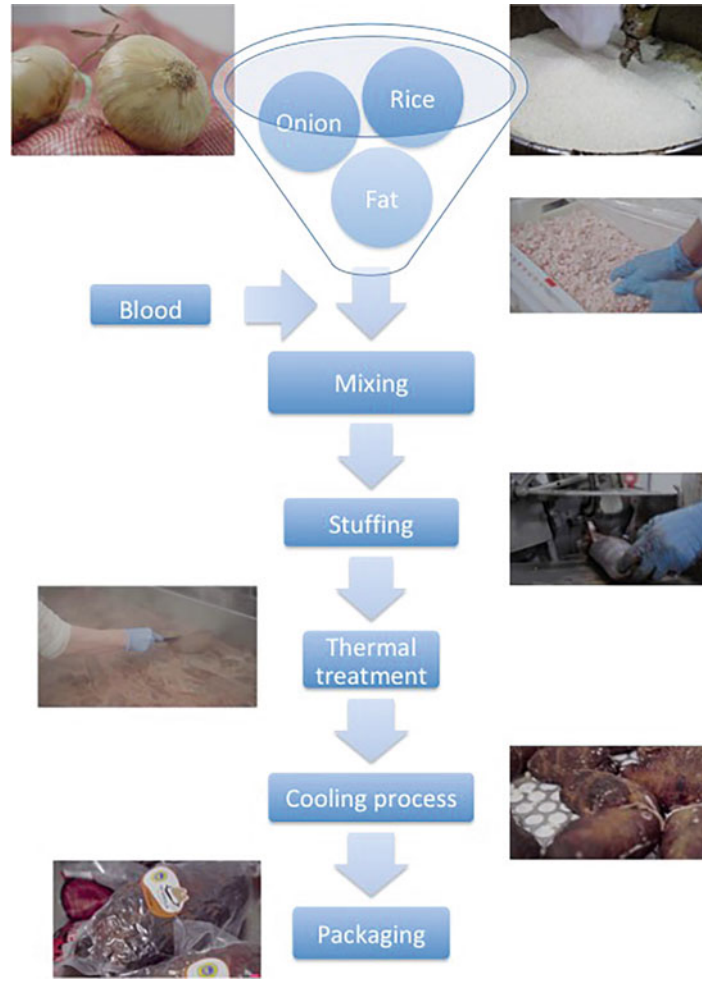


**Fig. 2** Diagram of the different steps of the manufacturing process of *Morcilla de Burgos*

1. The preparation of *Horcal* onions includes peeling and chopping steps, and the fat is also grinded, either frozen or chilled, in regular portions.
2. The main ingredients are mixed with blood, salt, and spices.
3. Then the mixture is stuffed into casings: usually large intestine from pig or small intestine from cow (*see* **Note 5**). The stuffing method requires some expertise since overfilling can provoke the bursting of the casings during the cooking process because of the swelling of the rice. The ends of each *morcilla* are stapled or tied shut (*see* **Note 6**).
4. The cooking process is generally done by immersion in hot water at temperatures below boiling point with gentle

movements to about the breakage of the product. The *morcillas* are cooked for around 1 h (*see* **Note 7**).

5. After the thermal processing, the product is air cooled at 8–10 °C. This step is crucial for the microbial quality of the product. In this point, post-cooking microbial contamination can occur and it will determine the shelf life of the product, especially when it is vacuum packed [7–9].

According to the GPI specifications, Morcilla de Burgos can be sold as a whole, with or without casing, in portions or slices, but always packaged to know its origin.

This product presents a good nutritional balance and the interesting contents of iron because of the blood (165.38–234.85 mg/kg) [1] make the Morcilla de Burgos a good source of heme iron, easily and more efficiently absorbed than inorganic iron.

## 4 Notes

1. The external appearance in mainly determined by the origin of the natural casing used. *Morcillas* elaborated with natural casings from beef are darker and more uniform than the ones elaborated by large bowel from pigs.
2. *Horcal* variety onion presents flattened spherical in shape, diameter of at least 80 mm, weight greater than 100 g, brown skin and the flesh varying from white to light greenish-yellow in color.
3. It may be precooked.
4. It is stored frozen or refrigerated below 4 °C.
5. If natural casings are used, they have to be clean, well preserved and they have to be previously washed and acondicionated.
6. When *morcillas* are tied, enough thread is left to hang it up to air.
7. When precooked rice is use, cooking time can be reduced.

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## References


1. Santos EM, Gonzalez-Fernandez C, Jaime I, Rovira J (2003) Physicochemical and sensory characterisation of "morcilla" from Burgos, a traditional Spanish blood sausage. Meat Sci 65(2):893–898
2. European Commission, 2008. Poverty and social exclusion in rural areas. Final study report. Directorate-general for employment, social affairs and equal opportunities. Unit E2
3. European Union, 2018. Commission Implementing Regulation (EU) 2018/1214 of 29 August 2018 entering a name in the register of protected designations of origin and protected geographical indications ("Morcilla de Burgos" (PGI)). Official Journal of the European Community, 5 September 2018, num 224
4. Arán S (1914) Mataderos, carnes y substancias alimenticias. Industrias de la carne. Gómez Hnos, Sevilla
5. Sanz Egaña C (1928) Industrias de la carne: chacinería moderna (embutidos y salazones). Espasa-Calpe SA, Madrid
6. Martín Bejarano S (2001) Enciclopedia de la carne y los productos cárnicos, vol II. Ediciones Martín & Macías
7. Santos EM, Diez AM, González-Fernández C, Jaime I, Rovira J (2005) Microbiological and sensory changes in "morcilla" from Burgos preserved in air, vacuum and modified atmosphere packaging. Meat Sci 71(2):249–255
8. Diez AM, Santos EM, Jaime I, Rovira J (2008a) Application of organic acid salts and high-pressure treatments to improve the preservation of blood sausage. Food Microbiol 25(1):154–161
9. Diez AM, Santos EM, Jaime I, Rovira J (2009a) Effectiveness of combined preservation methods to extend the shelf life of "morcilla" from Burgos. Meat Sci 81(1):171–177
10. Santos EM, Jaime I, Rovira J, Lyhs U, Korkeala H, Björkroth J (2005) Characterization and identification of lactic acid bacteria in "morcilla" from Burgos. Int J Food Microbiol 97(3):285–296
11. Diez AM, Jaime I, Rovira J (2009c) The influence of different preservation methods on spoilage bacteria populations inoculated in "morcilla" from Burgos during anaerobic cold storage. Int J Food Microbiol 132(2-3):91–99
12. Diez AM, Urso R, Rantsiou K, Jaime I, Rovira J, Cocolin L (2008b) Spoilage of blood sausages "morcilla" from Burgos treated with high hydrostatic pressure. Int J Food Microbiol 123(3):246–253
13. Diario Oficial de la Unión Europea (2016). Procedimientos relativos a la Aplicación de la política de competencia. Publicación de una solicitud con arreglo al artículo 50, apartado 2, letra a), del Reglamento (UE) n.o 1151/2012 del Parlamento Europeo y del Consejo, sobre los regímenes de calidad de los productos agrícolas y alimenticios 2016/C 455/07. 6 de Diciembre de 2016

# Chapter 5

# Salchichón

José Angel Pérez-Alvarez, Manuel Viuda-Martos, Gema Nieto, José Manuel Lorenzo, and Juana Fernández-López

## Abstract

*"Salchichón"* is a traditional dry-cured sausage specialty well distributed in Spain. This sausage is processed in artisanal or industrial techniques. It's one of the "flagships" of Spanish meat products. According to the Spanish Government Departments (Ministry of Agriculture) in 2019, Spaniards eat 11.41 kg/year of processed meats and represented 25.2% of the consumed meat. In these statistics, "*Salchichón"* is the second most-consumed dry-cured fermented sausage in Spain (0.42 kg/year/inhabitant), Andalusia is the Spanish region with higher consumption of these types of meat products (12.09 kg/year/inhabitant). *"Salchichón"* is the third most-consumed dry-cured meat product in Spain for this, is protected by the Spanish Laws. "Salchichón" cover a wide variety of dry-cured sausages ("Fuet", "Imperial de Lorca", "Longaniza de Pascua", among others"). "*Salchichón*" normally is elaborated using lean (shoulder, loins, ham, and other trimmings) and fatty (backfat, belly, among others) pork meats from white and/or Iberian pig breeds, salt, and spices.

Notwithstanding the great variety of "Salchichón" specialities, they have in common the following processing steps: mincing (meat cuts), mixing (meat, salt and spices), stuffing (natural or artificial casing and 8–120 mm diameter), fermentation (14–26 °C) and dry-maturation (natural, cave, artificial maturation chambers, 3–4 days to 2 months processing times). According to its specialty, *"Salchichón"* has legal regulations that guarantee product quality. They have Traditional elaboration processes mean that both products differ enormously from one region to another, or even between different producers. Therefore, nowadays, both sausages have a protected geographical indication, which establishes the minimum characteristics and the processing and formulation conditions that guarantee the quality of the aforementioned products.

In this chapter, formulation and the different elaboration processing steps are described.

**Key words** Salchichón, Dry-cured meat product, Fermented sausage, Dry-cured fermented sausage, Spanish meat products, Research and innovation

## 1 Introduction

From a technological point of view, dry-cured meat products (whole and/or comminuted, dehydrated, or fermented) are one of the oldest meat preparations but, these meat products represent something else. In these types of meat products, art, tradition,

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culture, gastronomy, food technology, innovation is combined, without forgetting the use of local raw materials (sustainability) and also, enhance the Circular Economy.

"*Salchichón,*" as other dry-cured meat products represent the effort of thousands of years to economize and preserve meat that could not be consumed fresh after slaughter [1, 2] for longer periods, and through its processing, increase its shelf-life of raw material of high nutritional [3], economic value with a great social and cultural relevance.

Among the dry-cured sausages, "Salchichón" represents one of the oldest meat products, since its elaboration has been described since Roman times, although it is also indicated in some texts that they have Greek origin. From a cultural point of view, these meat products are eminently Mediterranean that, regardless of the "seashore" where are produced and the consumer's religion (Christian, Hebraic, or Muslim), that are processed, their elaboration process is similar and only adapt the different raw materials to the "food rules" or precepts (Halal, Kosher, Friday of lent) that the three great religions have about them.

There is a great diversity of dry-cured sausages under the appellative of "*Salchichón*" or similar (*"Longaniza de Lorca,"* "*Longaniza de Aragón,*" "*Longaniza de Pascua,*" etc., *"fuet," "espetect,"* among others) (Figs. 1 and 2). Most of these "*Salchichón*" types have high acceptability but with low commercial distribution or scientific studies (physicochemical, microbiological, among others) about them [1].

They have some differences caused by the processor's recipes, the elaboration process (time, temperatures, dehydration conditions) with different raw meat types (*see* **Note 1**), and origins (the Mediterranean or Continentals), formulations (meat/fat ratio, formulation depends on the "*Salchichón*" type), condiments (salt, wine, garlic, among others), spices (pepper: black or white pepper, whole, grinded or both, garlic, among others), additives (with or without dairy ingredients, sugars and starches, curing agents, colorants, etc.), meat grinding size (2–10 mm), casing diameter (10 to 200 mm) and origin (natural or artificial), smoking (only in the northern regions of Spain) and drying (industrial, natural chambers, even caves), artisanal or industrial scales (Fig. 3), small (snack type) or length sized (1.5–2 m) (Figs. 4, and 5) [4, 5]. "Salchichón" types had great development and innovation thanks to the spices that came from "the New World," that spread throughout the world, especially in Europe. This sausage spreads in Spain and other countries in the 1960s, caused by the western country's economic development, the fusion of traditional sausage "making art" together with advances in man-made casing manufacturing


**Fig. 1** Commercial presentation of different "Salchichón" types. (**a**) Artisanal "*Fuet*"; (**b**) Artisanal "*Longaniza imperial de Lorca*" and (**c**) Industrial "Salchichón de Toledo"


**Fig. 2** Packaged and unpackaged Spanish commercial samples of "*Salchichón*" and "*Longaniza*". (**a**) "*Salchichón*" extra semi-circular shape (65 mm); (**b**) "*Longaniza*" extra (33 mm); (**c**) "*Salchichón*" extra round shape (65 mm)

on-going. According to Suursa & Barbut [6], the sausages were stuffed into attractive and functional casings.

All "*Salchichón*" types can be eaten in all processing stages (*see* **Note 2**). These dry-cured sausages are self-stable meat product when rich intermediate moisture values. When this value is not reached, heat treatment is suggested for its consumption.

Therefore, considering the abovementioned, the main objective of this chapter is to make a detailed description of the different processing conditions (formulations, raw materials, ingredients, times, temperatures, etc.) of the Spanish "*Salchichón*."


**Fig. 3** "*Longaniza seca*" elaborated with different pork breeds. (**a**) "White breeds" (commercial meat); (**b**) "*Chato Murciano*" breed; and (**c**) "*Porco Celta*" breed

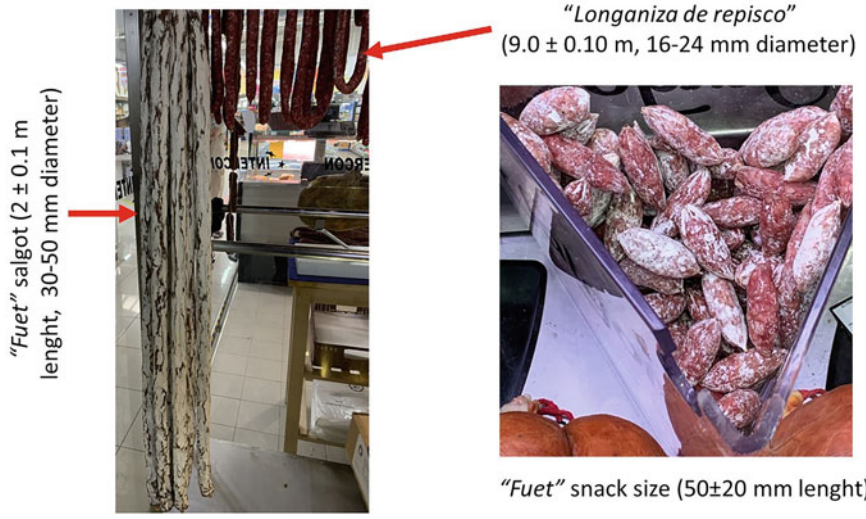


**Fig. 4** Length, diameter, and size of different "*Salchichón*" types ("*Fuet*" and "*Longaniza de repisco*") commercially available in the Spanish market


**Fig. 5** Different types of commercial "Salchichón" type snacks in the Spanish market. (**a**) Fuet cocktail size; (**b**) fuet stick size; (**c**) chicken Longaniza sticks size; (**d**) Longaniza sticks size

## 2 Materials

To avoid possible fraud to the consumer, *Salchichón* is regulated by the Spanish Laws. For this reason, this dry-cured sausage, as well as meat product it must comply with the provisions of 1.1 of Annex I of Regulation 853/2004 of the European Parliament and of the Council of April 29, 2004. In 2014, Spanish legislation protects "*Salchichón.*" Thus, the Royal Decree 474/2014, [7], approves the meat products quality standard. This document, according to their elaboration process and treatment applied, classify meat products, the composition, and quality characteristics, labeling, safety standards (to control elaboration process, critical control points during processing, industrial auto-control rules, and traceability, are established. In Table 1 the legal requirements for the different commercial "*Salchichón*" types can be seen [7].

As was mentioned above, "*Salchichón*" can be described as a dry-cured sausage that is made with minced lean a fatty tissues, added with salt (marine or rock), to which curing salts (nitrites and/or nitrates, ascorbates, erythorbates) are added with other ingredients (*see* **Note 3**), starter cultures [3, 8, 9] among others. In Iberian "*Salchichón,*" some producers even used small amounts of paprika to improve the flavor and taste) and that after a process of mixing and resting, it is stuffed into natural or artificial casings (cellulose, collagen, small and large intestine from pork, beef, veal, sheep, foal) that undergo a fermentation process (using autochthonous microbiota or starter cultures and depending on the "*Salchichón*" specialities it can be applied a smoking process) and drying-maturation [10, 11]. However, the elaboration process, as well as the main steps, are mentioned, as will be discussed in the following sections of this chapter.

**Table 1**
**Commercial categories, composition, and legal requirements for the different "*Salchichón*" types commercialized in the Spanish market [7]**

| *Salchichón* type | Commercial category | Fat (g/100 g D.M.) | Carbohydrates (g glucose/100 g D.M.) | Protein (g/100 g D.M.) | Collagen/protein ratio (%) | Added protein (g/100 g) |
|---|---|---|---|---|---|---|
| Commercial | Premium (extra) | ≤57 | ≤9 | ≤30 | ≤16 | ≤1 |
| Salami | Premium (extra) | ≤68 | ≤9 | ≤22 | ≤25 | ≤1 |
| *Salchichón* de Málaga | Premium (extra) | ≤50 | ≤5 | ≤37 | ≤14 | ≤1 |
| Iberian *Salchichón* | Premium (extra) | ≤65 | ≤5 | ≤22 | ≤25 | ≤1 |
| *Salchichón* | | ≤70 | ≤10 | ≤22 | ≤30 | ≤3 |

*D.M.* Dry matter

## 3 Methods

Among sensory properties, in "*Salchichón,*" one of the most valued-added characteristics that consumers appreciated it's the long shelf-life (auto-stable at room temperature). This is caused by different barriers or hurdles [12] for the spoilage microbial growth and favors beneficial microbiota. Also, ultrastructural modifications caused by the salt effect upon myofibrillar proteins (actin–myosin complex) and acidic gelification of those proteins by the effect of lactic acid, generated by the microbiota metabolism (mainly by the Lactic Acid Bacteria-LAB), curing agents such as nitrate, nitrite, and sodium ascorbate. Nitrites contribute with the antioxidant and antimicrobial activity in the sausages, among cured color formation and avoid the warmed-over-flavor in this type of sausages: Microbiota metabolism among lactic acid formation also contributes to flavor and taste formation. The combination of these factors provokes hurdles that also reduce the redox potential, and generates an intermediate moisture food (water activity ≤0.90).

The dry-cured sausages can be described as processed meat products that are made with minced lean a fatty tissues, added with salt (marine or rock), to which curing salts (nitrites and/or nitrates, ascorbates, erythorbates) are added with other ingredients (carbohydrates: lactose, glucose, saccharose, potato starch, cooked rice, dietary fibers; unsaturated fatty acids [8, 13] lemon juice, wine, vinegar, nuts: almonds, walnuts, pistachios, etc.), additives

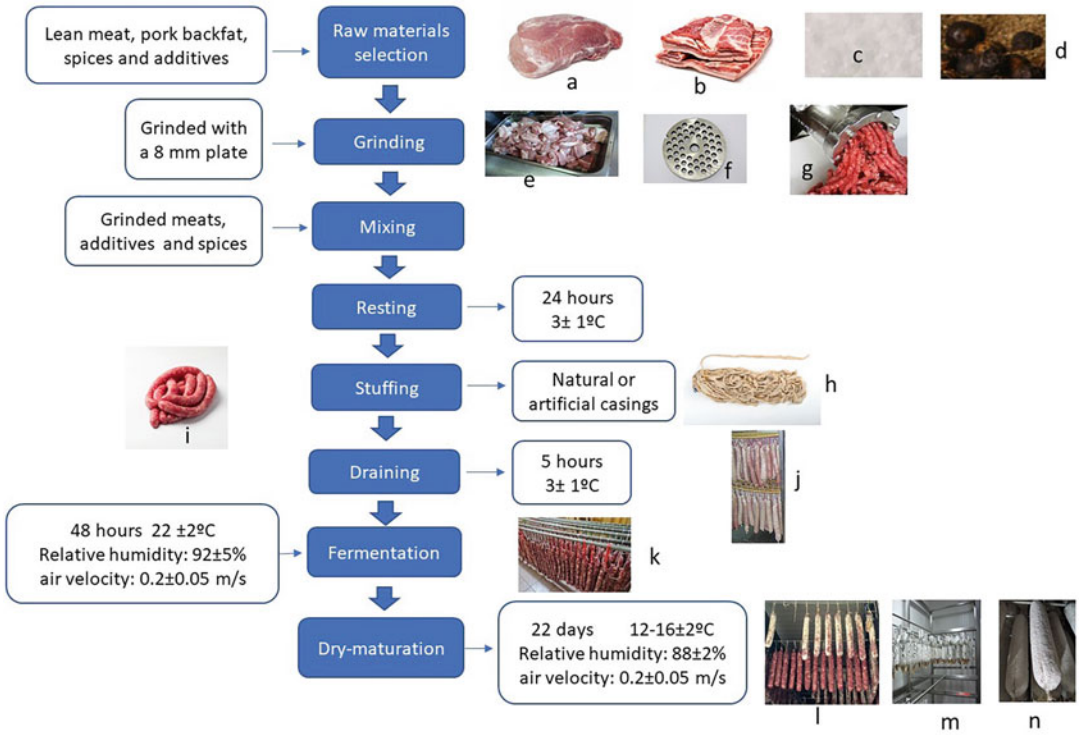


**Fig. 6** Conventional commercial "*Salchichón*" processing flow chart. (**a**) Pork lean meat; (**b**) Pork backfat; (**c**) Salt; (**d**) Ground and whole black pepper; (**e**) Trimmed lean meat; (**f**) Grinder 8 mm plate; (**g**) Ground meat; (**h**) Natural pork casings; (**i**) Stuffed "*Salchichón*" meat batter; (**j**) Drained "*Salchichón*" fresh sausages; (**k**) "*Salchichón*" during fermentation stage in controlled conditions chamber; (**l**) "*Salchichón*" during the first week on the dry-maturation stage; (**m**) "*Salchichón*" during the second week on the dry-maturation stage; (**n**) Finished "*Salchichón*" at the end of the dry-maturation stage

(phosphates) and spices (black and white pepper, anise, cinnamon, garlic, onion, oregano, among others) and that after a process of mixing and resting, it is pressed into natural or artificial casings that undergo a fermentation process (employing autochthonous microbiota or starter cultures and depending on the dry-cured sausages specialties it can be applied a smoking process) and drying-maturation [10]. In Fig. 6 the flow chart of the "*Salchichón*" elaboration process can be observed.

There is not only one formulation for each *Salchichón*" type, all of them are elaborated considering the producer's traditional knowledge or the innovation developed (fats, carbohydrates, additives reduction, new ingredients addition, among others) [5], to satisfy the consumer's special requirements applied to this well-known dry-cured sausage.

The "*Salchichón*" processing stages can be summarized as:

1. Raw material: "*Salchichón,*" as a meat product, is prepared totally or partially with authorized meat (pork, beef, poultry,

game, among others) mentioned in point 1.1 of Annex I of Regulation 853/2004 of the European Parliament and of the Council of April 29, 2004, and is prepared according to establish in the European Community Food Regulations Laws.

2. Mincing-Mixing: All lean and fatty cuts are ground with different plates holes (2–10 mm) according to each sausage specifications, ingredients are incorporated and make de "Salchichón meat batter." In, both stages meat proteins, fats, salt, and other ingredients start all. At this stage, important changes take place (*see* **Note 4**). At this point, the "meat batter" is formed.
3. Stuffing: The meat batter is introduced, by pressure, in a natural or artificial casing, that gives the special shape and length (Figs. 1, 2, 3, 4, 5).
4. Resting: is a short-term stage (12–24 h), in this stage allows that the formulation water excess can be eliminated through the casing pores.
5. Fermentation: In this stage, temperature favored, the microbiota growth ("wild microbiota" or that the starter culture is intentionally incorporated). Microbiota metabolizes "natural" or added sugars and produces lactic acid, which reduces "*Salchichón*" pH. Changes in pH produce several changes in the meat batter (*see* **Note 5**) take place. From an industrial point of view, this stage can be made in two ways: cold and warm fermentation. Thus, "cold" fermentation (fermentation temperatures are between 16 and 18 °C) and "warm" fermentation (fermentation temperatures between 19 and 28 °C). The fermentation time will depend on the "Salchichón" diameter (1–2 days in cold fermentations to 7 days in "warm fermentations") and sensory characteristics of the sausages. In both fermentation types, the relative humidity in the fermentation chamber is high (90–95%), to avoid that the surface dehydrates and separation between meat batter and casing takes place. This aspect must be avoided during the changes from sol to gel in the stuffed sausage meat batter ("fresh Salchichón").
6. Smoking: This treatment is applied in few "*Salchichón*" types, mainly in rural areas from the north of Spain (*see* **Note 6**).
7. Dry-maturation is the longest stage of the elaboration process. In this stage, chemical, physical, physicochemical, microbiological, and sensorial changes take place. From the industrial point of view "*Salchichón*" must lose, at least 30% of their original weight ("merma"). Also, water activity (Aw) is a good indicator that the product is finished (Aw $\leq$0.90, Intermediate Moisture Food) and is self-stable at room temperature (Fig. 2). This stage is characterized by a slow and gradual reduction in chamber humidity (90–80%), pH increase caused by the microbiota evolution, the dynamic enzymatic activity

**Table 2**
**Agreements between the Spanish Health Agencies and the Meat Industry for the reduction of salt, fat, and sugars content in Salchichon (Premium quality) until 2020**

| Ingredient | Reduced amount in meat products (%) | Average concentration (g/100 g) 2016 | Average concentration (g/100 g) 2020 |
|---|---|---|---|
| Salt (NaCl) | 16 | 3.9 | 3.5[a] |
| Total fat | 5 | 41.0 | 38.95 |
| Total sugars | 10 | 4.0 | 3.6 |

[a]To ensure *Salchichón* microbiological safety, only a reduction of 10% can be applied [14]

(to produce aromatic compounds) and most notorious physical change (sausage hardening).

The consumer's information, according to legal requirements for labeling of the Spanish "*Salchichón*" commercial types and another dry-cured specialty associated with this sausage, ingredients, additives and energy value (kJ and kcal) found in the Spanish market is described in [5].

In 2019, the Spanish meat industries and the Spanish Health authorities (Ministry of Health, Consumption and Social Welfare) have reached an agreement (Table 2) about how to reduce the health restrictors (salt content, sugars, saturated fats, and additives) in the meat products. As result of this agreement, meat processors have incorporated some practices to make meat products healthier [14].

## 4 Notes

1. Traditionally, "Salchichón-types" is made with pork meats. There are different pork breeds (normally, "White," "Celta," "Chato Murciano," and "Iberian breeds") that are used in these dry-cured sausages. Also, other meat types (goat, sheep, foal or beef meats, and games) can be used as raw material.
2. All "Salchichón-types," can be eaten during mixing-resting stage, at the end of the fermentation stage and in all dry-curing stage.
3. "Salchichón-types" can be formulated with no-meat ingredients such as: (carbohydrates: lactose, glucose, saccharose, potato starch, cooked rice, maltodextrins, quinoa flour, dietary fibers (pea, soy, orange, lemon, apple, datepalm, tiger nut) [8]; lemon juice, white wine, vinegar, nuts: date palm, roasted almonds, walnuts, pistachios, pine seed, chia, and sunflowers seeds, etc.), additives (phosphates), and spices (black and white pepper, anise, cinnamon, garlic, onion, oregano.

4. During this stage, the biochemical, chemical physicochemical, microbiological, physical, and sensorial changes take place. Meat color pigments are formed and solubilization of actomyosin complex occurs.
5. Biochemical (enzyme activities), chemical (protein and fat hydrolysis among others), physical (color, texture) and physicochemical (water holding capacity, oil holding capacity, water activity, etc.) changes take place. Microbiota metabolism also generates other chemicals, physical, physicochemical, and sensory changes that characterize this type of meat product.
6. In the drying-smoking chamber, the smoke must impinge on the sausage indirectly. Woods used should not be damp or green, they should not come from resinous wood (avoid the use of pine wood or similar).

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### References

1. Aleu, G. (2017). Estudio de distintas matrices de formulación con propiedades funcionales de productos crudo-curados embutidos característicos de la Provincia de Córdoba. Ph.D. Thesis. Facultad de Ciencias Agropecuarias. Taholic University of Cordoba (Argentine). pp: 1–148
2. Marchello M, Garden-Robinson J (2017) The art and practice of sausage making. North Dakota State University, Fargo, North Dakota, pp 1–12
3. Sirini N, Roldán A, Lucas-González R, Fernández-López J et al (2020) Effect of chestnut flour and probiotic microorganism on the functionality of dry-cured meat sausagets. LWT 134:110197
4. Toldrá F, Nip W-K, Hiu YH (2007) Dry-fermented sausages: an overview. In: Toldrá F (ed) Handbook of fermented meat and poultry, 1st edn. Blackwell Publishing, Hoboken, New Jersey, pp 321–325OGA
5. Pérez-Alvarez JA, Viuda-Martos M, Fernández-López J (2022) Salchichon (Spanish dry-cured sausage). An integrated point of view through culture, technology and innovation. In: Munekata PES, Pateiro M, FRanco D, Lorenzo JM (eds) Pork meat quality and processed meat products. CRC press. Taylor & Francis Group, Boca Raton FL, USA. ISBN: 978-0-429-32403-1 (ebk)
6. Suursa P, Barbut S (2020) Collagen use for co-extruded sausage casings – a review. Trends Food Sci Technol 102:91–101
7. BOE (2014) Real Decreto 474/2014, de 13 de junio, por el que se aprueba la norma de calidad de derivados cárnicos.Ministerio de la Presidencia. 147, 18 de junio de 2014 Sec. I. 46058–46078
8. Sánchez-Zapata E, Díaz-Vela J, Pérez-Chabela ML, Pérez-Alvarez JA, Fernández-López J (2013) Evaluation of the effect of Tiger nut fibre as a carrier of unsaturated fatty acids rich oil on the quality of dry-cured sausages. Food Bioproc Technol 6(5):1181–1190
9. Sayas-Barberá E, Viuda-Martos M, Fernández-López J et al (2012) Combined use of a probiotic culture and citrus fiber in a traditional

sausage 'Longaniza de Pascua'. Food Control 27(2):343–350

10. Sayas-Barberá E, Fernández-López J, Pérez-Alvarez JA (2007) In: Sayas-Barberá E, Fernández-López J, Pérez-Alvarez JA (eds) Elaboración de embutidos crudo-curados. In Industrialización de Productos de Origen Animal. Universidad Miguel Hernández de Elche, Elche (Spain), pp 77–101
11. Lorenzo JM, Munekata PES, Campagnol PCB, Zhu Z, Alpas H, Barba FJ, Tomasevic I (2017) Technological aspects of horse meat products – a review. Food Res Int 102:176–183
12. Leistner (1995) Stable and safe fermented sausages worldwide. In: Campbell-Platt G, Cook PE (eds) Fermented meats. Blackie Academic & Professional, London, pp 160–175
13. Lorenzo JM, Munekata PES, Pateiro M, Campagnol PCB, Domínguez R (2016) Healthy Spanish salchichón enriched with encapsulated n − 3 long chain fatty acids in konjac glucomannan matrix. Food Res Int 89(1):289–295
14. BOE (2019). Resolución de 8 de febrero de 2019, de la Secretaría General de Sanidad y Consumo, por la que se publica el Convenio entre la Agencia Española de Consumo, Seguridad Alimentaria y Nutrición y la Federación Empresarial de Carnes e Industrias Cárnicas, para el desarrollo de los acuerdos del plan de colaboración para la mejora de la composición de los alimentos y bebidas y otras medidas 2017-2020. Ministerio de Sanidad, Consumo y Bienestar Social. Boletín Oficial del Estado, miércoles 13 de marzo de 2019. Gobierno de España. 62. Sec III: 24134–24143
15. Sayas-Barberá E, Pérez-Alvarez JA et al (1998) Physical and physicochemical characterization of Longaniza imperial de Lorca. Alimentaria 294:27–33

# Chapter 6

# Androlla and Botillo

**Rubén Domínguez, Mirian Pateiro, Paulo C. B. Campagnol, Marcelo Rosmini, Paulo E. S. Munekata, Alfredo Teixeira, and José Manuel Lorenzo**

## Abstract

The raising and slaughter of pigs has been a common and traditional practice in the northwestern part of the Iberian Peninsula, including Galicia, Leon, Asturias, or northern Portugal. As a result of this, there are multiple meat products derived from the cultural and climatic peculiarities of each region. In this sense, two typical dry-ripening sausages of Galicia are the androlla and the botillo, although these are also widely consumed in other regions of the northwest of the Iberian Peninsula.

Traditional production processes mean that both products differ enormously from one region to another, or even between different producers. Therefore, nowadays, both sausages have a protected geographical indication, which establishes the minimum characteristics and the processing and formulation conditions that guarantee the quality of said products. With this in mind, the present chapter describes in detail the formulation and the different stages of elaboration of both meat products (androlla and botillo).

**Key words** Traditional meat products, Pork sausage, Dry-cured products, Dry-fermented sausages, Galician meat products, Atlantic-diet, Manufacture process

## 1 Introduction

Androlla and Botillo are two traditional dry-fermented sausages manufactured in Galicia [1], although they are also consumed in other regions of the northwest of the Iberian Peninsula, such as North of Portugal, and Leon or Asturias in Spain. These products were traditionally cured in the "lareiras" (Fig. 1), which were part of the Galician culture (and from the North of Portugal) and were used for curing meat products derived from pig slaughter, widely distributed in these geographical areas and of a family nature. This is because over time, in the different geographical areas, specific products have been developed in accordance with their cultural and climatic peculiarities [2].

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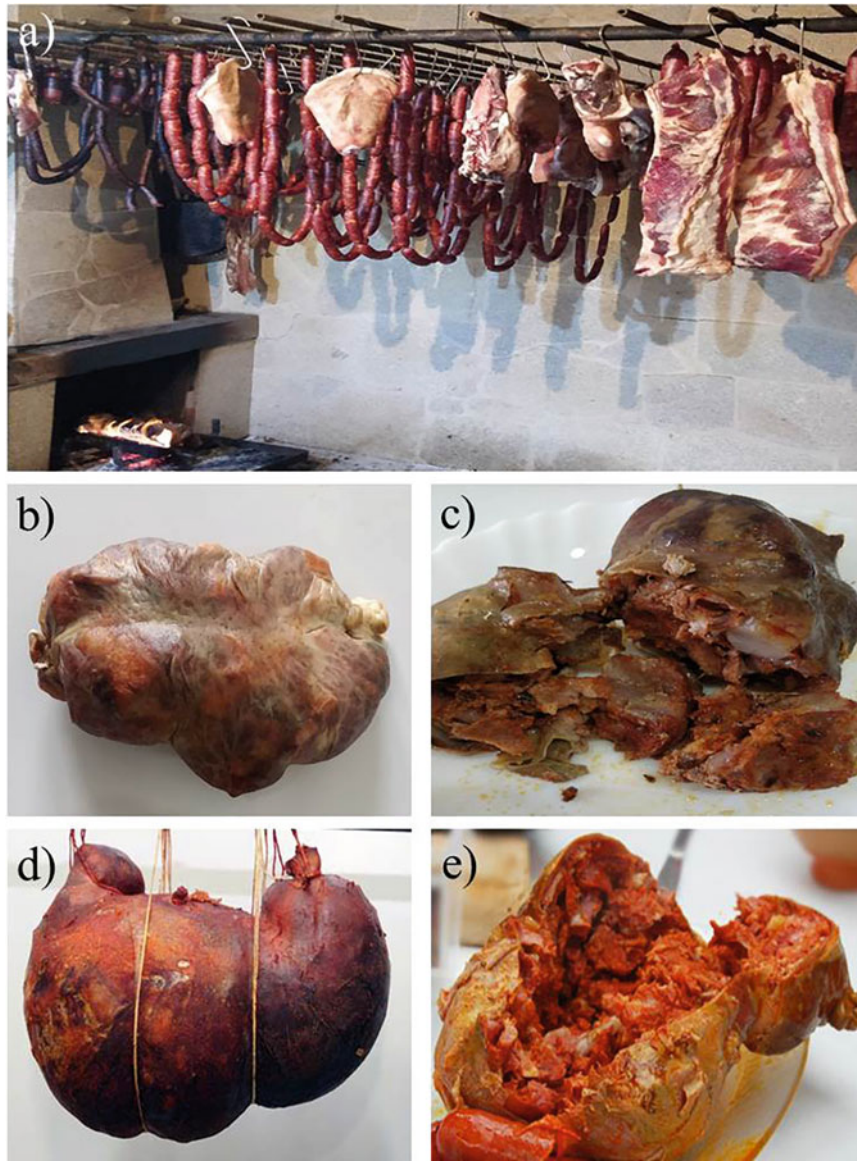


**Fig. 1** Typical "lareira" (**a**), a traditional place in Galician and North Portuguese houses for curing meat products. Androlla appearance after dry-ripening process (**b**) and after cooking (**c**). Botillo appearance after dry-ripening process (**d**) and after cooking (**e**)

During the last decade, and taking into account its great acceptance among consumers, its production has increased, although it is still a typical meat product, made in a traditional or semi-industrial way, following absolutely empiric traditional procedures, so there is great heterogeneity in the products found in the markets [3]. This means that each company or each manufacturer has a unique recipe and probably different from other manufacturers. To avoid large differences and try to standardize these meat products while protecting their quality and characteristics, since 2009 both are

protected under a quality mark with Protected Geographical Indication, which sets minimum criteria for formulation and processing steps that ensure the correct quality of the final product [4, 5].

Despite their wide consumptions, compared to other traditional meat products, the studies carried out on these two products are very scarce. In fact, the few studies carried out in this regard focus on the chemical, physicochemical [2, 6, 7] and microbiological characterization [3], as well as the biogenic amine contents [7, 8]. Additionally, and taking into account that the fermentation and ripening process of sausages involves several proteolytic and lipolytic reactions, responsible for the typical organoleptic characteristic of these products, the study of the proteolytic, lipolytic, and biogenic amines generation capacity of various strains of staphylococci and bacillus isolated from androlla and botillo were analyzed [1, 9]. The objective of these studies is better understanding the role of microorganisms in the release of compounds that play a vital role in the development of the aroma and flavor of these products. Moreover, the use of starter cultures containing selected indigenous microbiota, adapted to meat environment, guarantee products with reproducible organoleptic and hygienic properties [1]. Finally, and taking into account that they are smoked meat products, a study has been carried out on the PAH content in these sausages [10].

Therefore, taking into account the aforementioned, the main objective of this chapter is to make a detailed description of the stages of the manufacturing process as well as the formulation of the androlla and the botillo.

## 2 Materials

According to the regional regulation [4], Androlla is the meat product resulting from the mixture of rib (minimum 90%) and skin, obtained from pork cuts, suitably seasoned and stuffed in large intestine of pigs or cattle, and which are subsequently subjected to a process of smoked with oak wood (*Quercus robur* L.) and cured. The characteristics of the product covered by the protected geographical indication are the following (Fig. 1) (*see* **Note 1**):

1. Shape and external appearance: defined by the shape of the casing, with its own texture and roughness. Casing without tears, completely filled with the meat dough and well adhered to it.
2. Weight: given that the casing in which it is stuffed is natural and not calibrated, the weight will be variable, ranging from a minimum of 0.2 kg to a maximum of 1 kg.
3. Consistency: firm and compact to the touch. The cut will present a heterogeneous and not very tied appearance.

4. Color: intense red, defined by the raw material and the seasonings. It will not present yellowish tones that denote oxidation.
5. Aroma: intense marinated and smoked sausage. Once prepared for consumption, the odor of cooked lean will predominate.
6. Taste: pleasant, spicy, and with a balanced sweet/salty ratio.
7. Texture: fibrous and not homogeneous, depending on the portion that is tasted.

Similarly, Botillo, also known in some areas of Galicia as Botelo or Butelo, is the meat product resulting from the mixture of rib (minimum 70%) and skin, spine, lean, cheeks meat, and other bones with meat (spine and other bones with meat should never represent more than 15% of the total) obtained from pork cuts, suitably marinated and stuffed in cecum, stomachs or bladders, also from pork, which are subsequently subjected to a smoking process with oak wood (*Quercus robur* L.) and cured [5]. The characteristics of the botillo covered by the protected geographical indication are the following (Fig. 1) (*see* **Note 1**):

As in the androlla, shape and external appearance of botillo are defined by the shape of the casing, with its own texture and roughness. Its shape will be oval, in the case of the cecum, and bag-shaped in the case of stomachs or bladders. In this case, the weight of botillo will be variable, since the casing in which it is stuffed is natural and not calibrated, ranging between 0.5 kg and 2 kg in the case of the cecum and bladders, and between 1 kg and 5 kg in the case of stomachs. Moreover, the consistency, color, aroma, taste, and texture characteristics must be exactly the same as those described for the androlla.

In both cases, their consumption is carried out after cooking. It should be noted that the main difference between both products lies in the quantity and variations in some of the ingredients as well as in the casing used. This determines that the botillo is a meat product much thicker than the androlla, so that some of the stages of its elaboration have to be carried out for a longer time. However, the general production process as well as the main stages are shared for both products, as will be discussed in the following sections of this chapter [11].

1. Main ingredients: Pork ribs and skin (*see* **Note 2**).
2. In botillo formulation, also the use of spine and other bones with meat, lean and/or cheeks meat is allowed (*see* **Note 3**).
3. Common salt, sweet and spicy paprika, garlic and, optionally, nitrifying salt and oregano are used as seasoning ingredients/spices (*see* **Note 4**).
4. Casings: In androlla, the allowed casing is the large intestine, while botillo could be stuffed in cecum, stomach, or bladders.

## 3 Methods

The different phases of the manufacturing process will be carried out in accordance with the traditional knowledge of the producers, in order to obtain a product of the highest quality. The elaboration process of both meat products (androlla and botillo) consists of a series of steps, including meat selection, mincing, mixing, macerating, stuffing, smoking, and curing, which will be carried out as described below (Fig. 2):

1. The selection of the meat is carried out at a maximum temperature of 7 °C and a pH of 5.4 to 6.2.
2. The mincing of the ingredients is done in pieces or regular portions.
3. Mixing the "meat" ingredients with the salt and the species/seasoning ingredients.
4. The maceration will be carried out after mixing, for a minimum period of 12 h and at a maximum temperature of 5 °C. Dough knead is usually carried out (*see* **Note 5**).
5. Then the dough will be stuffed into large intestine (androlla) or the cecum, stomach, or natural pig bladders (botillo) and tied (manually or automatic). The stuffing method used should

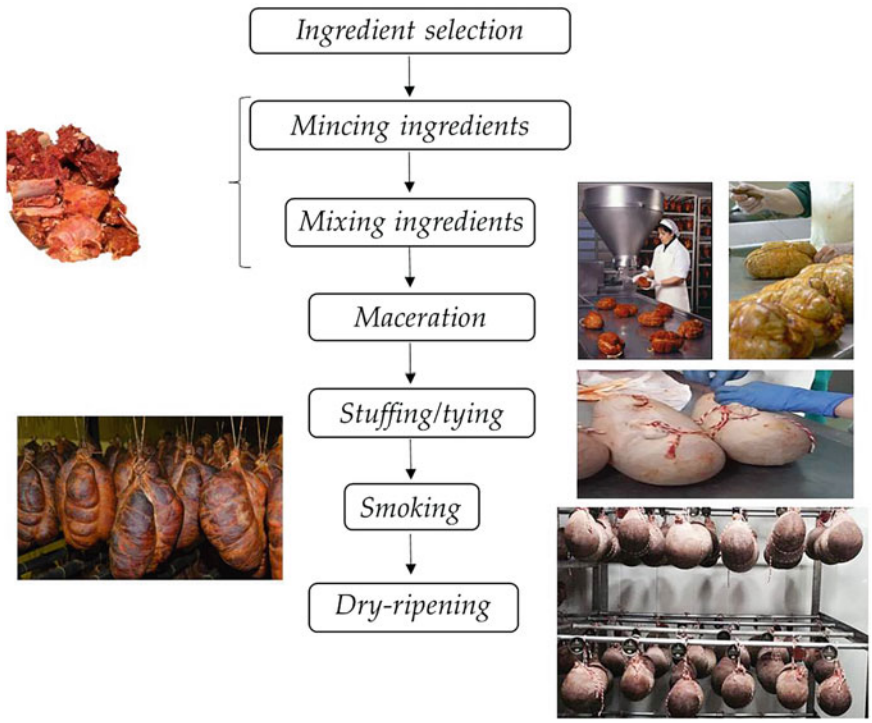


**Fig. 2** Diagram of the different stages of the manufacturing process of androlla and botillo

avoid the formation of air pockets between the meat mass, as well as the breakage of the casing. Cotton twine or staple are used for tying (*see* **Note 6**).

6. Dry oak wood is used for smoking, a species of the Quercus genus (*Quercus robur* L.) typical of the region. The minimum smoking time will be 10 h in androlla and 30 h in botillo (*see* **Note 7**). This process will take place in premises conditioned for this purpose or in natural drying rooms, which allow ventilation control.
7. Dry-curing is the final stage of the elaboration, in which the drying and ripening process is carried out with a minimum of 5 days in androlla and 7 days in botillo, counted from the stuffing (*see* **Note 8**). This process is carried out in locals equipped for this purpose or in natural drying rooms, which allow ventilation control and, therefore, achieve optimal conditions of temperature and relative humidity, so that the resulting product acquires the traditional characteristics in terms of color, aroma, and flavor typical of Androlla and Botillo de Galicia.

The chemical composition of the final products (after the drying-ripening period), are specified in Table 1. Both products are commercialized in independent units. Androlla and botillo may be authorized to be sold vacuum packed, raw or after cooking, or in a modified atmosphere, provided that their quality and prestige are not impaired.

**Table 1**
**Proximate composition (g/100 g) and main fatty acids (g/100 of fat) of dry-ripening androlla and botillo**

| | Androlla | Botillo |
|---|---|---|
| Moisture | 37.9–44.6 | 50.6–53.0 |
| Protein | 21.7 | 17.7–40.2 |
| Fat | 21.2–26.4 | 14.81–17.8 |
| Ash | 4.04 | 4.85 |
| Salt | 2.27–3.14 | 2.58–3.18 |
| pH | 5.39 | 5.54–5.62 |
| SFA | 37.99 | 36.08 |
| MUFA | 49.51 | 47.98 |
| PUFA | 12.51 | 15.93 |

*SFA* saturated fatty acids, *MUFA* Monounsaturated fatty acids, *PUFA* polyunsaturated fatty acids, Data obtained by published articles [2, 3, 6, 7]

## 4 Notes

1. The raw material will come from castrated males or females. Animals used for reproduction cannot be used to obtain androlla and botillo covered by the protected geographical indication.
2. The ribs must represent at least 90% in the androlla and 70% in the botillo.
3. Bones other than ribs must be less than 15% of the botillo weight.
4. These ingredients are common to both products. There are no specific amounts, so each manufacturer mixes these ingredients according to their own criteria.
5. Although a minimum of 12 h is established, maceration periods of 24 to 48 h are recommended [6].
6. Before or after stuffing, the casing of botillo can be subjected to a coating process with a solution of paprika and water.
7. Although minimum smoking times are established, generally, the time of the smoking process is longer, reaching 8–10 days in the androlla and 7–15 days in the botillo [6].
8. Longer drying-ripening times are recommended for the development of more intense typical product aromas and flavors. In the case of androlla, the drying-ripening process can take 1–-2 months, while in botillo it would be longer than 3 months [6].

## Acknowledgments

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### References

1. Cachaldora A, Fonseca S, Franco I et al (2013) Technological and safety characteristics of Staphylococcaceae isolated from Spanish traditional dry-cured sausages. Food Microbiol 33: 61–68
2. Franco I, Iglesias S, Prieto B et al (2004) Perfiles de ácidos grasos totales y libres en embutidos crudo-curados tradicionales de Galicia. Grasas Aceites 55:273–281
3. García Fontán MCMC, Lorenzo JMJM, Martínez S et al (2007) Microbiological characteristics of Botillo, a Spanish traditional pork sausage. LWT—Food Sci Technol 40:1610–1622
4. DOGA (2009), ORDEN de 23 de marzo de 2009 por la que se adopta decisión favorable en relación con la solicitud de registro de la indicación geográfica protegida Androlla de Galicia

5. DOGA (2009), ORDEN de 6 de febrero de 2009 por la que se adopta decisión favorable en relación con la solicitud de registro de la indicación geográfica protegida Botelo de Galicia y se publica su pliego de condiciones
6. Lorenzo JM, Michinel M, López M et al (2000) Biochemical characteristics of two Spanish traditional dry-cured sausage varieties: Androlla and Botillo. J Food Compos Anal 13: 809–817
7. Lorenzo JM, Martínez S, Franco I et al (2008) Biogenic amine content in relation to physicochemical parameters and microbial counts in two kinds of Spanish traditional sausages. Arch Leb 59:70–75
8. Lorenzo JM, Cachaldora A, Fonseca S et al (2010) Production of biogenic amines "in vitro" in relation to the growth phase by Enterobacteriaceae species isolated from traditional sausages. Meat Sci 86:684–691
9. Cachaldora A, Fonseca S, Gómez M et al (2014) Metabolic characterization of bacillus subtilis and bacillus amyloliquefaciens strains isolated from traditional dry-cured sausages. J Food Prot 77:1605–1611
10. Lorenzo JM, Purriños L, Fontán MCG et al (2010) Polycyclic aromatic hydrocarbons (PAHs) in two Spanish traditional smoked sausage varieties: "Androlla" and "Botillo". Meat Sci 86:660–664
11. Lorenzo JM, Domínguez R, Pateiro M et al (2020) Catálogo de productos cárnicos Iberoamericanos, Red Healthy Meat (CYTED 119RT0568). Ourense, Spain

# Chapter 7

# Dry-Cured Ham

**Rubén Domínguez, Mirian Pateiro, Alfredo Teixeira, José Angel Pérez-Alvarez, Eva María Santos, Marco Antonio Trindade, Paulo E. S. Munekata, and José Manuel Lorenzo**

## Abstract

Dry-cured ham is one of the cured meat products consumed worldwide that is most appreciated by consumers. Its organoleptic characteristics are responsible for this great acceptance by the consumer. Even so, there are a great variety of factors, both intrinsic and extrinsic, that largely determine the quality of this product. Among them, the processing and dry-cured conditions are vital for the correct development of the typical characteristics. Both, proteolytic and lipolytic reactions and lipid oxidation during the drying-curing step are responsible for the flavor and the texture properties of ham, which has a strong influence on the sensory characteristics and determine the quality of the final product.

With this in mind, the present chapter describes in detail the formulation and the different stages of elaboration of dry-cured ham. Moreover, this chapter also explains the importance of quality to dry-cured ham manufacture.

**Key words** Traditional meat products, Manufacture process, Ham, Dry-cured process, Muscle food

## 1 Introduction

Dry-cured ham origin is not well known but the historical references date from antiquity. The beginning of the production of ham was centered in the Mediterranean regions due to their special climatic characteristics, which made them suitable for a correct curing process. However, technical advances have allowed its production to be introduced in other regions such as China or the USA [1]. Therefore, nowadays this product is a worldwide consumed high-quality meat product.

According to the Spanish regulation [2], dry-cured ham is the product made with the rear leg, which has generally been subjected to a salting process, possibly accompanied by the addition of spices, condiments, and additives, washing, resting or post-salting and maturing and drying for long enough to give it its own

José Manuel Lorenzo et al. (eds.), *Production of Traditional Mediterranean Meat Products*, Methods and Protocols in Food Science, https://doi.org/10.1007/978-1-0716-2103-5_7,

organoleptic characteristics. As reported by the regulation, the manufacturing process usually involves the salting of the entire back leg with the aim to stabilize the raw material, followed by a post-salting step in which the salt is distributed through the piece (at low temperatures), and finally, dry-cured step in which the ham is submitted to different drying conditions, increasing temperature and decreasing relative humidity [3]. Through this process, the release of free amino acids and fatty acids (from protein and lipids, respectively) and the further conversion to other secondary products during oxidative and Maillard reactions giving rise the volatile compounds and thus, the particular flavor and odor of this product [4–6]. Also, the proteolytic reactions have a critical influence on the texture properties of dry-cured hams, since excessive proteolysis could produce a detrimental in the ham quality [7]. In this regard, the correct distribution of the salt in the muscle is essential for appropriate development of the process [3]. It is well known that both, the content and distribution of salt throughout the piece regulates the enzymatic reactions and also control microbial growth [8, 9]. Moreover, the salt content also exerts an important role in the oxidative processes during the dry-curing step, since it is pro-oxidant [6], which influence the final flavor of the product. Thus, salting, post-salting, and curing stages are critical steps in dry-cured ham manufacture. However, current consumers are aware about the effect of diet in their health, and several studies related the high sodium intake with the development of various diseases [8]. So, following both, consumers demand and international health institutions recommendations, the meat industry has proposed the partial NaCl replacement by other salts [10–16]. Nevertheless, this aspect has several implications in both, nutritional and sensory quality, since the sodium chloride replacers have different inhibitory effects than NaCl, which affect all the aforementioned reactions [17].

On the other hand, due to the specific and characteristic manufacture process or pig breeds used for the dry-cured ham production, several quality seals and marks worldwide have been created (Jamón Serrano, Jamón de Jabugo, Jamón de Guijuelo, Jamón Ibérico, Presunto do Alentejo, Presunto de Barrancos, Presunto de Barroso, Prosciutto di Parma, Prosciutto di Norcia, Prosciutto Toscano, Elenski but, etc.), which are protected as Protected Geographical Indications, Protected Denominations of Origin and Guaranteed Traditional Specialties or any other quality protected mark [18]. This fact not only prevents fraud but also regulates and standardizes the production process, facilitating uniformity in the quality of the final product. In addition, within each denomination, there is the possibility of a subclassification based on the duration of the curing process (e.g., Bodega, Reserva, Gran Reserva, etc.). Despite the variations between all of them, the general process is shared.

Therefore, taking into account the aforementioned, the main objective of this chapter is to make a detailed description of the stages of the manufacturing process as well as the formulation of the dry-cured ham.

## 2 Materials

1. Back leg of pig (*see* **Note 1**).
2. Common salt.
3. Nitrifying salt (nitrite/nitrate) and other additives such as ascorbate or sugar (*see* **Note 2**).
4. Salting and post-salting rooms (temperature and relative humidity controlled) (*see* **Note 3**).
5. Dry-curing room (temperature, relative humidity and air speed controlled) (*see* **Note 3**).
6. Auxiliary materials (scales, pH meter, containers, knives, etc.) (*see* **Note 4**).

## 3 Methods

The different phases of the manufacturing process will be carried out in accordance with the traditional knowledge of the producers and the PDO, PGI, or other protection marks specifications. The objective of the dry-cured ham manufacture is to obtain add-value products, without defects, sanitary secure and with genuine and appreciated organoleptic characteristics [1]. Although little differences between producers, the manufacturing process of dry-cured ham consist of a common series of steps, including an exhaustive control, selection and classification of raw material, salting, post-salting, dry-curing, and in most cases an ageing period to obtain extra quality products, which will be carried out as described below (Fig. 1). Though it is not common, it is important to highlight that some manufacturers include a smoking step, as in the case of Country Ham.

1. The selection, classification, and control of the raw meat should be carried out at refrigerated temperatures (<7 °C). An exhaustive control of pH should be carried out to prevent future problems (PSE of DFD defects), and the pH values 24 h after slaughter must range between 5.6 and 6.2.
2. After selection, each piece is outlined removing part of the muscle, fat, and skin to get the desired form. Then, bleed is made by either manual pressure or mechanical pressure removing the rest of the blood. Legs are kept in a refrigeration

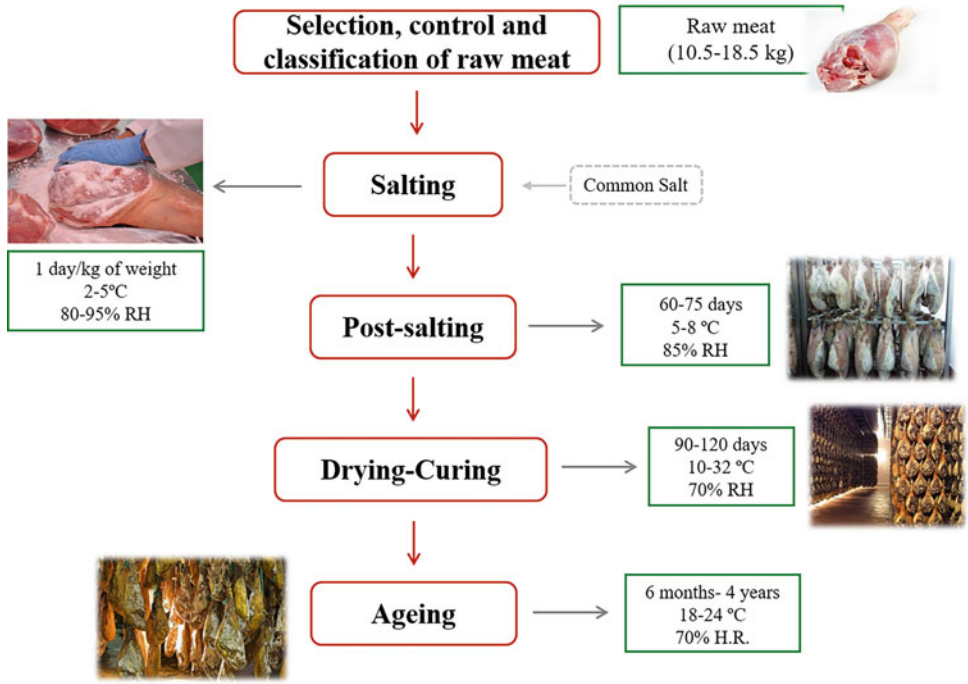


**Fig. 1** Diagram of the different stages of the manufacturing process of dry-cured ham

chamber at 0–3 °C for 1 or 2 days to reduce internal temperature. Finally, pieces are classified by weight and fat level (*see* **Note 5**).

3. In order to achieve microbial stabilization, the next step is the salting process. First, the curing salts (both common and nitrifying salts) are incorporated. In this case, they could be added by the unspecified amount, in which hams are piled into a chamber previous rubbed with a first layer of curing salts (Fig. 2). For uniform distribution re-piling and adding of dry-curing salt should be carried out every week with the lower piles up and the upper ones down. The salting time is dependent on the mass of the meat and is from 1 day up to 2.5 days per kg (generally 1 day/kg) if the meat is fresh and less than 1 day/kg if the meat was previously frozen [12]. Another possibility is the addition of a determinate amount of salts (between 35 and 90 g per kg of weight), but this procedure is longer (about 2–4 weeks) and complex. The salting process occurs at 2–5 °C and 80–95% of relative humidity to obtain the inhibition of undesirable microorganisms and to prevent the external desiccation of hams. During the salting step, internal water leaves outside and lead the salt diffusion to the internal muscles.

**Fig. 2** Examples of hams salting using dry-salting method

4. Once the necessary time for salting has elapsed, the post-salting process is carried out. In this step, salt is spread out uniformly into the different muscles of the ham and cause partial dehydration by osmosis. This produces control of microbial growth and regulates proteolytic and lipolytic phenomena, which are vital for the development of characteristic aroma and texture. The first operation is the removal of excess salt by brushing each piece (*see* **Note 6**), which are hanged in racks by the feet. In order to maintain the microbiological stability, while the water activity is >0.96 the pieces should be maintained below 5 °C, and then, the temperature could be increased to 5–8 °C. Additionally, with the aim to prevent the formation of a crust, high relative humidity (about 85%) should be maintained during this step, but enough low to remove the superficial humidity. In this case, also the air circulation and air speed are important since they ensure the correct dehydration of the pieces. The post-salting step lasts between 60 and 75 days (*see* **Note 7**).
5. The next phase is drying-curing, in which the most important biochemical changes takes place. In this step, the proteolytic and lipolytic phenomena, as well as a moderate oxidative process are the main responsible for the development of the typical

**Table 1**
**Proximate composition (g/100 g) of dry-cured ham**

| | Bermúdez et al. [19] | Yim et al. [20] | Carcò et al. [21] |
|---|---|---|---|
| Moisture | 35.8–46.6 | 53.9–56.0 | 50.4–50.8 |
| Protein | 73.1–80.7[a] | 26.8–28.0 | 28.0–28.9 |
| Fat | 5.96–12.8[a] | 3.24–6.17 | 13.3–14.6 |
| Ash | 11.4–12.4[a] | 11.8–13.0 | 6.8–7.1 |
| Salt | – | 14.1–17.3 | 5.16–5.34 |
| pH | 5.98–6.02 | 5.74–5.83 | 5.49–5.52 |

[a]Expressed as percentage of dry-matter

sensorial characteristics of dry-cured ham. In this phase, the temperature change over time. In the beginning, about 10–12 °C and moderate-high relative humidity (~70%) is recommendable to prevent intense dehydration which could form a crust and also affect the biochemical changes. The temperature value increases progressively until 32–35 °C at the final of this step. This fact ensures the correct development of flavor and aroma of the product. The drying-curing phase duration is, at least 3 (generally between 3 and 4 months) months, but it can be extended to 12 months (*see* **Note 8**). The proximate composition of the final product is shown in Table 1.

6. The ageing phase is optional. This step duration varies between 6 months and 4 years, in which the pieces are maintained at 18–24 °C and 70% of relative humidity. In this phase, the biochemical and enzymatic reactions beginning previously continue for a minimum period of 10 months. At this moment, the action of microorganisms, basically yeasts and molds, has an important role in final flavor development. The final dry-cured ham (Fig. 3) presents high quality and it is very appreciated by consumers.

## 4 Notes

1. Pieces with petechiae or/and hematomas should be removed due to it could be originated by anomalous stunning or bone fractures, and they can be derived in spoiling problems.
2. Nitrite helps to red color development since it reacts with myoglobin and originates nitrosomyoglobin, the typical pigment of raw-cured meat products. Nitrite also inhibits the growth of some pathogenic microorganisms such as Clostridium.

**Fig. 3** Final product after drying-curing step

3. Salting and post-salting rooms need similar temperatures (refrigerate temperature) and high relative humidity (>85%), so the same room can be used for both steps. The case of the drying-curing process requires high temperatures, low relative humidity and being able to control the air speed, so specific rooms are needed for this step.
4. The typical materials used during the meat products manufacturing process, including volumetric and gravimetric material to measure/weight raw meat and/or ingredients, as well as all necessary material to manage and control the raw meat.
5. A correct classification of the pieces guarantees complete control over the times necessary for salting.
6. All excess salt must be carefully removed, well by brushing, and the piece can also be washed to ensure that they are completely free of salt.
7. The time that remains in this phase depends mainly on the size and width of each piece. The correct distribution of the salt in this phase must ensure the stability of the piece.
8. Longer drying-ripening times are recommended for the development of more intense typical product aromas and flavors.

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### References

1. Pérez-Santaescolástica C, Munekata PES, Pateiro M et al (2021) Dry-cured ham. In: Munekata PES, Pateiro M, Franco D et al (eds) Pork. Meat quality and processed meat products. CRC Press, Boca Raton, USA, pp 33–75
2. BOE Real Decreto 474/2014, de 13 de junio, por el que se aprueba la norma de calidad de derivados cárnicos. https://www.boe.es/diario_boe/txt.php?id=BOE-A-2014-6435
3. Pérez-Santaescolástica, C., Fraeye, I., Barba, F. J., Gómez, B., Tomasevic, I., Romero, A., ... & Lorenzo, J. M. (2019). Application of non-invasive technologies in dry-cured ham: An overview. Trends in Food Science & Technology, 86, 360-374.
4. Domínguez R, Purriños L, Pérez-Santaescolástica C et al (2019) Characterization of volatile compounds of dry-cured meat products using HS-SPME-GC/MS technique. Food Anal Methods 12:1263–1284
5. Bermúdez R, Franco D, Carballo J et al (2015) Influence of type of muscle on volatile compounds throughout the manufacture of Celta dry-cured ham. Food Sci Technol Int 21:581–592
6. Domínguez R, Pateiro M, Gagaoua M et al (2019) A comprehensive review on lipid oxidation in meat and meat products. Antioxidants (Basel) 8:429
7. Pérez-Santaescolástica C, Carballo J, Fulladosa E et al (2018) Effect of proteolysis index level on instrumental adhesiveness, free amino acids content and volatile compounds profile of dry-cured ham. Food Res Int 107:559–566
8. Pateiro M, Munekata PES, Cittadini A et al (2021) Metallic-based salt substitutes to reduce sodium content in meat products. Curr Opin Food Sci 38:21–31
9. Cittadini A, Domínguez R, Gómez B et al (2020) Effect of NaCl replacement by other chloride salts on physicochemical parameters, proteolysis and lipolysis of dry-cured foal "cecina". J Food Sci Technol 57:1628–1635
10. Nachtigall FM, Vidal VAS, Pyarasani RD et al (2019) Substitution effects of NaCl by KCl and $CaCl_2$ on lipolysis of salted meat. Foods 8:595
11. Lorenzo JM, Bermúdez R, Domínguez R et al (2015) Physicochemical and microbial changes during the manufacturing process of dry-cured lacón salted with potassium, calcium and magnesium chloride as a partial replacement for sodium chloride. Food Control 50:763–769
12. Domínguez R, Pateiro M, Pérez-Santaescolástica C et al (2017) Salt reduction strategies in meat products made from whole pieces. In: Lorenzo JM, Carballo FJ (eds) Strategies for obtaining healthier foods. Nova Science Publishers, Hauppauge, New York, pp 267–289
13. Pedro D, Saldaña E, Lorenzo JM et al (2021) Low-sodium dry-cured rabbit leg: a novel meat product with healthier properties. Meat Sci 173:108372
14. Lorenzo JM, Cittadini A, Bermúdez R et al (2015) Influence of partial replacement of NaCl with KCl, $CaCl_2$ and $MgCl_2$ on proteolysis, lipolysis and sensory properties during the manufacture of dry-cured lacón. Food Control 55:90–96
15. Vargas-Ramella M, Lorenzo JM, Domínguez R et al (2021) Effect of NaCl partial replacement by chloride salts on physicochemical characteristics, volatile compounds and sensorial properties of dry-cured deer cecina. Foods 10:669
16. Domínguez R, Munekata PE, Cittadini A et al (2016) Effect of the partial NaCl substitution by other chloride salts on the volatile profile during the ripening of dry-cured lacón. Grasas Aceites 67:e128
17. Vidal VAS, Lorenzo JM, Munekata PES et al (2020) Challenges to reduce or replace NaCl by chloride salts in meat products made from whole pieces–a review. Crit Rev Food Sci Nutr 61:2194–2206
18. Lorenzo JM, Domínguez R, Pateiro M, et al (2020) Catálogo de productos cárnicos Iberoamericanos, Red Healthy Meat (CYTED 119RT0568), Ourense, Spain

19. Bermúdez R, Pateiro M, Domínguez R et al (2018) Physicochemical changes of semimembranosus muscle during the processing of dry-cured ham from Celta pig. Effect of crossbreeding with Duroc and landrace genotypes. Anim Prod Sci 58:1958–1965
20. Yim D-G, Hong D-I, Chung K-Y (2016) Quality characteristics of dry-cured ham made from two different three-way crossbred pigs. Asian-Australas J Anim Sci 29:257
21. Carcò G, Schiavon S, Casiraghi E et al (2019) Influence of dietary protein content on the chemico-physical profile of dry-cured hams produced by pigs of two breeds. Sci Rep 8: 19068

# Chapter 8

# Dry-Cured Lacón

**Laura Purriños, Roberto Bermúdez, Daniel Franco, José Manuel Lorenzo, and Javier Carballo**

## Abstract

Dry-cured "lacón" is a traditional dried and ripened meat product made in the NW of Spain (autonomous communities of Galicia, Asturias, and NW of Castilla y León) from the fore leg of the pig cut at the shoulder blade-humerus joint, following a manufacturing process very similar to that used in the manufacture of dry-cured hams. Raw pieces are firstly dry-salted and then dried and ripened for variable times under appropriate environmental conditions. Depending on the degree of ripening, the final product can be consumed both raw or cooked after a desalting process. According to the aims of the book in which it is included, in this chapter the manufacture process of the dry-cured "lacón" is described in depth also providing very brief information on the biochemical and microbiological characteristics of the final product.

**Key words** Dry-cured "lacón", Spanish traditional meat products, Manufacture process

## 1 Introduction

Dry-cured "lacón" is a traditional meat product made in the NW of Spain (autonomous communities of Galicia, Asturias and NW of Castilla y León) from the fore leg of the pig cut at the shoulder blade-humerus joint, following a manufacturing process very similar to that used in the manufacture of dry-cured hams. Raw pieces are firstly dry-salted and then dried and ripened for variable times under appropriate environmental conditions.

The term "lacón" is a Spanish word derived from the Latin word "lacca" which refers to the meat product made from the fore leg of the pig by drying and ripening processes. References to this foodstuff are abundant in literature, mainly in books describing the Galician traditional gastronomy [1, 2]. However, the interest for the increase of the scientific knowledge of this meat product and for the improvement of its quality is very recent. This product has been manufactured, even also in the industries, following traditional guidelines based on the empiric knowledge, with little

José Manuel Lorenzo et al. (eds.), *Production of Traditional Mediterranean Meat Products*, Methods and Protocols in Food Science, https://doi.org/10.1007/978-1-0716-2103-5_8,

standardization of the production process and with a scarce control on the duration of the different steps and on the environmental conditions in the manufacturing rooms. As a consequence of this fact, the chemical and organoleptic characteristics, and therefore the quality, of the final products were very variable. In the markets, together with products correctly manufactured and having typical and optimal organoleptic characteristics, there were units of rather poor quality. This fact negatively influenced the commercial image of this product and limited its demand by the consumers. In the last two decades, an extensive research was performed on the biochemical [3–6], microbiological [7], and sensory [5, 8] characteristics of this meat product, on the biochemical [9–12] and microbiological [7, 13–15] changes that take place during its manufacture, on the effect of some features of the manufacture process on these changes [10, 11, 13–19], and on the effect of the culinary treatment on its chemical composition and nutritional value [20, 21]. This allowed to know in depth the chemical, microbiological, and sensory characteristics of this meat product and the effect on these characteristics of some modifications made in the traditional manufacturing procedure. Overall, this knowledge allowed the obtaining of more homogeneous and high quality products, whit a notable improvement of the image and acceptance in markets. In the Galicia autonomous community, this product has been distinguished with a Geographically Protected Identity (I.G.P. Lacón Gallego) [22]. Although it is necessary to indicate that most of the dry-cured "lacón" produced in Galicia is manufactured outside the I.G.P. "Lacón Gallego."

In this chapter, and according to the aims of the book in which it is included, the manufacture process of the dry-cured "lacón" is described also providing very brief information on the biochemical and microbiological characteristics of the final product.

## 2 Materials

Raw materials and additives for manufacture of dry-cured "lacón" are:

**Raw pieces**: The raw piece is constituted by the pig foreleg cut at the shoulder blade-humerus joint (Fig. 1). The foot can be optionally eliminated although the pieces that are manufactured under the designation "I.G.P. Lacón Gallego" must keep it. The weight of the raw piece is very variable depending on the weight of the carcass from which it come, the "I.G.P. Lacón Gallego" however only qualifies raw pieces ranging from 3.5 to 6.5 kg. To obtain final products of optimum quality, the raw pieces must be at 0–4 °C, have pH values in the 5.6–6.2 range (avoiding PSE or DFD meats), be free of bumps, wounds, or bruises, and have been preserved refrigerated and for short periods of time until the start of

**Fig. 1** Raw piece used in the manufacture of dry-cured "lacón"

production. The use of old or improperly stored raw pieces with the surface too dry or with superficial microbial growth (slime) hinders the penetration of the salt and compromises the microbial stability of the product in the first stages of processing. Also, in order to avoid the "boar taint" defect the pieces must come from castrated males or from females that are not slaughtered during heat. Regarding the pig breed from which pieces come, the I.G.P. "Lacón Gallego" admits the breeds Celta (the autochthonous Galician breed), Large White, Landrace, Duroc, and their crosses (*see* **Note 1**). Also, according to the feeding of the pigs, the I.G.P. "Lacón Gallego" distinguishes two classes of manufactured product: "Traditional Lacón Gallego" coming from pigs fed with traditional feed (cereals, acorns, chestnuts, and tubers) and "Lacón Gallego" coming from pigs fed with authorized commercial compound feed. Due to the negative influence on the sensory quality of the product, the I.G.P. "Lacón Gallego" prohibits the use of fish oils and meals and their derivatives in pigs' feeding (*see* **Note 2**).

**Salt**: For salting, coarse marine edible salt without insolubles is used. Salt should have a medium granulometry (comprising a mix of grains of between 2 and 6 mm thick). A too coarse salt dissolves with difficulty and slows down the salting process. On the other hand, too fine a salt dissolves quickly, the pieces of meat come into direct contact with each other and the penetration of the salt into

the interior of the pieces is made difficult. Salt composition is also important. Nitrate and/or nitrite impurities are desirable for the formation of the nitrosylmyoglobin pigment and the development of the typical red color of the cured meat. Heavy metal impurities (Fe and Cu) are undesirable because they accelerate the oxidation reactions of the fat and exacerbate the rancidity of the finished products.

**Additives**: Additives are usually used in the industrial manufacture. The use of some additives improve the manufacturing process and the organoleptic characteristics of the final products. According to the results of the research made on this subject, the addition of glucose (2 g/kg of meat), sodium nitrite (E250) (125 mg/kg), sodium nitrate (E251) (175 mg/kg), sodium ascorbate (E301) (500 mg/kg), and sodium citrate (E331) (100 mg/kg) significantly increases the percentage of conversion to cured meat pigments and improves the color and the odor of the final product assessed by using sensory analysis [10].

## 3 Methods

Manufacture of dry-cured "lacón" is performed in the following steps (Fig. 2):

**Obtaining and selection of the raw pieces**: After the slaughter of the pigs by the methods contemplated by the regulations, the carcasses are ideally aired for a minimum of 24 hours at temperatures of 0–5 °C and relative humidity of 80–90% before quartering. After cutting, the pieces are examined discarding the defective ones and later classified by weight. It is very important that the pieces of each batch have a weight as identical as possible so that the salting intensity as well as the subsequent dehydration and maturation processes are homogeneous in all the pieces within the batch. The blood in the pieces is removed in an exhaustive way to prevent undesirable microbial growth.

**Salting**: Firstly, the interior side (the one without skin) of the pieces is rubbed with the coarse salt (Fig. 3a). At this moment, the additives, when added, are rubbed before the salt. After this, pieces are covered with an excess of salt, stacking the pieces by alternating layers of pieces and layers of salt (Fig. 3b). The pieces remain in contact with the salt for a time equivalent to one day per kilogram of weight. Experimentally, it has been observed that this salting time is the one that results in a final product with a better sensory quality [17]. To facilitate a correct penetration of the salt in the pieces and to avoid an undesirable microbial growth, the salting room must be at 2–5 °C and 80–90% relative humidity.

**Brushing/washing**: once finished the salting stage, the pieces are brushed to remove the solid salt from their surface and optionally washed with cold or warm water. When the pieces are washed,

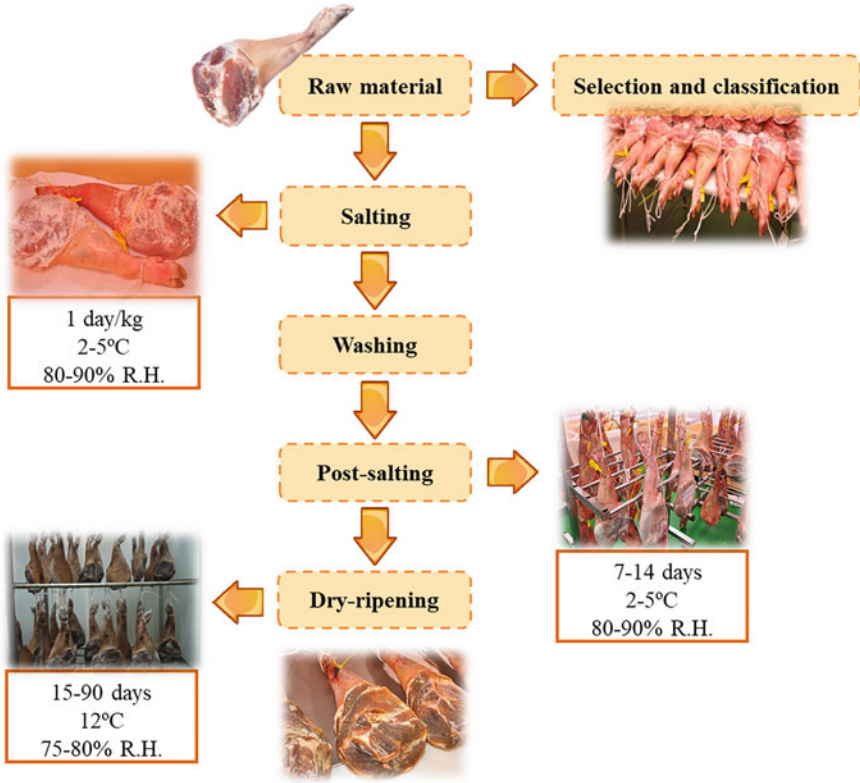


**Fig. 2** Manufacture process of the dry-cured "lacón"

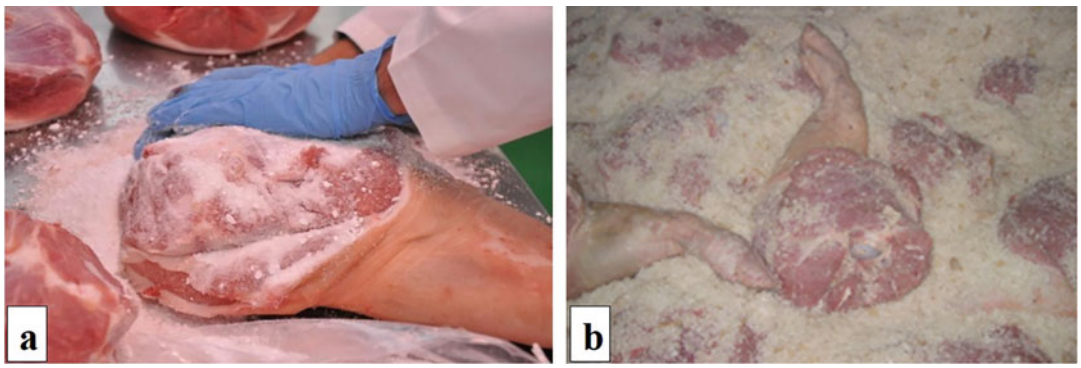


**Fig. 3** Dry-salting process in the manufacture of dry-cured "lacón". After rubbing with coarse salt (**a**) the pieces are covered with an excess of salt, stacking the pieces by alternating layers of pieces and layers of salt (**b**)

the water must have an optimal microbiological quality and the pieces must be allowed to drain and dry for a period of approximately 12 h before transferring them to the post-salting rooms.

**Post-salting**: takes place by leaving the pieces to remain in rooms at 2–5 °C and 85–90% relative humidity. During this phase, the salt, which until then had remained close to the surface

is homogeneously distributed throughout the piece. Salt assures the microbiological stability of the meat and at the same time controls and modulates the enzymatic activities and the physical and chemical transformations that will be responsible for the sensory characteristics of the final product. The duration of this phase is around 15 days. The P.D.O. "Lacón Gallego" establishes a minimum duration of 7 days for this phase.

In the traditional manufacture process, sometimes pieces were smoked during this stage using dry oak (*Quercus robur* L.) wood. Traditionally, and due to its dehydrating, antioxidant and antimicrobial effects, smoking was part of a combined preservation system together with salting and dehydration. At present, smoking is maintained as a hedonic agent that gives to the products a characteristic and desirable smell, color, and flavor. When the smoking only pursues a hedonic purpose, it is usually applied to the final product, immediately before it is marketed. The I.G.P. "Lacón Gallego" expressly prohibits the smoking in the pieces covered by this denomination (*see* **Note 3**).

**Drying-ripening**: once finished the post-salting stage, pieces are transferred to rooms at 12 °C and 74–78% relative humidity. During this stage, a controlled and progressive dehydration of the pieces takes place, at the same time that the proteolytic, lipolytic, and oxidative processes responsible for the aroma, flavor, and texture desirable and characteristic of the final product ready for consumption. The optimal duration of this phase is 12–24 weeks depending on the size of the pieces. The I.G.P. "Lacón Gallego" establishes a minimum duration of 15 days for this phase. An excessively short drying-ripening period, which is relatively prevalent in the industry for reasons of economic profitability, leads to end products with poor aroma and flavor [5], being merely salty raw meats (*see* **Note 4**). On the contrary, the excessive prolongation of this phase gives rise to products that are too hard and dry and with a degree of rancidity of the fat that is unpleasant. Depending of the degree of ripening, the final product (Fig. 4) can be consumed raw or cooked after a desalting process.

## 4 Characteristics of the Final Product

Table 1 shows a summary of the values of the compositional and physicochemical parameters, and of the parameters indicating the degree of modification of the protein and fat components in the dry-cured "lacón" pieces at the end of the manufacturing process. In general, results reasonably agree among the studies carried out and reported in the literature. The high salt contents possibly achieved due to the low thickness of the pieces are noteworthy, and which require a desalting of the product before its cooking prior to consumption. Values of moisture content and water activity

**Fig. 4** Dry-cured "lacón" ready for consumption (raw or cooked)

**Table 1**
**Chemical composition, physicochemical parameters and some characteristics of the protein and fat fractions of dry-cured "lacón" at the end of the manufacture process**

| | Data from Marra et al. [3] | Data from Lorenzo et al. [9] | Data from Veiga et al. [6] | Data from Lorenzo et al. [10] |
|---|---|---|---|---|
| Moisture (g/100 g) | 50.44 ± 4.14 | 39.62 ± 7.40 | 60.97 ± 3.24 | 42.02 ± 2.81 |
| Protein ($N \times 6.25$)[a] | 56.40 ± 5.53 | 52.80 ± 4.21 | 63.35 ± 3.77 | 58.0 ± 5.09 |
| Fat[a] | 19.73 ± 7.53 | 22.31 ± 8.04 | 14.76 ± 4.14 | 20.7 ± 1.15 |
| Ash[a] | 20.66 ± 4.31 | 23.35 ± 3.80 | 21.64 ± 2.91 | 15.7 ± 5.50 |
| NaCl[a] | 16.2 ± 4.18 | 19.50 ± 1.72 | 18.67 ± 6.52 | 13.1 ± 4.90 |
| Total carbohydrates[b] | 0.58 ± 0.23 | 0.16 ± 0.04 | | 0.03 ± 0.00 |
| Hydroxyproline[a] | 0.76 ± 0.23 | 0.58 ± 0.07 | | 0.70 ± 0.17 |
| Nitrate[c] | 41.1 ± 58.1 | 58.37 ± 3.58 | 66.87 ± 26.82 | 39.0 ± 6.04 |
| pH | 6.14 ± 0.19 | 6.16 ± 0.14 | 5.91 ± 0.22 | 6.40 ± 0.22 |
| Titratable acidity[d] | 0.08 ± 0.03 | 0.72 ± 0.07 | | 0.15 ± 0.08 |
| $a_w$ | 0.872 ± 0.030 | 0.767 ± 0.052 | 0.91 ± 0.01 | 0.876 ± 0.075 |

(continued)

**Table 1**
**(continued)**

| | Data from Marra et al. [3] | Data from Lorenzo et al. [9] | Data from Veiga et al. [6] | Data from Lorenzo et al. [10] |
|---|---|---|---|---|
| Nitrosyl–heme pigments[c] | 34.2 ± 24.5 | | | |
| Total heme pigments[c] | 279 ± 183 | | | |
| P.C.[e] | 13.5 ± 9.36 | 16.44 ± 2.09 | | 17.50 ± 1.27 |
| Total nitrogen[f] | | 8.45 ± 0.67 | | 9.19 ± 0.81 |
| Non-protein nitrogen[f] | | 0.77 ± 0.17 | | 0.74 ± 0.06 |
| α-Amino acidic nitrogen[f] | | 0.39 ± 0.07 | | 0.43 ± 0.01 |
| Total basic volatile nitrogen[f] | | 0.05 ± 0.01 | | 0.11 ± 0.04 |
| Free fatty acids[g] | 2.33 ± 0.17 | 4.99 ± 0.67 | | 2.77 ± 1.15 |
| Peroxide value[h] | 37.7 ± 10.1 | | | |
| Thiobarbituric acid value[i] | | | 4.01 ± 1.50 | 10.39 ± 3.18 |

[a] Expressed as g/100 g of total solids
[b]Expressed as g of glucose/100 g of total solids
[c]Expressed as ppm
[d]Expressed as g lactic acid/100 g
[e]*P.C.* Percent conversion to cured meat pigments
[f]Expressed as g/100 g of total solids
[g]Expressed as % of oleic acid
[h]Expressed as meq $O_2$/kg of fat
[i]Expressed as mg malonaldehyde/kg meat

are those that show a wider range. Differences in moisture contents and in $a_w$ values reported by different authors in the final products probably mainly reflect differences in the duration of the manufacture process, and above all in the duration of the drying-ripening stage. The duration of the manufacture process is critical in the achievement of the typical organoleptic characteristics of this product. The shortening of the manufacture processes with very short drying-ripening periods gives rise to products hardly ripened, and having severe deficiencies in flavor, color, and texture [5].

The values of the different nitrogen fractions (non-protein nitrogen, α-aminoacidic nitrogen and total basic volatile nitrogen) indicate that the proteolytic processes taking place during the manufacture of this meat product are only moderate. The high salt contents, the low temperatures during the manufacture (never

above 12 °C), and the intense dehydration suffered by the pieces during the manufacture (*see* **Note 5**) appear to be the cause of the low protein degradation observed in dry-cured "lacón" when compared with other dry-cured meat products made from whole cuts such as the hams.

The values reported for the parameters that indicate the degree of lipolysis (free fatty acids) and the auto-oxidation of the fat (peroxide value and thiobarbituric acid value) reveal that appreciable lipolytic and oxidative changes take place during the manufacture of dry-cured "lacón." When compared these values with those reported for other dry-cured meat products such as hams after similar ripening periods, data indicated a moderate lipolysis but a strong lipid oxidation during the manufacture process of dry-cured "lacón." This circumstance could be related with the higher NaCl (a recognized prooxidant agent) contents in the "lacón" and with the lower size of the "lacón" pieces that causes an increase of the surface per unit of weight and therefore the surface of contact with the air, and consequently with the oxygen, during the manufacture process.

Table 2 shows the counts of the most representative microbial groups both in the surface and in the interior of the pieces at the end of the manufacture of dry-cured "lacón." As a result of the intensity of the salting process and of the high NaCl concentrations reached both on the surface and in the interior of the pieces, the

**Table 2**
**Counts of some microbial groups ($log_{10}$ C.F.U./g) in the surface and in the interior of the pieces of dry-cured "lacón" at the end of the manufacture process. (Data from Vilar et al. [7])**

| Microbial group | | |
|---|---|---|
| Total aerobic mesophilic bacteria | Surface | 4.79 ± 1.55 |
| | Interior | 1.99 ± 1.47 |
| Salt-tolerant bacteria | Surface | 4.91 ± 1.52 |
| | Interior | 1.69 ± 1.66 |
| Lactic acid bacteria | Surface | 3.45 ± 0.98 |
| | Interior | 1.25 ± 1.23 |
| Molds and yeasts | Surface | 4.22 ± 1.69 |
| | Interior | 1.17 ± 1.17 |
| Enterococci | Surface | 0.16 ± 0.22 |
| | Interior | – |
| Enterobacteriaceae | Surface | – |
| | Interior | – |

–, Absence in 0.2 g

salt-tolerant bacteria counts practically coincided with those of the total mesophilic aerobic bacteria. Molds and yeasts also showed high counts. Enterobacteriaceae were absent both in the surface and in the interior of the pieces, while enterococci were present only in the surface of one of the five batches studied.

## 5 Notes

1. Crossbreeds with Belgian White and Pietrain are also allowed as long as these breeds do not intervene in a proportion greater than 25%.
2. The use of fish products in pigs' feeding determines the appearance of strange, atypical flavors and aromas in the manufactured "lacón" and also accelerates the lipid auto-oxidation processes during ripening with early and excessive rancidity.
3. This measure is intended primarily to avoid the variability in the organoleptic characteristics resulting from uneven intensity of smoking. In addition, smoking is not to the unanimous liking of all consumers and excessive smoking could mask the genuine and characteristic flavor and aroma of this meat product.
4. The presence in the markets of insufficiently ripened pieces, lacking the characteristic flavor and aroma, seriously damages the image of the product.
5. The intense dehydration undergo by this meat product during the manufacture is a consequence of the particular shape of the pig foreleg, much less thick than the hind leg used for the manufacture of hams.

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### References

1. Cunqueiro A (1973) A cociña galega [The Galician cuisine]. Galaxia, Vigo, Spain
2. Puga y Parga MM (1905) La cocina práctica [The practical cuisine]. Editorial Roel, La Coruña (Spain)
3. Marra AI, Salgado A, Prieto B et al (1999) Biochemical characteristics of dry-cured lacón. Food Chem 67:33–37
4. Rodríguez MP, Carballo J, López M (2001) Characterization of the lipid fraction of some Galician (NW of Spain) traditional meat products. Grasas Aceites 52:291–296

5. Lorenzo JM, García Fontán MC, Franco I et al (2002) Relationship between biochemical characteristics and sensory quality in dry-cured lacón (a traditional meat product) marketed in Galicia (NW of Spain). Suggestions for improvement. Alimentaria 338:31–37
6. Veiga A, Cobos A, Ros C et al (2003) Chemical and fatty acid composition of "Lacón gallego" (dry-cured pork foreleg): differences between external and internal muscles. J Food Compos Anal 16:121–132
7. Vilar I, García Fontán MC, Prieto B et al (2000) A survey on the microbiological changes during the manufacture of dry-cured lacón, a Spanish traditional meat product. J Appl Microbiol 89:1018–1026
8. Purriños L, Bermúdez R, Temperán S et al (2011) Influence of salt content and processing time on sensory characteristics of cooked "lacón". Meat Sci 87:436–442
9. Lorenzo JM, Prieto B, Carballo J et al (2003) Compositional and degradative changes during the manufacture of dry-cured "lacón". J Sci Food Agric 83:593–601
10. Lorenzo JM, García Fontán MC, Franco I et al (2008) Biochemical characteristics of dry-cured lacón (a Spanish traditional meat product) throughout the manufacture, and sensorial properties of the final product. Effect of some additives. Food Control 19:1148–1158
11. Lorenzo JM, García Fontán MC, Franco I et al (2008) Proteolytic and lipolytic modifications during the manufacture of dry-cured lacón, a Spanish traditional meat product: effect of some additives. Food Chem 110:137–149
12. Purriños L, Bermúdez R, Franco D et al (2011) Development of volatile compounds during the manufacture of dry-cured "Lacón", a Spanish traditional meat product. J Food Sci 76:C89–C97
13. Lorenzo JM, García Fontán MC, Cachaldora A et al (2010) Study of the lactic acid bacteria throughout the manufacture of dry-cured lacón (a Spanish traditional meat product). Effect of some additives. Food Microbiol 27: 229–235
14. Lorenzo JM, García Fontán MC, Gómez M et al (2012) Study of the Micrococcaceae and Staphylococcaceae throughout the manufacture of dry-cured lacón (a Spanish traditional meat product) made without or with additives. J Food Res 1:200–211
15. Purriños L, García Fontán MC, Carballo J et al (2013) Study of the counts, species and characteristics of the yeast population during the manufacture of dry-cured "lacón". Effect of salt level. Food Microbiol 34:12–18
16. Garrido R, Gómez M, Franco I et al (2009) Lipolytic and oxidative changes during the manufacture of dry-cured lacón. Effect of the time of salting. Grasas Aceites 60:255–261
17. Garrido R, Domínguez R, Lorenzo JM et al (2012) Effect of the length of salting time on the proteolytic changes in dry-cured lacón during ripening and on the sensory characteristics of the final product. Food Control 25:789–796
18. Purriños L, Franco D, Carballo J et al (2012) Influence of salting time on volatile compounds during the manufacture of dry-cured pork shoulder "lacón". Meat Sci 92:627–634
19. Garrido R, Lorenzo JM, Franco I et al (2014) Effect of the salting duration on lipid oxidation and the fatty acid content of dry-cured lacón. J Food Res 3:46–60
20. Cobos A, Veiga A, Díaz O (2004) Effects of culinary treatment (desalting and boiling) on chemical and lipid composition of dry-cured pork forelegs. Meat Sci 68:411–418
21. Cobos A, Veiga A, Díaz O (2008) Chemical and lipid composition of deboned pieces of dry-cured pork forelegs as affected by desalting and boiling: the effects of vacuum packaging. Food Chem 106:951–956
22. Official Journal of the European Communities. 2001. COMMISSION REGULATION (EC) No 898/2001 of 7 May 2001 L 126, Vol. 44, 8 May 2001 (p 18). Supplementing the Annex to Regulation (EC) No 2400/96 on the entry of certain names in the "Register of protected designations of origin and protected geographical indications" provided for in Council Regulation (EEC) No 2081/92 on the protection of geographical indications and designations of origin for agricultural products and foodstuffs

# Chapter 9

# Dry-Cured Loin

**Rubén Domínguez, Mirian Pateiro, María Elena Sosa-Morales, Jorge Felipe Reyes, Adriana Pazos, Gema Nieto, Paulo E. S. Munekata, and José Manuel Lorenzo**

## Abstract

The dry-cured loin is one of the cured meat products consumed worldwide, and due to its excellent organoleptic characteristics, it is most appreciated by consumers. However, the most important properties (both, sensorial and nutritional characteristics) depend on the manufacturing process, including the type and amount of spices used in the seasoning phase and also from the drying-curing conditions. Therefore, although each manufacturer has its own formulation, the main phases are common, and the final characteristics are similar.

With this in mind, the present chapter describes in detail the formulation and the different stages of elaboration of dry-cured loin.

**Key words** Manufacture process, Loin, Dry-cured product, Muscle food, Seasoning, Ripening process

## 1 Introduction

Dry-cured loins, one popular dry-cured meat product, are considered as a high quality product worldwide consumed, with an outstanding flavor parameter [1]. The dry-cured is a typically Spanish dry-cured meat product that is considered the noblest and valuable piece of the pork carcass, exceeding its price even that of ham [2, 3].

The dry-cured loin could be defined as a meat product made with the muscular package formed by the *Longissimus thoracis et lumborum* muscles of the pig, in a single piece, practically free of external fat and tendons, which has generally undergone salting, seasoning and curing process, and stuffed in natural casings or artificial casings, which has undergone an adequate drying-curing process [4]. As reported, the manufacturing process usually involves the salting of the raw loin in order to stabilize the raw meat, followed by a seasoning step with spices (paprika, oregano,

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garlic, and/or other spices) and stuffing in a casing. Usually, olive oil is also used in the seasoning step. Finally, in the drying-curing phase the loin is submitted to different drying conditions, increasing temperature and decreasing relative humidity in order to achieve the typical characteristics of the dry-cured loin. It is important to highlight that the duration of the drying-curing process is shorter (usually 50–60 days) than those used for other traditional meat products made with whole pieces (e.g., dry-cured ham, cecina, or lacón).

Through the manufacturing process, the release of free amino acids and fatty acids (from protein and lipids, respectively) and the further conversion to other secondary products during oxidative and Maillard reactions giving rise to the particular flavor and odor of this product [5, 6]. In this regard, several authors reported a progressive increase of both, proteolysis [1, 7, 8] and lipolysis phenomena [9–11] during the different steps of manufacturing process. This fact was also observed after the drying-curing process, during the loin storage [12]. The free fatty acids and free amino acids serve as precursors for further reactions [6] and the release of odorant compounds [5], which are responsible for the characteristic aroma and flavor of this product. Thus, as expected, multiple researchers also observed that both, the content and the profile of volatile compounds changed with the evolution of manufacture phases [9, 10, 13]. However, not only these reactions are responsible for the aroma of dry-cured loin since it uses spices in its manufacture process, which impart the characteristic volatiles of these spices, mainly terpenoids [5]. Among all steps, the drying-curing phase is responsible for the most important biochemical changes, which determine the quality of the final product and the sensory characteristics. In this phase, the enzymatic activity, oxidative reactions and the distribution of all ingredients through the pieces ensure the complete development of a quality product. Additionally, the progressive moisture release produces an increase in the hardness and improve the texture parameters of this product [9–11]. Therefore, all steps should be carefully controlled since variations on the typical characteristics of this product could influence consumer acceptance [9].

Taking into account the aforementioned, the main objective of this chapter is to make a detailed description of the stages of the manufacturing process as well as the formulation of the dry-cured loin.

## 2 Materials

1. Loin (*Longissimus thoracis et lumborum* muscles) of pig (*see* **Note 1**).
2. Common salt.

3. Nitrifying salt (nitrite/nitrate) (*see* **Note 2**).
4. Spices (garlic, oregano, and paprika) (*see* **Note 3**).
5. Olive oil (*see* **Note 3**).
6. Collagen casings.
7. Dry-curing room (temperature, relative humidity and air speed controlled) (*see* **Note 4**).
8. Auxiliary materials (scales, containers, knives, etc.) (*see* **Note 5**).

## 3 Methods

The objective of the different phases of the dry-cured loin manufacturing process is to obtain high-value products, without defects, sanitary secure and with genuine and appreciated organoleptic characteristics. Although there are few differences between producers, the manufacturing process has the next common steps (Fig. 1):

1. After extract the muscles (*Longissimus thoracis et lumborum*) from animal carcasses, the pieces (loins) are refrigerated for 48 h in a cold room between 2 and 4 °C. Each piece of loin is properly profiled, eliminating the excess parts (pieces of meat, excess superficial fat, etc.) to achieve the desired shape (*see* **Note 6**).
2. The next step is the salting phase. This phase can be carried out manually or in rotary drums. In this stage, the loins are rubbed by massaging with 3 g/kg of the nitrification salts (nitrates and nitrites) and then covered with excess common salt. Only in the case that a rotatory drum is used, the loins are macerated for approximately 20 min under refrigerated and vacuum conditions. Then, in any case (manually of with rotatory drums), they are placed in a container adding any remaining salt and stored for 2.4 h/kg of loin (*see* **Note 7**) in a refrigeration chamber at 2–4 °C and 85–95% of relative humidity, to allow the salt to penetrate and stabilize the product.
3. After this time, the loins were brushed to remove excess of salt (*see* **Note 8**). The next step is seasoned with spices. For this phase, all loins are rubbed by massaging with 15 g/kg of paprika, 2 g/kg of fresh garlic, 0.5 g/kg of oregano, and 25 g/kg of extra virgin olive oil until a uniform distribution is achieved. Then, the loins were kept at refrigerating conditions (3–5 °C/85–95% of relative humidity) for 2.5 days to allow the seasoning mixture to penetrate (*see* **Note 9**).

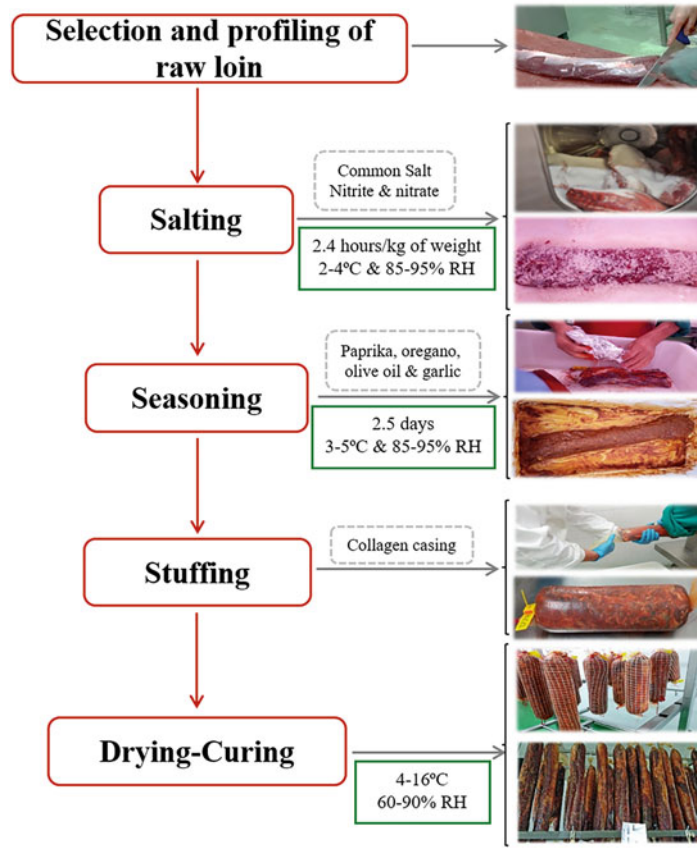


**Fig. 1** Diagram of the different stages of the manufacturing process of dry-cured loin

4. The seasoned loins are then stuffed into collagen casings (75 mm internal diameter) (*see* **Note 10**) and transferred to a dry-cured room.
5. The next phase is drying-curing, in which the most important biochemical changes takes place, and they ensure the correct development of the typical sensorial characteristics of dry-cured loin. In this phase, the temperature and relative humidity change over time (*see* **Note 11**). The initial drying-curing conditions are set at low temperatures (4–6 °C) and high relative humidity (85–90%). The progressive changes of the drying-curing conditions are shown in Table 1, going from the conditions previously described to the final conditions of 14–16 °C and 60–65%, which are maintained for one month. In this phase, the air circulation and air speed are important since they ensure the correct dehydration of the pieces. The proximate composition of dry-cured loins is shown in Table 2, while an example of final product (after drying-curing phase) is shown in Fig. 2.

**Table 1**
**Evolution of conditions (temperature and relative humidity) during drying-curing step**

| Days | Temperature (°C) | Relative humidity (%) |
|---|---|---|
| 0–14 | 4–6 | 85–90 |
| 15–21 | 6–8 | 80–85 |
| 22–30 | 8–10 | 70–75 |
| 30–60 | 14–16 | 60–65 |

**Table 2**
**Proximate composition (g/100 g) of loin after drying-curing process**

| | Lorenzo & Carballo [9] | Pateiro et al. [10] | Vargas-Ramella et al. [11] |
|---|---|---|---|
| Moisture | 36.5 | 34.0 | 38.8 |
| Protein[a] | 81.0 | 72.5 | 73.1 |
| Fat[a] | 3.41 | 11.7 | 4.6 |
| Ash[a] | 15.7 | – | 17.7 |
| pH | 5.90 | 5.80 | 5.57 |

[a]Expressed as percentage of dry-matter

**Fig. 2** Dry-cured loin after drying-curing step

## 4 Notes

1. Although loin from pigs is the most common raw meat used in the manufacture of dry-cured loin, the loin from other species (venison, foals/horses, veal, etc.) could be used.
2. Nitrite helps to red color development since it reacts with myoglobin and originates nitrosomyoglobin, the typical pigment of raw-cured meat products. Nitrite also inhibits the growth of some pathogenic microorganisms such as Clostridium.
3. Paprika gives the characteristic external color to the dry-cured loin. Moreover, the other spices specified in this process could be changed by others, and the use of olive oil is optional.
4. Drying-curing process requires moderate-high temperatures, low relative humidity and being able to control the air speed, so specific rooms are needed for this step.
5. The typical materials used during the meat products manufacturing process, including volumetric and gravimetric material to measure/weight raw meat and/or ingredients, as well as all necessary material to manage and control the raw meat.
6. Refrigeration temperatures must be maintained during all the operations carried out in the processing of the loins (with the exception of the drying-curing step), to avoid microbial proliferation and ensure the quality and safety of the final product.
7. The residence time to achieve the correct salting can vary. For example, in previously frozen pieces it can be less, while in pieces with large thicknesses this time can be increased.
8. All excess salt must be carefully removed by brushing to ensure that the pieces are completely free of salt.
9. During the 2.5 days that the seasoning is left to rest, the salt is also distributed evenly throughout all the pieces.
10. The diameter of the casings used to stuff the loins may vary depending on the characteristics and size of each of the pieces.
11. Drying-curing must be carried out progressively, slowly decreasing the relative humidity to avoid the formation of superficial crusts that would lead to an incorrect drying process.

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## References


1. Zhou CY, Wang Y, Pan DD et al (2017) The changes in the proteolysis activity and the accumulation of free amino acids during chinese traditional dry-cured loins processing. Food Sci Biotechnol 26:679–687
2. Purriños L, Gómez M, Domínguez R et al (2012) Embutidos crudo-curados de Cerdo Celta. In: Lorenzo JM, Fernandez M (eds) Manual del Cerdo Celta. Centro Tecnolóxico da Carne, Ourense, Spain, pp 125–153
3. Lorenzo JM, Domínguez R, Pateiro M et al (2020) Catálogo de productos cárnicos Iberoamericanos, red healthy meat (CYTED 119RT0568). Ourense, Spain
4. BOE Real Decreto 474/2014, de 13 de junio, por el que se aprueba la norma de calidad de derivados cárnicos. https://www.boe.es/diario_boe/txt.php?id=BOE-A-2014-6435
5. Domínguez R, Purriños L, Pérez-Santaescolástica C et al (2019) Characterization of volatile compounds of dry-cured meat products using HS-SPME-GC/MS technique. Food Anal Methods 12:1263–1284
6. Domínguez R, Pateiro M, Gagaoua M et al (2019) A comprehensive review on lipid oxidation in meat and meat products. Antioxidants (Basel) 8:429
7. Salazar E, Cayuela JM, Abellán A et al (2019) Effect of breed on proteolysis and free amino acid profiles of dry-cured loin during processing. Anim Prod Sci 59:1161–1167
8. Abellán A, Salazar E, Vázquez J et al (2018) Changes in proteolysis during the dry-cured processing of refrigerated and frozen loin. LWT- Food Sci Technol 96:507–512
9. Lorenzo JM, Carballo J (2015) Changes in physico-chemical properties and volatile compounds throughout the manufacturing process of dry-cured foal loin. Meat Sci 99:44–51
10. Pateiro M, Franco D, Carril JA et al (2015) Changes on physico-chemical properties, lipid oxidation and volatile compounds during the manufacture of celta dry-cured loin. J Food Sci Technol 52:4808–4818
11. Vargas-Ramella M, Domínguez R, Pateiro M et al (2020) Chemical and physico-chemical changes during the dry-cured processing of deer loin. Int J Food Sci Technol 55:1025–1031
12. Gómez M, Cachaldora A, Fonseca S et al (2018) Biochemical, oxidative, and Lipolytic changes during vacuum-packed storage of dry-cured loin: effect of chestnuts intake by Celta pigs. J Food Qual 2018:7690501
13. Vargas-Ramella M, Munekata PES, Pateiro M et al (2021) Evolution of volatile compounds during dry-cured deer loin processing. Int J Food Sci Technol:15255

# Chapter 10

# Dry-Cured Cecina

Natalia Ordóñez Gutiérrez, Irma Caro, and Javier Mateo

## Abstract

Spanish beef cecina is a traditional whole-piece dry-cured intermediate-moisture ready-to-eat meat product produced in Northwestern Spain. A certified beef cecina produced in the province of León "*Cecina de León*" has been granted a European protected geographical indication quality label. This chapter describes the quality characteristics of Cecina de León, the raw materials and the desirable characteristics of the beef used in the making of Cecina de León and explains the making process. This meat product is prepared using beef from animals weighing over 400 kg. The beef cuts used come from the hind legs, such as the silver side or top round. The cuts are dry salted and then hung in ripening chambers for several months. During ripening beef cecina is dry smoked for a number of days.

**Key words** Traditional meat products, Intermediate-moisture meats, Dry-cured meat products, Spanish meat products

## 1 Introduction

Spanish cecinas are whole-piece dry-cured intermediate-moisture ready-to-eat meat products which could be considered as a product similar to Italian bresaola, Turkish pastirma, or Swiss viande de grissons. The cecina making process consists of dry-salting meat cuts which are then ripened. Cecina cuts are dry smoked during ripening. The aw of cecinas ranges from 0.7 to 0.9, which confers the product microbial stability at room temperature [1]. In the past, cecinas were widely produced in the rural areas of Spain. However, nowadays, most cecinas are industrially produced. There are four types of cecinas on the market depending on the animal species whose meat is used for their preparation [2]: beef cecina, the most popular and abundant, produced in Northwest Spain, small-ruminant cecina—mainly goat cecina, which is typical of the central mountain region in the province of León—, equine cecina, and game cecina.

Beef cecina is made from the hind leg cuts of heavy cattle carcasses and is dry smoked during ripening. The cuts mainly

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**Fig. 1** Vacuum-packaged cecina and a cecina slice ready to be consumed

used for cecina preparation are round of beef (in Spanish *tapa*), thick flank or top rump (*babilla*), rump (*cadera*), silver side plus eye of round (*contra con redondo*), and the center of the silver side composed by the gluteobiceps muscle (*centro* de *contra*). The cecina obtained from the last cut is called "*suprema de cecina*."

Beef cecina is commercialized as whole cuts, cut portions, or sliced (Fig. 1). Cut portions and slices of cecina are usually vacuum packaged. In these cases, the control of aw and pH is determinant for its shelf life. When the aw is lower than 0.9 the shelf life of vacuum-packaged cecina cut portions could be extended up to 12 months. However, special attention should be paid to the final aw of the cecinas which are to be sliced, vacuum packaged and then refrigerated, since aw values higher than 0.9 do not guarantee microbial stability [3] (*see* **Note 1**). Another problem regarding the storage of vacuum-packaged portioned or sliced cecina is forming a white film on the product surface [4] (*see* **Note 2**).

The cecinas produced in León Province, the area in Spain where beef cecina is mostly produced, following an authorized procedure (Junta de Castilla y León, 2012) are granted the Protected Geographical Indication (PGI) "*Cecina de León*." PGI-Cecina de León production is about 100,000 whole cut pieces (averaging 7 kg) per year and it has an ever-increasing demand. More than 20% of its production is exported.

Descriptive studies on beef cecina ([5–7] and archival materials, N. Ordóñez-Gutiérrez, June, 10, 2021) reported the following

**Table 1**
**Nutritive value of dry-cured beef cecina (expressed as percentage)**

| | |
|---|---|
| Moisture | 45 |
| Protein | 39 |
| Fat | 9.5 |
| Carbohydrates | 0 |
| Salt | 5.3 |
| SFA (%) | 50 |
| MUFA (%) | 44 |
| PUFA (%) | 6 |

*SFA* saturated fatty acids, *MUFA* Monounsaturated fatty acids, *PUFA* polyunsaturated fatty acids; Data obtained from [8]

composition characteristics: 40–60% moisture, 5–15% fat, 28–45% protein, and 4–7% NaCl and a pH and aw of 5.8–6.1 and 0.86–0.92, respectively, with all those values depending on the anatomical region (beef cut), the ripening length or whether whole cuts or ready-to-eat slices are analyzed. The average nutritional value of beef cecina is shown in Table 1. Cecina, as a dry beef product, is rich in protein, vitamin B12, iron, phosphorus, and zinc.

The most abundant microbial population in cecina belongs to the *Micrococcaceae* family, i.e., staphylococci and micrococci, with lactic acid bacteria taking second place [4, 6]. The mesophilic microbial concentration found in the surface of the cecina pieces was near $10^7$ colony forming units (CFU)/g and in the inner part of $10^3$–$10^4$ CFU/g. The microbial concentration in cecina appeared to stabilize by the end of the ripening process [6].

Considering the regulation of the PGI "Cecina de León" and the abovementioned research studies as a reference, this chapter aims at describing the making process of beef cecina in detail.

## 2 Materials

Few raw materials are involved in the dry-cured beef cecina making process. Beef cecina is made of beef cuts and common salt which is usually coarse sea salt. Furthermore, a part of the cecinas is also prepared using nitrites or nitrates as additives mixed with the salt. Finally, holm oak and oak wood are normally used for the smoking process.

The PGI-granted Cecina de León is made from beef of at least five-year-old cattle weighing more than 400 kg, with preference to animals reared in the Castilla y León region (*see* **Note 3**). The

minimum weights of the different cuts are 8 kg for the top round, 10 kg for the silver side plus eye of round, 7 kg for the thick flank, and 6 kg for the rump. One of the principal reasons to establish minimum weight limits of body weight in adult cattle and beef cuts is to assure that beef cuts have a high content of intramuscular fat content which is responsible for tenderness, juiciness and flavor.

The PGI regulation specifies the typical sensory characteristics that a PGI-beef cecina [9] must have. Beef cecinas have to show a smoked, slightly-salty complex characteristic flavor and juicy and soft texture, scarcely fibrous. The color should also be slightly dark brown on the external surface and dark cherry to garnet red with a slight marbling in the internal cut surface. The instrumental color found in Cecina de León ranged 20–34 for lightness (L*), 7–13 for redness (a*), and 4–6 for yellowness (b*), and appeared to depend on the color of the beef, the use of nitrites in the formulation and the ripening time [3, 10], i.e., nitrites increased the a* value and ripening time reduce the L* value and increased a* and b*.

## 3 Methods

The cecina making process consists of the following steps: meat cuts are shaped and salted covered with coarse sea salt. Afterwards, the cuts are washed with water and then ripened in chambers under appropriate conditions. The ripening process includes a dry smoking period (Fig. 2).

1. The shaping of cuts, which can be fresh, aged under vacuum or thawed (*see* **Note 4**), is performed with a knife to remove extra fat or large tendons and provide the cut with a better exterior appearance.
2. The shaped cuts are covered with a layer of coarse sea salt, forming piles by alternating the layers of beef cuts and the layers of salt. Cuts are kept in the dry-salting rooms from 0.3 to 0.6 days per kg of beef cut under refrigerated conditions (2–5 °C) and air-relative humidity between 80% and 90% (*see* **Note 5**).
3. The beef cuts are removed from the piles and washed with warm water to remove excess salt; then, the water from their surface is allowed to drain.
4. The salted beef cuts are then hung in ventilated settling rooms where they stay for 30–170 days at a relative humidity of 85–90% and 3–8 °C to prevent microbial growth. During this step, named post-salting or settlement, salt, initially located near the cut surface, penetrates the interior of the cut.
5. The partially dry-cured cuts are then hung into air-drying chambers for c.a. more than 40 days and up to 170 days, either

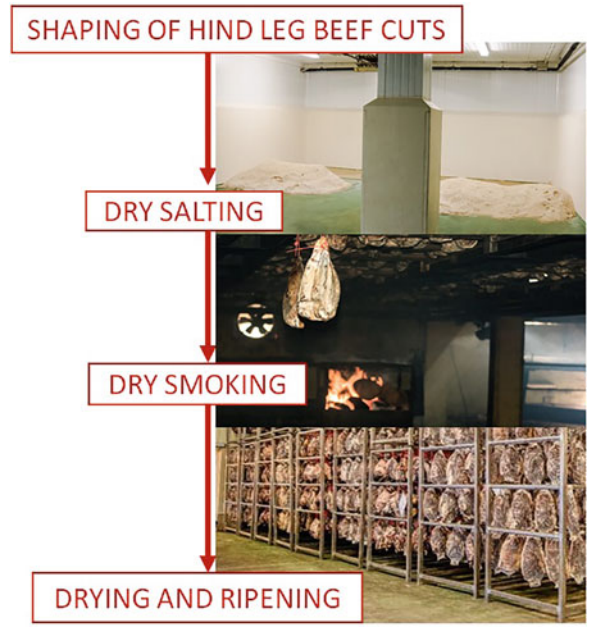


**Fig. 2** Making process of dry-cured beef cecina

in natural drying rooms provided with adjustable opening windows to manually regulate temperature and air humidity and ventilation, or drying rooms with automatic control of air conditions and ventilation. This step is carried out at 10–12 °C and relative humidity of 75–80%. Proteolysis and lipolysis are two relevant biochemical processes that occur during the cecina ripening process [10, 11] (*see* **Note 6**).

6. Dry smoking occurs after the settlement at any stage of the abovementioned 4 and 5 ripening process steps, earlier or later, following the producer's criterion. It is carried out in smoking chambers or rooms exposed to smoke generated by the slow combustion of local varieties of oak firewood. In addition to giving cecina a touch of traditional peculiar flavor, the smoke acts as a natural preservative, thus being capable of dispensing of other added chemicals. The length of this step is measured in hours and is carried out for 3–15 days with dry smoking and no-dry smoking alternative times. It is recommended to follow best practices for dry smoking meat to maintain the levels of polycyclic aromatic hydrocarbons low in the final product.
7. Finally, the dried-cured beef cuts are hung in drying chambers for the final ripening period at a relative humidity between 65–80% and temperature between 12 and 20 °C. For the length of this period, it should be considered that the total ripening period for a standard-PGI Cecina de León is of at least

7 months and for a long ripened-PGI Cecina de León (named *reserva*) of 12 months. In both cases, the targeted aw should be 0.9 or less to guarantee microbial stability (*see* Notes 1 and 7).

8. At one point during the ripening process after dry smoking, even in the final product, the cecina cut surface is manually covered by a thin layer of animal fat such as beef tallow or pork lard (*see* **Note 8**).

## 4 Notes

1. During the refrigerated storage of sliced cecina under vacuum with values equal to or higher than 0.9, which are due to a short dry-cured period, an increase in microbial growth on the surface of the slices could take place. Then, microbial concentrations could reach levels higher than $10^7$ CFU/g after two to four storage weeks, resulting in the appearance of off-flavors.
2. During storage of vacuum-packaged pieces of cecina a white film may appear on the cut surface, especially in those beef cecinas soft with a high aw. This has been attributed to the precipitation of small proteins and tyrosine, previously formed by proteolysis [12]. A way to reduce this problem is by rubbing the cecina cut with vegetable oil (such as sunflower oil or olive oil) which gives the cut certain shine and disguises its whitish appearance.
3. The age and breed of the cattle used are two key factors in the quality of beef cecina. The beef of mature over 5 years old cattle contents high fat infiltration and thus result in a juicier and more aromatic final product. Similarly breeds more prone to intramuscular fat storage result in a juicier and tastier product.
4. Beef cuts for preparing cecina sometimes are previously frozen and then thawed before salting. This process affects beef cecina sensory properties, namely reduces color intensity and changes in texture, attributed to disruption of tissue membranes due to freezing [13].
5. So as to control the salting process, it is necessary to consider temperature, cut size and the amount of fat content in each cut piece. Although a small excess of salt can make the ripening process easier and faster, a high-quality Cecina has to have the optimum point of salt, which could be 3–5%.
6. A slow and long ripening process, with the appropriate time which each beef cut requires, is of uppermost importance for the cecina eating quality. Proteolysis and lipolysis, which are mainly attributed to the action of endogenous meat enzymes and exert relevant effects on cecina flavor and texture, should

be sustained throughout the ripening process. These are maintained at suitable low rates by means of low temperature and aw. The age of the animal is also relevant when cecinas are subjected to a long ripening process since the proteolytic potential in beef decreases with age and results in a cecina with a better consistency.

7. The weight loss during ripening is due to water evaporation, and this loss in moisture and the salt absorbed during the salting step allow for the aw to decrease to values lower than 0.90. A cut of beef cecina with an aw slightly lower than 0.90 and containing 5–7% of sea salt losses approximately 40–45% of the initial weight, i.e., the weight of the fresh-cut before salting [6, 10].
8. The coating of the cecina piece surfaces with tallow or pork lard is carried out to protect the cecina against excessive desiccation and to the attack of insects or their larvae, which occur mainly in summer with high temperature. When the coating is applied to the final product it becomes a traditional alternative to vacuum packaging. The coating is carried out manually in most cases, heating the fat and spreading it on the surface with a food-grade silicone brush. There is another method that has been developed by immersing the pieces in a tank filled with hot liquid fat. In this case, precaution should be taken with temperature and immersion time so as not to affect the sensory characteristics of cecina with heat.

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### References

1. Zumalacárregui JM, Díez VA (2001) Cecina y Tasajo. In: Martín S (ed) Enciclopedia de la carne y de los productos cárnicos, vol II. Ediciones Martín & Macías, Madrid
2. Hierro E, de la Hoz L, Ordoñez JA (2004) Headspace volatile compounds from salted and occasionally smoked dried meats (cecinas) as affected by animal species. Food Chem 85: 649–657
3. Rubio B, Martínez B, González-Fernández C et al (2006) Influence of storage period and packaging method on sliced dry cured beef "Cecina de León": Efects on microbiological, physicochemical and sensory quality. Meat Sci 74:710–717
4. Rubio B, Martínez B, González-Fernández C et al (2007) Effect of modified atmosphere packaging on the microbiological and sensory quality on a dry cured beef product: "Cecina de León". Meat Sci 75:515–522
5. Gutiérrez E, Domínguez MC, Zumalacárregui JM (1988) Caracterización de la Cecina de vacuno elaborada en la Provincia de León. Anales de la Facultad de Veterinaria de León 34: 111–118
6. García I, Zumalacárregui JM, Díez V (1995) Microbial succession and identification of *Micrococcaceae* in dried beef cecina, an intermediate moisture meat product. Food Microbiol 12:309–315

7. Molinero C, Martínez B, Rubio B et al (2008) The effects of extended curing on the microbiological, physicochemical and sensorial characteristics of Cecina de León. Meat Sci 80:370–379
8. MAPA (2021) Carne y Productos Cárnicos. In: Características nutricionales de los principales alimentos de nuestra dieta. The Ministerio de Agricultura, Pesca y Alimentación. Available via Plataforma de conocimiento para el medio rural y pesquero. https://www.mapa.gob.es/es/ministerio/servicios/informacion/plataforma-de-conocimiento-para-el-medio-rural-y-pesquero/observatorio-de-buenas-practicas/buenas-practicas-sobre-alimentacion/caract-nutricionales.aspx. Accessed 15 July 2021
9. Junta de Castilla y León (2012) Pliego de condiciones de la Indicación Geográfica Protegida "Cecina de león". Instituto Tecnológico Agrario, Consejería de Agricultura y Ganadería. Available via Calidad diferenciada, DOP e IGP. https://www.itacyl.es/web/guest. Accessed 20 July 2021
10. Molinero C, Martínez B, Rubio B et al (2008) The anatomical origin of raw meat affects the sensory and chemical characteristics of a dry-cured beef product: Cecina de León. Food Sci Technol Int 14:225–232
11. García I, Díez V, Zumalacárregui JM (1997) Changes in proteins during the ripening of spanish dried beef Cecina. Meat Sci 46:379–385
12. Toldrá F, Flores K, Voyle CA (2006) Study of the white film developed on the cut surface of cacuum-packed dry-cured ham slices. J Food Sci 55:1189–1191
13. Molinero C, Martínez B, Rubio B et al (2006) Effect of the freezing process on raw material during the manufacture process of "cecina de león". In: Declan T, Pearce R, Byrne B, Kerry J (eds) Harnessing and exploiting global opportunities. 52nd International Congress of Meat Science and Technology. 13–18 August. Wageningen Academic Publishers, Wageningen, pp 471–472. https://doi.org/10.3920/978-90-8686-579-6

# Chapter 11

# Salame Felino

Enrico Novelli and Emanuela Zanardi

## Abstract

Italy has a long and ancient history of producing dry-cured meat. In particular, in the Po valley, located in Northern Italy, the availability of salt and the possibility of raising pigs contributed to the development of the manufacture of dry-cured pork products, taking also the advantage of climatic conditions of the Mediterranean area. The uniqueness of traditional Italian pork products relies also on the use of meat obtained from so-called *heavy pigs* as they are slaughtered at an average live weight of at least 160 kg.

Dry-fermented sausages account for a significant part of Italian charcuterie. Regional or local habits, family recipes, environmental peculiarities, and other factors have given rise to a wide range of Italian salami. The present chapter presents the peculiar traits and the steps of the manufacturing process of Salame Felino, a traditional *salame* produced in Northern Italy, in particular in the administrative territory of the province of Parma. Although domestic production for family consumption is still present in this area, nowadays Salame Felino is produced industrially by local producers who adopt the production specification laid down by the consortium of the producers. In 2013, Salame Felino has been included in the register of Protected Geographical Indication (PGI) meat products. The appearance, the texture and the flavor of the Salame Felino are characteristics easily distinguishable from all the others Italian bagged and fermented meat products.

**Key words** Traditional dry-cured meat products, Italian meat products, Pork sausage, Dry-fermented sausages, Manufacture process

## 1 Introduction

Salame Felino is one of the typical Italian dry-fermented sausages, traditionally manufactured in the administrative territory of the province of Parma. Its name derives from *Felino*, a small village located near the Parma hills where pig farming and salami production are widely documented from ancient times. The first document related to the production of *salame* dates back to 1436, when Niccolò Piccinino, a commander of arms employed by the Duke of Milan and with operational base in that geographical area, ordered that "*porchos viginti a carnibus pro sallamine*" (twenty pigs to make salami) be procured. Unlike the common habit of using large quantities of salt to stabilize the pork product, in the

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Felino area a technology was developed that allowed the production of salami with a limited quantity of salt, exploiting the characteristics of the territory: the salt, of excellent quality, was produced in nearby Salsomaggiore, while its location made Felino suitable for the production of excellent sausages, thanks to its characteristics of temperature, humidity, and air circulation. In the nineteenth century more producers of dry-cured pork were registered in Felino than in any other village of the Parma area. In the same period the dry-cured pork products from Parma were also sent to Lombardy: it was around 1897 that in Milan the salami generically defined as "Parma" was declared "di Felino," underlining its quality as a product prepared with pigs fed with acorns. Although domestic production for family consumption was prevalent, during the 1900s, a significant increase in the production capacity was observed due to the application of modern technologies while maintaining the peculiar characteristics of softness and delicate flavor of the Salame Felino. Since 2013 Salame Felino is protected by quality scheme for Protected Geographical Indication [1], which sets some requirements for formulation and processing steps that ensure the correct quality of the final product. Nowadays it is produced in artisanal and industrial way following the product specification laid down by a consortium of fourteen producers [2]. The *Consorzio di Tutela del Salame Felino IGP* was founded with the aim of protecting, promoting, and enhancing this product.

A characterization of Salame Felino has been carried out on matured sausages, purchased on the market of Northern Italy, by measuring some physical, chemical, and sensory attributes [3, 4]. The characteristics of the industrially produced Salame Felino are affected by different environmental conditions in the drying chambers and starter cultures. The effects of these factors on biogenic amine content, volatile compound profile, and sensory descriptors have been documented [5]. The evolution of microbial population and the microbiological safety during maturing have been assessed [6, 7]. In particular, the environmental conditions prevailing in the first 48 h after stuffing are critical with regard to the growth and subsequent survival rate of *Listeria monocytogenes* and *Salmonella enterica*. Fermentation temperatures above 20 °C are needed at least the first 48–72 h of fermentation, for the pH to become an important contributing factor to the inactivation of both pathogens [8].

The main objective of this chapter is to make a detailed description of the stages of the manufacturing process as well as the formulation of the Salame Felino.

## 2 Materials

According to the product specification [2], the characteristics of the Salame Felino covered by the Protected Geographical Indication are the following:

- Irregular cylindrical shape (defined by the shape of the natural casing), length ranging from 15 and 130 cm, weight ranging from 0.2 and 4.5 kg (Fig. 1).
- Nonelastic consistency, compact.
- Delicate aroma; sweet and delicate taste.
- Ruby red color, without spots.

**Fig. 1** Salame Felino at the end of processing. Typical long shape obtained using the pig casing called *gentile* or *culare* (rectum). Courtesy of salumificio Terre Ducali Parma (Lesignano de' Bagni, Parma)

**Table 1**
**Proximate composition (g/100 g) and some physicochemical parameters of Salame Felino**

| | Min. –Max. |
|---|---|
| Moisture | 28.0–48.9 |
| Protein | 23.5–36.7 |
| Fat | 21.0–34.3 |
| NaCl | 3.35–5.20 |
| pH | 5.40–6.36 |
| $L^*$ | 39.1–47.3 |
| $a^*$ | 22.1–30.1 |
| $b^*$ | 5.68–8.90 |

$L^*$, $a^*$, $b^*$ are the coordinates of the tristimulus color system. $L^*$ is referred to the lightness dimension, that ranges from 0 (pure black) to 100 (diffuse white), while the chromatic dimensions are $a^*$ (negative values for green and positive for red) and $b^*$ (negative values for blue and positive for yellow). The asterisk (*), that frequently is omitted, means that the above mentioned coordinate values are obtained by a cubic root and not by a linear transformation
Data obtained by published article [2]

– Physicochemical characteristics: total protein content: min. 23%; collagen/protein max. 0.10; moisture/protein max. 2.00; fat/-protein max. 1.50; pH > 5,3; total lactic acid bacteria >100.000 (Table 1).

Pork for Salame Felino is from typical Italian heavy pigs, slaughtered at minimum 9 months of age and live weight of at least 160 kg (*see* **Note 1**). This requirement is common to most of the Protected Designation of Origin (PDO) and PGI Italian pork products, starting from the most famous Parma ham.

Main ingredients of Salame Felino are trimmings from pork shoulder (*trito di sottospalla*) and pork belly cut into small pieces. Other ingredients and additives traditionally used are sodium chloride, whole and ground black pepper, potassium nitrate, sodium nitrite, sodium ascorbate, saccharose or dextrose or fructose, white wine, crushed garlic, and starter culture (*see* **Note 2**). Natural casing obtained from rectum intestine of pig (called *gentile* or *culare*) is used to stuff the mince after mincing and mixing.

## 3 Methods

The production process of Salame Felino consists of a series of steps, including meat selection, mincing, mixing, stuffing, dipping, drying, and maturation, as described below:

1. At selection, raw meat from the slaughterhouse is kept at 0–4 °C. In the specific of the belly cut, it is very important to foresee a resting phase in the cell, preliminary to the processing, at temperatures slightly below zero degrees centigrade for at least 24 or 48 h with the aim of avoiding and/or reducing its partial melting during the subsequent phase of grinding.
2. Raw meat is minced by an 8 mm holes mincer and then transferred to the mixer. The Salame Felino is characterized by having a very well-defined cut surface, with fat particles having a circular or almost circular shape and with clear and well-defined margins without any signs of crushing or fraying. To obtain this effect, in addition to proceeding with the grinding of the belly cut kept at a temperature just below zero degrees, it is necessary to adjust with extreme precision the rotation speed of both the auger of the meat mincer and the relative knives. The latter in particular must be subjected to frequent sharpening.
3. Other ingredients and additives are added and mixed for about 2 min. At the end of this step, the temperature of the mixture rises up to about 6 °C. If black pepper is ground just before its addition to the meat batter the quantity needed can be lower (values significant lower than 0.1%) with interesting gaining also in terms of delicate aroma and flavor of the end product that are sensory traits extremely appreciated in this *salame*. The taste of Salame Felino must be sweet, never acid. The taste of Salame Felino must be sweet, never acid and to obtain this result is very important the choose and selection of the correct starter culture. There are no restrictions or limitations fixed by the Protection Consortium in the type of bacterial strains to employ. One example, without any intent of generalization, can be a mix of *Staphylococcus xylosus* and *Lactobacillus sakei*. Some strains of the latter, frequently used in this kind of *salame*, are medium strength acidifier in the sense that during the first days of drying the pH descent is gradual, with minimum values close to 5.2–5.3. This approach allows to obtain an end product whose texture is compact and not elastic.
4. After a resting phase of 24 h at 0–2 °C and no control of relative humidity (RH), the mixture is stuffed by a stuffing machine operating under vacuum to avoid the residue of air within the meat mass. The natural casing used (the so-called *gentile*) is one of the peculiarity of the Salame Felino. It is distinguishable for the smooth appearance and the high thickness that allow to hold the meat batter soft also after long ripening times.
5. Salame is tied by hand and sprinkled with an aqueous solution of molds sprayed on the casing.

**Fig. 2** Drying room for dripping and drying steps of Salame Felino. Courtesy of salumificio Terre Ducali Parma (Lesignano de' Bagni, Parma)

6. Salame is hung, transferred to the drying room and subjected to an initial dripping phase (at temperature of 20 °C or higher and no RH control for 14–20 h), followed by the drying step. The latter step is critical both for safety and sensory quality of the end product. Usually it is from 4 to 6 days long, the initial temperature in the industrial productions is equal or even higher than 20 °C together with a RH variable from 60% to 80% according to the diameter of the *salame*, the lean/fat ratio, and others minor factors of variability. However, the length of the drying step is function of the weight loss chose as target, which in turn depends by the quality of the lean fraction of the meat used. If an initial step aimed to loss water from the fresh meat is done inside ventilated cells before grinding it, the following drying step can be shorter. At the end of the drying phase the room temperature usually is one-third lower than it was at the beginning (Fig. 2).
7. Immediately after drying the *salame* is moved to the ripening chamber where it remains, more or less, for 60 days according to the weight loss assumed as target (*see* **Note 3**). The weight

**Fig. 3** Ripening room for the maturation step of Salame Felino. Courtesy of salumificio Terre Ducali Parma (Lesignano de' Bagni, Parma)

loss at the end of maturation (intended as complete cycle) is about 38%. As mentioned above, this value of weight loss can variate according to lean/fat ratio, diameter, salt concentration, etc. If the previous drying phase has been conducted correctly in terms of weight loss, during the first days of ripening some mold colonies appear on the casing surface. Among the rules fixed by the *Consorzio di Tutela del Salame Felino IGP*, the ripening must be carried out in rooms where sufficient air exchange is ensured at a temperature between 12 and 18 °C and must last at least 25 days. The pH, after a transient decrement during the drying step to values that anyway does not go lower that 5.1–5.2, during ripening go up to values that at the end of processing can reach 5.6–5.8, that make the Salame Felino a nonacidic meat product (Fig. 3).

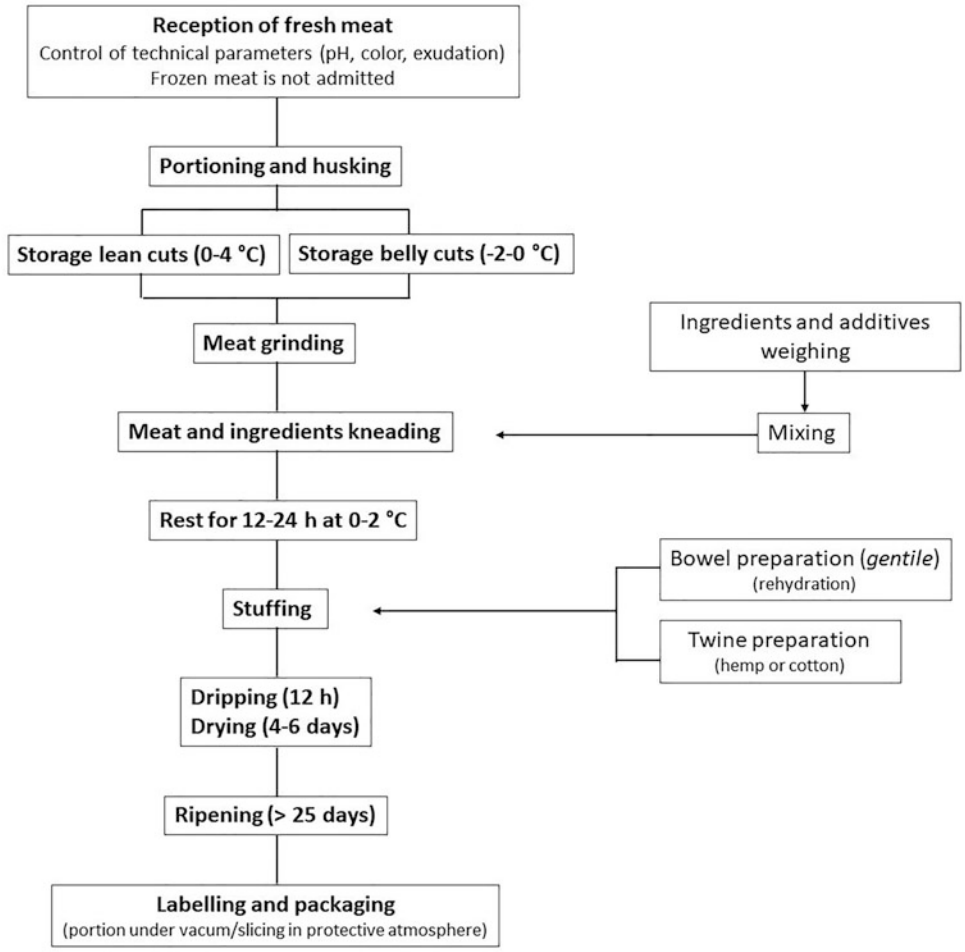


**Fig. 4** Flow diagram with the principal steps of the process of Salame Felino manufacturing

Salame Felino may be sold whole, half vacuum packed, and sliced and packed in modified atmosphere. The Salame Felino traditionally it is cut diagonally so the slices are oval in shape whose length is nearly double than the diameter of the *salame* itself, and this happen both in the retail sell as at home, infact many people still buy whole pieces to eat at home within several days. The scheme of flow diagram of Salame Felino manufacturing is reported in Fig. 4.

## 4 Notes

1. According to the production specification of Salame Felino PGI, the meat will come from castrated male or female pigs. Animals used for reproduction cannot be used.

2. Each producer has its own recipe in terms of type and amount of ingredients and additives.
3. According to the production specification of Salame Felino PGI, the maturation must be carried out in ripening room where sufficient air exchange is ensured at a temperature between 12 and 18 °C and must last at least 25 days.

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### References

1. Commission Implementing Regulation (EU) No 186/2013 of 5 March 2013 entering a name in the register of protected designations of origin and protected geographical indications (Salame Felino (PGI)). Official Journal of the European Union, L62/4 of 6.3.2013
2. Disciplinare di produzione della Indicazione Geografica Protetta "Salame Felino". http://www.salamefelino.com/consorzio/disciplinare/. Assessed 30 July 2021
3. Dellaglio S, Casiraghi E, Pompei C (1996) Chemical, physical and sensory attributes for the characterization of an Italian dry-cured sausage. Meat Sci 42:25–35
4. Saccani G, Fornelli G, Zanardi E (2013) Characterization of textural properties and changes of myofibrillar and sarcoplasmic proteins in Salame Felino during ripening. Int J Food Prop 16: 1460–14711
5. Tabanelli G, Coloretti F, Chiavari C et al (2002) Effects of starter cultures and fermentation climate on the properties of two types of typical Italian dry fermented sausages produced under industrial conditions. Food Control 26: 416–426
6. Dellapina G, Bianco D, Pancini E et al (1994) Microbiological evolution in Italian Felino, Milan and Hungarian style salami. Industria Conserve 69:85–90
7. Mataragas M, Bellio A, Rovetto F et al (2015) Risk-based control of food-borne pathogens listeria monocytogenes and salmonella enterica in the Italian fermented sausages cacciatore and Felino. Meat Sci 103:39–45
8. Mataragas M, Bellio A, Rovetto F et al (2015) Quantification of persistence of the food-borne pathogens listeria monocytogenes and salmonella enterica during manufacture of Italian fermented sausages. Food Control 47:552–559

# Chapter 12

# Bresaola


## Pasquale De Palo and Aristide Maggiolino



## Abstract

The demand of traditional food products has increased in many European countries and Bresaola is one of this. Bresaola founds its origins in Italy, although it is produced in many countries, and is usually produced with beef meat. Many attempts have been done to use different meat sources to develop new bresaola products, as buffalo meat, horse meat, wild boar meat, deer and goat meat, donkey meat and turkey meat, applying a similar production process to lean meat cuts to produce it.

Bresaola production and value in Italy (particularly of Protected Geographical Indication product) have strongly increased in last years, in fact its production increased from over 8500 tons of the 1999 to over 17,000 in 2009, doubling production and value (estimated about 300 million €). About the 13% is exported in other countries. This happened because of the ever-increasing consumers demand due to higher health conscious and their high expectation about sensorial characteristics.



**Key words** Traditional meat products, Meat products, Dry-cured products, Italian products, Manufacture process


## 1 Introduction

Bresaola originated in Italy, particularly in Valtellina region, between 1450 and 1500, and is also a Protected Geographical Indication (PGI) product. It is characterized by low fat and calories content, but contains high amounts of proteins, iron vitamins and minerals [1]. Bresaola is an air-dried and flavored Italian ham-like product that differ from other dry-cured products made from pork (as prosciutto). Bresaola is produced by selecting lean beef from the best cuts of bovine hindquarter, such as topside, round, and rump [1]. During the last decades, considering its great acceptance by consumers due to its composition and its inclusion in healthy diets, many studies attempted to use different varieties of meats aiming to develop bresaola products based on meat of species different from beef like horse, donkey, buffalo, goat, deer, wild boar, and turkey [1–5].


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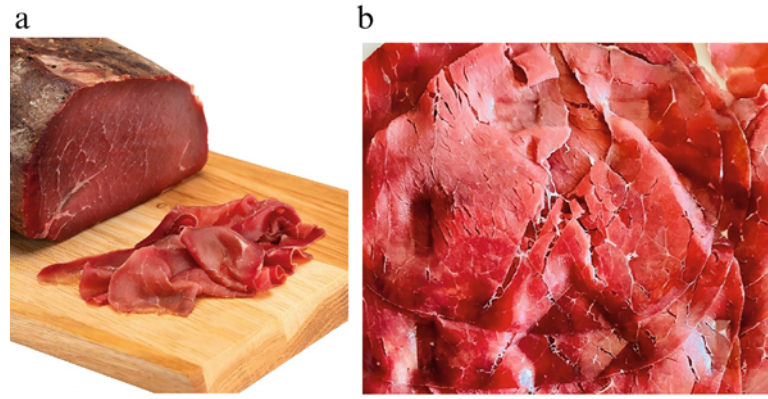


**Fig. 1** Typical bresaola (**a**) and bresaola slices (**b**)

During the last decades, and considering its great acceptance among consumers, its production has increased, giving not only a typical product dimension but also a semi-industrial or industrial approach to its production.

The traditional production method must follow strict rules. Usually visible fat is trimmed, meat is salted by "massaging" dried salt and spices (natural flavors) and then it is dried at a constant and appropriate humidity, temperature and air and aged for at least 3 weeks. When ready, it is served thiny sliced (*see* **Note 1**) and served raw, not cooked (Fig. 1). Flavor is usually described as moderately tasty with delicate smell, smooth ad compact [6].

Despite their wide consumptions, compared to other traditional meat products, the studies carried out on these two products are not scarce, but literature resulted relatively poor. In fact, the few studies carried out in this regard focus on use of nitrite and nitrate [7], the effect of muscle and/or animal category or species on chemical composition [1, 2–4, 8–10] and sensory characteristics [6].

Therefore, considering the aforementioned, the main objective of this chapter is to make a detailed description of the stages of the manufacturing process as well as the formulation of the bresaola.

## 2 Materials

The Bresaola of Valtellina Production Disciplinary was implemented by the Italian law by decree of 23 December 1998 of the Ministry of Agricultural, Food and Forestry Policies. It is made by beef meat (*see* **Note 2**). The characteristics of the product covered by the protected geographical indication (PGI) are the following:

– Shape and external appearance: they are defined by the dimension of the muscle and the shape of the casing, with its own

texture and roughness. Casing without tears and well adhered to meat (*see* **Note 3**).

- Weight: it is given by muscle used, age, and weight of animals (*see* **Note 4**).
- Consistency: firm and compact to the touch.
- Color: intense red, defined by the raw material and the seasonings. It will not present yellowish tones that denote oxidation.
- Aroma: depending on spices used.
- Taste: pleasant and with a balanced sweet/salty ratio.
- Texture: fibrous and homogeneous, depending on the portion that is tasted.

It is consumed raw, not cooked. However, the general production process as well as the main stages are shared and will be discussed in the following section of this chapter.

1. Main ingredients: beef meat, but also other species are used (*see* **Note 4**).
2. Common salt (*see* **Note 5**), ground pepper, natural flavors, wine, spices, sugars, sodium and potassium nitrites, sodium and potassium nitrates, ascorbic acid (*see* **Note 6**).
3. Casings: it can be used both natural and synthetic.

## 3 Methods

The Bresaola of Valtellina Production Disciplinary was implemented by the Italian law by decree of 23 December 1998 of the Ministry of Agricultural, Food and Forestry Policies. However, same manufacturing processes are carried out to produce Bresaola not included in the production disciplinary, with variation linked to species involved and spices included.

The different phases of the manufacturing process will be carried out in accordance with the traditional knowledge of the producers, in order to obtain a product of the highest quality. The elaboration process consists of a series of steps, including meat selection, meat salting, rubbing, washing, casing, drying, and ageing, which will be carried out as described below:

1. Meat selection. Bresaola was done selecting beef meat, particularly some muscles that give peculiar characteristic to the product (weight, dimension) (*see* **Note 4**). Initially, muscles are trimmed of the covering fat.
2. Meat salting. The salting is carried out dry in steel tanks. The meat is sprinkled with the mix of salts and spices (*see* **Notes 5** and **6**) and lasts from 10 to 20 days (*see* **Note 7**).

**Table 1**
**Proximate composition (g/100 g) and main fatty acids (g/100 g of fat) of Bresaola obtained from different species**

| | Beef/cattle | Donkey | Lamb | Mutton |
|---|---|---|---|---|
| Moisture | 51.8–58.65 | 56.92 | 35.23 | 38.2 |
| Protein | 31.45 | 34.65 | 42.37 | 40.27 |
| Fat | 1.41–5.70 | 2.85 | 8.80 | 8.99 |
| Ash | 5.35 | 5.55 | 5.81 | 4.9 |
| SFA | 39.32–47.61 | 33.41–35.75 | 46.03 | 47.79 |
| MUFA | 23.72–49.41 | 41.58–41.84 | 43.49 | 45.12 |
| PUFA | 6.65–36.93 | 22.02–24.08 | 10.48 | 7.08 |

*SFA* saturated fatty acids, *MUFA* Monounsaturated fatty acids, *PUFA* polyunsaturated fatty acids; Data obtained by published articles [3, 8–10]

3. Meat rubbing. Every 3–4 days the pieces are transferred to new containers after eliminating the excess brine by means of massage operations, which allow a faster and more uniform migration of the salt inside the product (*see* **Note 8**).
4. Meat washing. Bresaola is washed to remove the excess rub present on the surface.
5. Casing. After washing, the bresaola is stuffed into natural or artificial casings.
6. Drying. It is carried out in special rooms with constant or controlled temperature, humidity, and ventilation. Drying must allow rapid dehydration of the product in the first days of treatment (*see* **Note 9**).
7. Ageing. It is carried out in special rooms at a controlled temperature between 12 and 18 °C and a relative humidity ranging from 70% to 90% for a variable period ranging from 2 to 4 weeks (*see* **Note 10**).

The chemical composition of the Bresaola of different species is reported in Table 1.

## 4 Notes

1. Slices are served about 1/1.5 mm thin.
2. PGI bresaola provides for the exclusive use of beef meat. Bresaola is produced also using other species meat (horse, donkey, turkey, goat, lamb, buffalo) following similar production procedures.

3. Casing is used only for a part of the production process, then it is removed and the bresaola is served without it.
4. Different beef muscles can be used:
   - *rump*: corresponds to the posteromedial portion of the thigh musculature and includes the internal *rectus* muscle, the *adductor* muscle and the *semimembranous* muscle.
   - *tip of the hip*: it is the most valuable cut; it corresponds to the part of the rump deprived of the *adductor* muscle. It has a minimum weight of 2.5–3 kg.
   - *underside*: corresponds to the posterolateral portion of the thigh muscles and precisely to the *vastus* long muscle and weighs at least 2 kg.
   - *joist*: corresponds to the posterolateral portion of the thigh muscles and more particularly to the *semitendinosus* muscle and weighs at least 1 kg.
   - underneath: corresponds to the anterior fascia of the thigh, made up of the anterior *rectus* muscle and the *vastus* external, internal, and intermediate muscle (*quadriceps femoris*).

   Same cuts can be used for other species.
5. Quantities varying from 2.5 to 3.5 kg per 100 kg, depending on the season.
6. The salty mixture often changes from producer to producer and is handed down as a recipe to be jealously guarded. Sugars are added with the aim of favoring the microbial phenomena responsible for a large part of the aging of the product.
7. The salting duration ranged from 10 to 20 days, depending on the season, the muscle size and the altitude of the place of production.
8. In this phase the meat is flavored, losing part of the free water present in the muscle tissue.
9. It is carried out at a temperature between 20 and 30 °C and in conditions of air humidity ranging between 35% and 65%.
10. The curing rooms, as well as the drying rooms, must be equipped with systems for maintaining and detecting temperature and humidity and must allow for optimal air exchange. This maturation process causes a considerable weight loss and a consequent flavor of the product due to the concentration of the aromas and salt, making it possible to keep the bresaola for quite long periods while maintaining all the characteristics of flavor, softness, and digestibility.

## References


1. Paleari MA, Beretta G, Colombo F et al (2000) Buffalo meat as a salted and cured product. Meat Sci 54:365–367
2. Marino R, Della Malva A, Gliatta G et al (2009) Quality of donkey bresaola. Ital J Anim Sci 8:715–717
3. Marino R, Albenzio M, Della Malva A et al (2015) Nutritional properties and consumer evaluation of donkey bresaola and salami: comparison with conventional products. Meat Sci 101:19–24
4. Paleari MA, Moretti VM, Beretta G et al (2003) Cured products from different animal species. Meat Sci 63:485–489
5. Dalzini E, Cosciani-Cunico E, D'Amico S et al (2014) Growth potential of listeria monocytogenes in sliced Turkey bresaola packed in modified atmosphere. Italian J Food Safety 3:44–46
6. Braghieri A, Girolami A, Carlucci A et al (2009) Sensory properties affecting acceptability of "bresaola" from podolian young bulls. J Sens Stud 24:677–697
7. Berardi G, Albenzio M, Marino R et al (2021) Different use of nitrite and nitrate in meats: a survey on typical and commercial Italian products as a contribution to risk assessment. LWT 150:112004
8. Alabiso M, Maniaci G, Giosuè C et al (2020) Effect of muscle type and animal category on fatty acid composition of bresaola made from meat of Cinisara cattle: preliminary investigation. CyTA J Food 18:734–741
9. Maniaci G, Alabiso M, Francesca N et al (2020) Bresaola made from Cinisara cattle: effect of muscle type and animal category on physicochemical and sensory traits. CyTA J Food 18: 383–391
10. Zhang R, Yoo MJ, Gathercole J et al (2018) Effect of animal age on the nutritional and physicochemical qualities of ovine bresaola. Food Chem 254:317–325

# Chapter 13

# Pepperoni

Aristide Maggiolino and Pasquale De Palo

## Abstract

Approximately 390 million pounds of dry sausage are sold annually in the United States, with pepperoni being the largest volume variety produced. The largest buyers of the pepperoni are pizza restaurant chains, where pepperoni reigns as the most requested pizza topping. The top three pizza chains in the United States (Pizza Hut, Domino's, and Little Ceasars) combined for over $9.4 billion in sales in 1990, with sales continuing to expand. One of the difficulties of producing a large volume of pepperoni or other dry sausages is that the process is capital and technology intensive. The manufacture of dry sausage takes large amounts of equipment such as grinders, mixers, stuffers, and smokehouses, but unlike other sausage products, fermentation rooms, and drying rooms are also needed. In addition to the large amount of equipment necessary, the process of dry sausage manufacture from raw materials to a finished product can take up to 2 months for some specialty sausages such as San Francisco style pepperoni. Since the drying of such products can take weeks, pepperoni manufacturers are faced with large, expensive inventories. With such a large amount of inventory on hand, product that does not meet the customer's specifications can be extremely costly to the manufacturer.

One of the major problems in the production of pepperoni is a textural change referred to as cupping, or the curling of pepperoni slices when they are cooked on pizzas.

**Key words** Traditional meat products, Pepperoni, Dry-cured products, Dry-fermented sausages, Manufacture process

## 1 Introduction

Pepperoni is classified as a dry sausage with a moisture to protein ratio of 1.6:1. a moisture content between 30% and 36% with a pH between 4.7 and 5.0 and acidity as expressed in lactic acid from 0.4% to 1.5% [1]. It is made from pork, or a combination of beef and pork (turkey meat is also commonly used as a substitute) [2], beginning from a particular reduction by either grinding or chopping meat, then mixed and re-grinded. During the last decade, and considering its great acceptance among consumers, its production has increased. Pepperoni is frequently restricted to pizza in the eyes

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of consumers, but new food trends are beginning to show its versatility. An example is the "Hormel Pepperoni" that, in a year report ending in the first months of 2019, seals for a total of $7,275,755.49. Pepperoni is a market that can see a large amount of growth in coming years based of the increase in meat snacking trends. Despite its wide consumption, literature and studies carried out on Pepperoni are tendentially scarce. Moreover, the few studies carried out in this regard focus on chemical composition [3], biogenic amines [4–6], microbiology and toxins [7–9] and their potential risk assessment for consumers, on starter cultures and sensory profile [10], on storage and oxidative stability [11, 12].

Therefore, considering what reported, the main objective of this chapter is to make a detailed description of the stages of the manufacturing process as well as the formulation of the pepperoni.

## 2 Materials

Pepperoni is the meat dry sausage resulting from the mixture of pork meat obtained from different pork cuts or the mix of pig and beef meat (*see* **Note 1**), grinded, mixed with spices and salts and stuffed in casing. The characteristics of the product covered by the protected geographical indication are the following (Fig. 1):

1. Shape and external appearance: it is defined by the shape of the casing, with its own texture and roughness. There is no one

**Fig. 1** Pepperoni slices

right shape, or size, for pepperoni. Casing without tears, filled with the meat dough and well adhered to it, easy-to-peel and usually fibrous casings of 45–47 mm diameter.

2. Weight: Considering that the widest filling pipe in relation to the diameter of the casing has to be used to avoid back rolling of the sausage mass, weight is variable.
3. Consistency: firm and compact to the touch. The cut will present a heterogeneous and not very tied appearance.
4. Color: red, defined by the raw material. It will not present yellowish tones that denote oxidation.
5. Aroma: intense, smoked. Once prepared for consumption, the odor of cooked lean will predominate.
6. Taste: pleasant, spicy, and with a balanced sweet/salty ratio.
7. Texture: fibrous and not homogeneous, depending on raw material used.
   (a) Main ingredients: Pork meat and fat (*see* **Note 1**). Mix of pork and beef meat and pork fat, sometimes mix of pork and turkey meat (*see* **Note 2**).
   (b) Common salt, sugar, cayenne pepper, sweet paprika, anise seed, garlic, red wine, ascorbic acid, saltpeterweet, and white vinegar are used as ingredients/spices (*see* **Note 3**).
   (c) Casings: is not specified which part of intestine must be used, and if natural or synthetic. It is used the common sausage casing (*see* **Note 4**).

## 3 Methods

The different phases of the manufacturing process will be carried out in accordance with the traditional knowledge of the producers, in order to obtain a product of the highest quality. The elaboration process consists of a series of steps, including meat grinding and mixing, fermentation, thermal processing drying:

1. The grinding (*see* **Note 5**) of the ingredients is done in pieces or regular portions. Grinding is necessary to allow an initial protein extraction in order to provide binding between the meat particles (*see* **Note 6**).
2. Mixing the "meat" ingredients with the salt and the species. There are several reasons mixing time is important in the manufacture of dry sausage (*see* **Note 7**). One of the most important factors is controlling over mixing and the loss of particle size. Yet, a certain degree of mixing is necessary to distribute ingredients throughout the batch and to extract some myofibrillar proteins which are important in the

development of sausage texture. Mechanical action such as mixing shears muscle fibers and exposes myofibrillar proteins. Therefore, an increase in mechanical action by extending mixing time would be expected to expose more myofibrillar proteins and therefore alter the textural properties of dry sausages by allowing more proteins to contribute binding sites in the sausage system.

3. Mixing temperature control. It has been suggested that temperature control during the mixing and stuffing of pepperoni is critical because of its importance of ensuring product quality in terms of particle size and textural properties. It has been suggested to do it at refrigerated temperature, between −2 and 2 °C. Meat must be kept as cold as possible to prevent smearing during stuffing, a condition where fat covers the meat particles upon mixing, inhibiting the drying of the product and leaving an unappealing coating on the sausage.
4. Fermentation. It originated with the addition of sugar, salt, and commercial starter followed with a holding period during which developed a desired flavor and texture in addition to enhanced preservation of the sausage. During this holding time, bacteria converted the sugar added to the sausage to lactic acid, thereby lowering the pH of the sausage and increasing the keeping qualities of the sausage due to the elimination or limited growth of spoilage and pathogenic bacteria because of the lower pH. Since pepperoni is a dry sausage, a low pH is also desirable due to the reduction of water holding capacity (WHC) as pH decreases. This decrease in WHC makes the drying process more efficient since there is less water in the matrix to be removed. Fermentation is usually conducted at 38.9 °C dry bulb and 37.8 °C wet bulb until a pH of 4.8 was attained.
5. Cooking. After fermentation, chubs were heated to and held at an internal temperature of 53.3 °C for about 60 min. Pepperoni chubs are then transported and dried in an environmentally controlled chamber.
6. Drying. Drying is performed to develop characteristics such as desired flavor and texture. Cooked sausage drying was performed at a temperature of 13–18 °C with a relative humidity of 65–75% for 7–12 days (*see* **Note 8**).

The chemical composition of the final product (after the drying-ripening period) is specified in Table 1.

**Table 1**
**Chemical composition (g/100 g), pH and fatty acid composition (g/100 g of FAMEs) of pepperoni**

| | Pepperoni |
|---|---|
| Moisture | 46.4–47.5 |
| Protein | 13.1–13.7 |
| Fat | 31.5–33.2 |
| Ash | 4.0–4.3 |
| Cl | 1.9–2.1 |
| NaCl | 3.1–3.5 |
| pH | 4.8 |
| SFA | 38.6–40.9 |
| MUFA | 46.7–47.4 |
| PUFA | 10.1–11.2 |

*SFA* saturated fatty acids, *MUFA* Monounsaturated fatty acids, *PUFA* polyunsaturated fatty acids; Data obtained by published articles [12]

## 4 Notes

1. The final meat/fat proportion must be 70/30. Meats to be used are separated according to how much fat is present. First lean meat (95/5 respectively muscle/intramuscular fat), followed by 80/20 and then the fatter 50/50 trim. Pork fat and fatty trims should be hard fats (from the shoulder, ham, back fat, or jowls), because softer fats can cause fat caps and soft texture in the finished product.
2. Usually the portion of pork, if mixed, is the 70%.
3. Salt is present at around 27–29 g per kilogram of sausage mass. Quantity of other spices is never specified and depend by the manufacturer recipe. However paprika is the most abundant, and spices can change according the recipe.
4. The most common casing size used in USA for pepperoni sausage is 1 1/2″ (38 mm) in diameter. However, it is also used a bit thicker size, like 2″–2 1/2″ (50–60 mm).
5. The holes bored into the plate have specific diameters (12.7–3.2 mm; 0.5–0.12 in., respectively). Meats must be comminuted in two or three steps with a sequential reduction in the grind size. Meats must be kept cold during any grinding operation to prevent smearing/liquidization of the fat.

6. Grinding should not be excessive to cause an increase in the product's ability to bind water, or to cause textural changes upon drying.
7. Mixing time ranged from 6 to 12 min.
8. If sausages are dried slowly, yeast and mold can grow on the surface producing an undesirable product. In contrast, if the product is dried too quickly, case hardening can result.

## References


1. Terrell RN, Smith GC, Carpenter ZL (1977) Practical manufacturing technology for dry and semi-dry sausage. Proc Rec Meat Conf Am Meat Sci Assoc 30:39–44
2. Hui YH (ed) (2006) Handbook of food science, technology, and engineering, vol 149. CRC Press, Boca Raton, FL
3. Palumbo SA, Zaika LL, Kissinger JC et al (1976) Microbiology and technology of the pepperoni process. J Food Sci 41:12–17
4. Cadayong BP, Barraquio VL (2014) Human exposure risk assessment to biogenic amines in cheeses and fermented sausages in Southern Luzon. Philippine J Sci 143:107–112
5. Puangsombat K, Gadgil P, Houser TA et al (2011) Heterocyclic amine content in commercial ready to eat meat products. Meat Sci 88:227–233
6. Bandolin SC, Pham LJ, Barraquio VL (2010) Biogenic amines in some commercially available fermented sausages in Laguna and Metro Manila. Philippine Agric Sci 93:468–473
7. Glass KA, Kaspar CW, Sindelar JJ et al (2012) Validation of pepperoni process for control of Shiga toxin–producing Escherichia coli. J Food Protect 75:838–846
8. Riordan DC, Duffy G, Sheridan JJ et al (2000) Effects of acid adaptation, product pH, and heating on survival of Escherichia coli O157: H7 in pepperoni. Appl Environ Microb 66: 1726–1729
9. Duffy G, Whiting RC, Sheridan JJ (1999) The effect of a competitive microflora, pH and temperature on the growth kinetics of Escherichia coli O157: H7. Food Microbiol 16:299–307
10. Montes Álvarez J, Restrepo Flórez C, Patiño Gómez J et al (2013) Effect of the concentration of starter cultures and dextrose on the quality of the maturation and the sensory life of pepperoni. Revista Lasallista de Investigación 10:101–111
11. Lin Y, Huang M, Zhou G et al (2011) Prooxidant effects of the combination of green tea extract and sodium nitrite for accelerating lipolysis and lipid oxidation in pepperoni during storage. J Food Sci 76:C694–C700
12. Kristinsson HG, Jónsdóttir R, Valdimarsdottir T et al (2001) Oxidative stability of pork pepperoni during processing and different packing and storage conditions as influenced by fat source. J Muscle Foods 12:301–315

# Chapter 14

# Coppa

Chiara Aquilani and Carolina Pugliese

## Abstract

Pig farming has always been an important activity in Italy, indeed, over the years, multiple pork products have been developed with specific characteristics owe to the local environmental and cultural conditions. Traditional recipes have been refined over centuries thanks to the know-how of manufacturers. Coppa, often known as Capocollo, is a traditional dry-cured pork product derived from the muscles of the cervical regions. It is spread almost all over the Italian peninsula, even if some differences in ingredients and processing are common among different regions as a result of centuries of coevolution with the cultural and climatic conditions of the different Italian territories.

Some of these products, thanks to their strong bond with the territory and a quite consolidated traditional recipe, have obtained the protection of quality marks (PDO and PGI). Up to date, two of them, "Coppa Piacentina" and "Capocollo di Calabria" have a protected denomination of origin (PDO), whereas a third one, "Coppa di Parma", has obtained a protected geographical indication (PGI).

The present chapter aims to give a detailed description of the formulation and the different steps of processing of the three different products under PDO and PGI protection: Capocollo Calabrese, Coppa Piacentina, and Coppa di Parma.

**Key words** Traditional meat products, Capocollo, Dry-cured products, Italian pork products, Mediterranean diet, Manufacture process

## 1 Introduction

Coppa is a traditional dry-cured pork product manufactured in Italy. It is widespread along the peninsula, although under different names. The most commons ones are "Coppa" and "Capocollo", but in some central-southern regions (Marche, Umbria, and Lazio), it is also called "Lonza" or "Lonzino." Usually, the cervical muscles of the upper and thoracic region of pigs, were used. Animals should be slaughtered at the live weight of 160 kg and at least 9 months of age. Moreover, they must belong to Italian Landrace and Large White lines, Duroc or crosses among them. For the Calabrian capocollo, it is also allowed the use of Apulo-Calabrese local breed. Unless being widespread in all the Italian regions, the

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specific microclimatic conditions and local manufacturing processes have led to a great variability in products' characteristics, with each producer keeping its own recipe.

To date, the European Union has recognized three quality marks to protect the traditional manufacturing processes of this product:

- Capocollo di Calabria (PDO) [1] (Fig. 1).
- Coppa Piacentina (PDO) [2] (Fig. 2).
- Coppa di Parma (PGI) [3] (Fig. 3).


**Fig. 1** Capocollo di Calabria


**Fig. 2** Coppa Piacentina

**Fig. 3** Coppa di Parma

**Table 1**
**Main characteristics of Coppa/Capocollo under protection of quality marks**

| | "Capocollo di Calabria" | "Coppa Piacentina" | "Coppa di Parma" |
|---|---|---|---|
| Quality mark | PDO | PDO | PGI |
| Slaughtering weight (kg) | 140 | 160 | 160 |
| Slaughtering age (months) | 8 | 9 | 9 |
| Raw product weight (kg) | 3.5–5.5 | >2.5 | >2 |
| Seasoned product length (cm) | – | – | 25–40 |
| Seasoned product weight (kg) | – | >1.5 | >1.3 |

Even if quite similar, the materials and processing methods used between for the 3 different products slightly differ, as showed in Table 1.

Despite diffusion and consumer's acceptance of Coppa, few research has been made on this product, if compared to other traditional dry-cured products such as Italian dry-cured ham or salami. Researches were carried out to assess the effect of different rates of postmortem pH decline on the technological quality of Calabrian Capocollo [4] and on the effect of different dietary supplementation on the quality characteristics of Coppa di Parma [5]. Few studies were also carried out on the Coppa in order to assess the effects of irradiation on fatty acid and cholesterol [6] and on the development of radiolytic compounds, 2-alkylcyclobutanones specifically [7]. Similarly, Pietri et al. [8] addressed another important topic concerning cured pork

products, investigating the occurrence of ochratoxin A in raw ham muscles and in pork products, including the Coppa.

Taking into account the aforementioned variability in traditional recipes, the main objective of this chapter is to make a detailed description of the stages of the manufacturing process as well as the formulation of the three types of Coppa under protection of quality marks.

## 2 Materials

Coppa is made of the muscles excised between the head and the beginning of the thoracic region of the pigs, including a variable portion of subcutaneous fat (about 3–4 mm).

Since these products are covered by PDO/PGI [9], geographical limitations insists on animals breed and origins, and on location of the production process. Also, meat of sows and boars is never admitted.

Concerning the breed, animals registered in Landrace, Large White or Duroc Italian Herdbooks and their crosses are admitted. The meat of Apulo-Calabrese breed is also admitted for Calabrian Capocollo. The protocol of PDO Calabrian Capocollo requires that animals are born in Calabria, Puglia, Basilicata, Campania, or Sicily and they must be reared in Calabria starting from 4 months of age. To produce Coppa Piacentina, instead, animals have to be raised in Lombardy and Emilia-Romagna, whereas the production process must take place in the territory of Piacenza.

Animals at slaughter must reach 160 kg ± 10% of live weight and 9 months of age, except for Calabrian Capocollo where limits are set at 140 kg as minimum live weight and 8 months for age.

The production area of Coppa di Parma includes the areas of Parma, Modena, Reggio Emilia, Mantua and Pavia, the municipalities settled along the strip of Po river and the areas of Lodi and Cremona, as well as the Municipality of San Colombano al Lambro in the area of Milan. Even if any geographical limitation is set for rearing, animals must belong to Landrace, Large White or Duroc Italian Herdbooks, or their crosses.

In addition to meat, the ingredients used are salt (in variable percentage according to the recipe), black pepper, red pepper, and possibly other spices (e.g., cinnamon, cloves, laurel, nutmeg). The single product specifications also provide indications for the use of sugar, wine vinegar, sodium or potassium nitrite and nitrate, ascorbic acid.

The raw product is then seasoned, stuffed in large intestine of cattle or pig.

At the end of the process, the Coppa must present the following characteristics:

**Table 2**
**Proximate composition of seasoned Coppa/Capocollo as reported by production specifications**

| | "Capocollo di Calabria" | "Coppa Piacentina" | "Coppa di Parma" |
|---|---|---|---|
| Salt (%) | – | 1.5–3.5 | 2.6–3.5 |
| Moisture (%) | – | 27–43 | – |
| Fat (%) | – | – | – |
| Protein (%) | – | 19–34 | >20 |
| Ash | – | 1–7.5 | – |
| pH | – | 5.5–6.5 | >5.7 |

- Shape and external appearance: cylindrical shape slightly thinner at the end, tied by strings.
- Consistence: compact and homogeneous, not oily. The case detaches easily.
- Color: bright red/pink, possibly marbled.
- Odor and flavor: pleasant, of aged meat, and of medium intensity, characteristic of the product.
- Taste: pleasant and with a balanced saltiness/sweetness proportion, it becomes more characteristic as the seasoning proceeds.
- Chemical composition (Table 2) and microbiological parameters depend on the product (*see* **Note 1**).

The general production process is displayed in the following section.

## 3 Methods

Beside some differences reported in the respective production specifications, a shared production process can be outlined for the three products. Once the required portion of meat is obtained from the carcass several manufacturing phases are carried out, as listed below:

1. The meat is trimmed to obtain a regular cylindrical shape, then it is washed and salted.
2. The salting phase lasts 7 days on average; during this period the product is maintained in refrigerating cell (0.5–4 °C) to promote dehydration. The salting phase can range from 4 to 10 days for Calabrian Capocollo, at least 7 days for Coppa Piacentina, and from 6 to 10 days for Coppa di Parma.

3. After the salting phase, the product is washed and massaged. Five additional days of rest in refrigerating cell (0.5–5 °C) are required for Coppa di Parma.
4. After being washed, products are stuffed into large intestine of cattle or pork and tied by strings.
5. Once tied, products undergo to the drying phase, which is carried out at controlled temperature and humidity for 7–15 days depending on the production specification (*see* **Note 2**).
6. The seasoning phase starts at the end of the drying and it lasts several months, depending on the production specification (*see* **Note 3**). It takes place in locals equipped for this purpose or in natural drying rooms.

All the production specifications allow the commercialization of whole pieces, sliced product, and vacuum-packed format, provided that all the packaging operations take place in the area protected by the PDO/PGI.

## 4 Notes

1. Coppa di Parma production specification also sets limits on microbiological parameters: *Enterobacteriaceae* (ufc/g) < 10; *Escherichia Coli* (ufc/g) < 10; *Staphylococcus aureus* (ufc/g) < 100.
2. Coppa Piacentina production specification reports the following drying indication: controlled temperature (15–25 °C) and humidity (RH 40–90%) for 7 days (or until the appearance of the characteristic flowering that determines the change to the typical pink color).

   Coppa di Parma: after the resting phase, temperature is risen to 18 °C in 8–10 h, then drying could start. From day 1 to 3 of the drying phase, temperature is kept from 13 to 23 °C (RH 55–75%). The second phase lasts 12–15 days, temperature is lowered until 14 °C (RH 65–85%).
3. Calabrian Capocollo specification requires 100 days of seasoning.

   Coppa Piacentina seasoning takes place at temperature ranging from 10–20 °C (RH 70–90%) and it lasts at least 6 months after the end of the salting phase. Products can be exposed to natural light and ventilation when season ensure the adequate temperature and humidity conditions. Moreover, the traditional seasoning process requires that, during part of the seasoning period, products are kept in cellars.

   Coppa di Parma seasoning phase requires temperature ranging from 12 to 16 °C (RH 70–87%). Seasoning minimum

length depends on product's size, it has to last minimum 60 days (from the start of salting phase) for pieces of 2–2.6 kg, and 90 days for pieces of more than 2.6 kg.

## Acknowledgments

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### References

1. European Commission (1998) COMMISSION REGULATION (EC) No 134/98 of 20 January 1998 on the registration of geographical indications and designations of origin under the procedure laid down in Article 17 of Council Regulation (EEC) No 2081/92
2. European Commission (1996) COMMISSION REGULATION (EC) no 1263/96 of 1 July 1996 supplementing the annex to regulation (EC) no 1107/96 on the registration of geographical indications and designations of origin under the procedure laid down in article 17 of regulation (EEC) no 2081/9. Off J Eur Communities L163:1–3
3. European Commission (2011) COMMISSION REGULATION (EC) No 1118/2011 of 31 October 2011 on the registration of geographical indications and designations of origin [Coppa di Parma]
4. Nanni Costa L, Tassone F, Dall'Olio S et al (2013) Effect of different rates of postmortem pH decline on the technological quality of Calabrian Capocollo. In: Trends in veterinary sciences. Current aspects in veterinary morphophysiology, biochemistry, animal production, food hygiene and clinical sciences, pp 165–169
5. Zanardi E, Novelli E, Ghiretti GP et al (2000) Oxidative stability of lipids and cholesterol in salame Milano, coppa and Parma ham: dietary supplementation with vitamin E and oleic acid. Meat Sci 55:169–175
6. Zanardi E, Battaglia A, Ghidini S et al (2009) Lipid oxidation of irradiated pork products. LWT Food Sci Technol 42:1301–1307
7. Zanardi E, Battaglia A, Ghidini S et al (2007) Evaluation of 2-alkylcyclobutanones in irradiated cured pork products during vacuum-packed storage. J Agric Food Chem 55:4264–4270
8. Pietri A, Bertuzzi T, Gualla A et al (2006) Occurrence of ochratoxin a in raw ham muscles and in pork products from northern Italy. Ital J Food Sci 18:99–106
9. Mipaaf - Disciplinari di produzione prodotti DOP, IGP e STG riconosciuti - 1.2 Prodotti a base di carne. https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/3339

# Chapter 15

# Lukanka

**Iskra Vitanova Ivanova, Clarizza May Diosso, Ilia Iliev, Saso Stojanovski, Penka Moncheva, and Svetoslav Dimitrov Todorov**

## Abstract

Biopreservation of meat products via fermentation is a well-known approach applied in different European countries since ancient times. Different fermented dry sausages are part of that preservation processes and important in the culinary heritage traditions in South European countries. The present overview aims to provide basic information on related to the characterization of the naturally fermented semi-dried Bulgarian sausages, *lukanka*, which is unique to Balkan Peninsula cuisine. What is the specificity of its fermentation processes; how do different starter and autochthonous meat microbiota interfere to form specific final products; what is the role of starter and adjunct cultures in the safety of the products; how is the Bulgarian *lukanka* classified in the perspective of other Mediterranean dry fermented sausages? These are some of the topics that will be discussed.

**Key words** Fermented dry sausages, *Lukanka*, Lactic acid bacteria, Starter cultures, Bacteriocins

## 1 Introduction

*Lukank*a is not only popular in Bulgaria, but also on Balkan Peninsula and South-East Europe, and widely appreciated for its gastronomical qualities. Nevertheless, the microbiological knowledge on spontaneous or conducted fermentation processes for preparation of *lukanka* are very limited. Only a few studies focused on the microbial population of *lukanka* and dynamics of its microbiota during fermentation and maturation process.

Dimov et al. [1] evaluated the presence of different lactobacilli in *lukanka*, comprising of whole cell protein (WCP) and DNA-based approaches; Stijanovski et al. [2] isolated more than 200 isolates, representatives from 7 genera: *Lactobacillus, Leuconostoc, Staphylococcus, Enterococcus, Lactococcus, Micrococcus, Streptococcus* from different samples of *lukanka*, produced by "Tandem" company, and confirmed that they were representatives of the commonly used meat starter cultures. Moreover, special attention

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was given to the representatives of genera *Lactobacillus*, obtained from different stages of the production, fermentation and maturation, and storage of the final product were analyzed and investigated for their relevance on technological properties. Furthermore, Stojanovski et al. [3] pre-selected and evaluated some of the technological properties for 42 of previously isolated *Lactobacillus* spp. from "Tandem" company produced *lukanka* and applied API Zym in the evaluation of the enzymatic profile of the isolated and studied lactobacilli [4].

Fermented meat products can be a rich source of LAB and can be used as vector for delivery of LAB to the consumers. *Lukanka* was shown to be harboring different LAB, and some of them can possess beneficial, including probiotic properties. In a previous study, Todorov et al. [5] evaluated different LAB obtained from *lukanka* with aim to assess their safety and potential probiotic properties.

The etymology of the name "*lukanka*"dates back to the nineteenth century. The reference material "How the Bulgarian sausage was created" by Marinov [6] describes that the name "*lukanka*"is associated with the original recipes of meat products in which onions are added (the word "onion" is at the root of the name *lukanka* in the Bulgarian language). In practice, the name "*lukanka*"is confirmed, although onions are dropped as an ingredient.

*Lukanka* is a Bulgarian salami-type fermented meat product, unique to Bulgarian cuisine heritage (Fig. 1). *Lukanka* can be described as a semi-dried sausage with a flattened cylindrical shape and brownish-red interior with skin that is normally covered with a white fungus. According to the standards, the final product has a low water activity, slightly acidic taste, and can be stored under refrigeration (during summer) or at ambient temperature in the winter period [5]. From technological point of view, use of the mix

**Fig. 1** *Lukanka,* Bulgarian salami-type fermented meat product

of small pieces of meat and fat give the interior a grainy structure. According to the traditional recommendations for preparation, *lukanka* is made of pork, veal, and spices (black pepper, cumin, salt), minced together and stuffed into a dried cow's intestine used as casing. After the stuffing process, the cylindrical salami is hung to dry for about 40–50 days in a well-ventilated location. In the process of drying, the salami is pressed to acquire its typical flat form [5].

*Lukanka* is produced in the different regions of Bulgaria and generally including geographically names to the name. For example, the name *Panagyurska lukanka* is specific in itself and originates etymologically from the name of the town of Panagyurishte—the place where the product was first industrially produced. Subsequently, the recipe and quality requirements for *Panagyurska lukanka* were standardized in 1958 with the Bulgarian state standard 2589–58 and have remained unchanged to this day. *Panagyurska lukanka* is a pressed raw-dried meat product of minced fresh beef (which can be replaced with fresh buffalo) and fresh pork, auxiliary materials and natural spices, stuffed in natural or artificial casings with a diameter (φ) 50–80 mm, tightly adhered to the filling mass.

The physicochemical characteristics of *Panagyurska lukanka* are the following: maximum water content: 40% by weight; maximum fat content: 42% by weight;—minimum protein content: 28% of the dry matter (according to Keldal method); maximum salt content: 4.6% by weight; minimum pH: 5.2. *Panagyurska lukanka* can be marketed whole, cut into pieces or slices, in vacuum packaging or in packaging in a modified atmosphere conditions.

Increasing the competitiveness of meat producers is associated with the implementation of capital investments that will allow the renewal of production assets and increase labor productivity. The development trends of the meat industry are related to the construction of strong and competitive meat processing enterprises. The implementation of an adapted European system for control of the parameters of the critical and control points in the technological processes in the production of meat products are one of the most important conditions. The categories included in the raw-dried meat products are sausage, *sushenitsa*, *babek* and *staretz*, sausage, sausage salami, bacon, raw-dried sausages, dried sticks. The average price that the Bulgarian buyer pays in the last year (2020) per kilogram of raw-dried meat products is BGN 16.04 (approx. 8.00 Euro).

According to Nilson Bulgaria for the period August 2018–July 2019, the market for raw-dried meats in Bulgaria contributed to the national economy with amounts to BGN 231.6 million (approx. 116 million Euro), representing an growth of around 6.7% for the mentioned period. Still with a small share of total

sales, namely 3.4%, *babek* and *staretz* is the most dynamically developing category in the last year with significant growth of 23.1% in volume and 20.3% in value.

## 2 Materials

The composition and quality requirements for the production of *Panagyurska lukanka* have been maintained for over 30 years.

The composition for 100 kg of filling mass: beef (buffalo) meat 60 kg, including up to 10% fat; lean pork 20 kg with up to 5% fat; pork belly 20 kg with up to 50% fat; seasoning: black or white natural pepper 0.3 kg; cumin 0.3 kg; additional ingredients: sugar 0.3 kg; salt 2.3 kg; preservatives: potassium nitrate 0.1 kg or sodium nitrate 0.085 kg; antioxidant: ascorbic acid (E300) 0.05 kg was determined in 1983 in Technical condition Nr 37–83, approved by the National Agrarian Industrial Union (NAPS)—*Panagyurska lukanka* to BDS 2589–83 (National standard). The traditional methods of drying and pressing, which are an essential part of the production process of *Panagyurska lukanka*, have also been preserved. Casing can be into the salted bovine large intestine or ovine caecum or artificial with diameter between 50 and 80 mm. Pressing also affects ripening and drying, which determine the quality of the finished product [7].

## 3 Methods

Production of fermented sausages, including *lukanka* in Bulgaria is a relatively new industrial practice, but is based from a century-old traditional artisanal practice. Growing from traditional artisanal knowledge built over centuries, industrial production was conducted. Nevertheless, many of the processes have not been clarified, and some of them are still being studied. Today, detailed expertise is essential for the industrial production of any fermented food product, where detailed understanding of the technological production are important for obtaining safe and high-quality final products. Some of the critical control points are following the good production practices in with strict sanitary and hygienic requirements. This is a critical key point in the production of fermented meat products, since these sausages are not subjected to heat treatment, therefore the possibility of additional contamination of the meat raw materials with unwanted microorganisms should be minimized. However, use of the correct fermentation process, right starter cultures, and conditions for the ripening process proceed in the desired direction can play a critical role in the reduction of food spoilage and guarantee modulation of microbiota of the final products. In the past, fermented dry meat products were produced in the cold periods of

the year, but industrial production of fermented sausages in Bulgarian are in air-conditioned facilities. The air temperature in the working premises for boning of meat, machine processing, preparation of stuffing mass, stuffing and packaging, should not be higher than 12 °C [8].

*Lukanka*, typically found in Bulgaria are raw-dried or raw-smoked durable sausage and are highly appreciated for their gastronomical characteristics. The specificity of the Bulgarian sausage can be justified in the following several areas [7, 9]:

- The taste and aromatic properties of the product are formed as a result of the use of selected, sorted by type and quality chilled raw meat (well ripened, skimmed, "tight" for 1 day before use meat, with a pH in the range 5.8–6.2) and spices. For the production of Bulgarian *lukanka* by traditional technology, meat stored in a frozen state is not allowed;
- Production method—in the drying part:
  - The use in the drying chambers of wooden air ducts, profiles for sausages (canes) and racks, as well as wooden presses;
  - The walls and ceilings are with rough plaster, which allows selection and preservation of the specific for Bulgaria lactic acid microflora, participating in the formation of the characteristic for the *lukanka* aromatic-taste bouquet;
  - Use of any other starter cultures (yeasts) and other chemical agents for pH adjustment is not permitted;
- Specific appearance—the flattened shape of the pieces, obtained as a result of repeated pressing. The surface of the product is covered with a coating of the so-called "white noble mold";
- Specific characteristic of the appearance of the cut surface—the section of the sausages has an elliptical cross-section, with a fine-grained structure and particle sizes of 2–4 mm.

The technological process includes the following stages [7, 9]:

- Boning, degreasing, and sorting of meat (*see* **Note 1**).
- Preparation of additional raw materials and auxiliary materials (*see* **Note 2**).
- Refrigeration and "ripening" of meat raw materials (*see* **Note 3**).
- Mixing of meat raw materials and preparation of the filling mass (*see* **Note 3**).
- Re-maturing of the filling mass (*see* **Note 3**).
- Filling and shaping of the product (*see* **Note 4**).
- Drying, draining, fermentation (*see* **Note 4**).
- Fermentation and smoking (*see* **Note 5**).

- Drying, fermentation, and maturing (*see* **Note 6**).
- Packaging, refrigerated storage, and forwarding.

## 4 Notes

1. Only the fresh meat can be used for the production of *lukanka*. Frozen meat or plant origin proteins are not permitted for the production process. Fresh meet needs to be with pH 5.6–6.2.
2. The fresh meat (excluding the bacon) is salted with table salt and allowed to drain in an inclined vessel at a temperature of −2 °C for 24 h with intensive blowing and repeated kneading.
3. The meat, bacon (frozen at −15 °C), seasonings (black or white natural pepper and cumin) and other ingredients (sugar, salt, preservatives, and antioxidants) are then mixed and ground on an industrial mincer equipment with a head diameter of 8 mm (this size is important in order to have specific "granulated" structure of the final products). The minced meat is spread tightly in an 8- to 10-cm-thick layer and allowed to mature at 0–4 °C for 36 h and tightened for 12 h at a temperature of −5 °C.
4. The finished minced meat is then filled in a casing (natural: salted bovine large intestine or ovine caecum or artificial, with diameter 50–80 mm through a filling machine and the sausages are placed on the frames and are left to drain for 2 days at 8–24 °C air temperature and relative humidity of 65–90%.
5. In industrial conditions, starter cultures can be applied. In artisanal processes, spontaneous fermentation or starter cultures can be used. Role of the microbial starter culture (naturally presented in the meat or added as selected starter culture) is to facilitate proteolysis of meat proteins, contribute to the organoleptic properties, reduction of the pH and contributing to the microbial safety of the final product.
6. This is followed by drying, smoking, and fermentation for 9 days at 17 °C air temperature and 70–85% relative humidity and first pressing for 24 h by flat wooden presses, followed by additional fermentation process for 11 day in same environmental conditions as previously mentioned with second pressing for 24 h on the 21st day and vacuuming of the finished product on the 25th day [8].

## 5 Conclusions

Mediterranean region is a homeland for production of variety of dry fermented sausages, each of them typical by his traditional way of preparation, ingredients and established over the time specific microflora. These traditional fermented products are important part of cultural heritage of the region, and rich source of isolation of microbial cultures with functional and biotechnological properties. *Lukanka*, Bulgarian dry fermented meat product is one of these treasures of the Mediterranean region. A product, highly appreciate for his gastronomical properties not only in Bulgarian lands, but in other parts of Balkan Peninsula and South-East Europe. Moreover, research on the LAB isolated form *lukanka* was proving their technological and beneficial properties, selecting them as potential starter cultures for production of functional fermented meat products with highly appreciated gastronomical and health promoting properties for the consumers. Hippocrates had a dream that 1 day our medicine will be a food and food will be our medicine. Maybe traditional fermented food products and their LAB can be realization of Hippocrates dream.

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### References

1. Dimov SG, Stojanovski S, Stoyanova R et al (2010) Molecular typing of lactobacilli isolated from dry sausage "Lukanka": comparison of whole cell protein (WCP) versus DNA-based methods. Biotechnol Biotechnolog Equip 24: 598–601
2. Stoyanovski S, Chipeva V, Dimov SG et al (2009) Characterization of lactic acid bacteria from dry sausages. Biotechnol Biotechnolog Equip 23:870–873
3. Stojanovski S, Dimov SG, Ivanova I et al (2010) Assessment of cell density and acidifying properties variation of forty-two *lactobacillus* strains isolated from "Lukanka" sausage. Biotechnol Biotechnolog Equip 24:708–711
4. Stoyanovski S, Gacovski Z, Antonova-Nikilova S et al (2013) API ZYM enzymatic profile of lactic acid bacteria isolated from traditional Bulgarian meat product "Lukanka". Bulg J Agric Sci 19: 86–89
5. Todorov SD, Stojanovski S, Iliev I et al (2017) Technology and safety assessment for lactic acid bacteria isolated from traditional Bulgarian fermented meat product "Lukanka". Braz J Microbiol 48:576–586
6. Marinov M (1975) Food industry, issue 1, Sofia, Bulgaria, p 40
7. Anonymous (2020) Publication of the amended product specification following the approval of a minor amendment pursuant to the second subparagraph of Article 53(2) of Regulation (EU) No 1151/2012. Official Journal of the European Union, C 108/18
8. Collection of traditional Bulgarian recipes and technologies "sausages and sausages" (2002) AMB, Sofia, pp 16–17
9. Dimitrova IP (2009) Comparative evaluation of the microflora of two types of *Panagyurska lukanka* produced by tandem company. MSc thesis, Sofia University, Biological Faculty, Sofia, Bulgaria

# Chapter 16

# Sucuk

Güzin Kaban, Zeynep Feyza Yılmaz Oral, and Mükerrem Kaya

## Abstract

The importance of traditional foods, an important part of cultural heritage, is to increase day by day. The oldest written text about traditional Turkish foods is "Divanü Lügati't Türk," which was written between 1072 and 1074 by Mahmud al-Kashgari. This book is the oldest dictionary of the Turkish language and it is very important since it reflects the social structure and way of life of Turkish clans. Sucuk, an unique traditional fermented sausage in Turkey, is one of traditional meat products mentioned in this book and is still consumed today. This product is known and also produced in Middle Asia, Middle East, Caucasus, and Balkans.

Fermentation in sucuk, a kind of dry-fermented sausage, is carried out by spontaneous microbiota. The manufacture of standard product is very difficult due to changes in raw material quality and environmental factors. However, sucuk produced using the traditional method is a product preferred by consumers as it has a unique taste and aroma. On the other hand, the traditional production is decreasing day by day depending on the technological development and it is being replaced by the standardized production process. This chapter describes in detail the formulation used in sucuk production and the product characteristics, as well as the manufacturing process of sucuk.

**Key words** Traditional meat product, Sucuk, Dry-fermented sausage, Fermentation, Beef meat, Sheep tail fat

## 1 Introduction

Sucuk, a traditional Turkish dry-fermented sausage, is widely produced and consumed in Turkey. It is made from beef and/or water buffalo and/or mutton meat. Nowadays, however, sucuk is usually made from beef meat. Fat is an essential component of sucuk and the type of fat used contributes effectively to flavor development and release as well as to sensory and technological properties. In addition, the type of fat is an important factor in terms of drying process. Beef fat and/or sheep tail fat are usually used as fat in the production [1]. Sheep tail fat is an important constituent of sucuk due to its strong influence on the sensory characteristics. The use of

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sheep tail fat significantly increases the amount of ethyl acetate and affects some esters [2].

Salt, major additive, is added in levels of 2–2.5% in the production of sucuk [1]. Nitrate and/or nitrite are used for their function such as antibacterial, color, flavor, and antioxidant purposes [3]. Saccharose or glucose is also added to the batter in order to encourage the growth of lactic acid bacteria during fermentation. In addition, black and red pepper, cumin, pimento and garlic are usually used as spices in the production [1]. The prepared batter is stuffed into air-dried bovine small intestines or collagen casings [4].

The traditional production is carried out in the autumn, since the air temperature, humidity, and wind are sufficient to enable the ripening of sucuk. In this production method, which is carried out depending on the weather conditions, the experience is very important [5]. Indigenous microbiota, which can originate from the environment or raw material, plays an important role in the production. This "house flora" consists of technologically important microorganisms. However, it is very important to manage the product formulation and fermentation/ripening conditions well that will encourage the development of indigenous microorganisms. In addition, re-inoculation (back slopping) is still a method used in sucuk production [4].

Due to the changing living conditions, sucuk production in households and butchers is almost no longer available. Also, due to the necessity of standardization and acceleration of production in order to meet the increasing demand, the production is carried out on an industrial scale today and the use of starter culture is increasing day by day. However, natural fermentation by the indigenous bacteria is still performed by some small-scale facilities. On the other hand, it is very important to preserve the characteristic features of this product. Traditional sucuk production still maintains its popularity due to the typical aroma of sucuk and traditional meat products are also preferred by consumers because of desirable sensory characteristics [6].

Sucuk, classified in the group of dry-fermented sausages, is a safety meat product that can be consumed raw due to its low pH and water activity values. However, it is usually cooked before consumption in Turkish cusine [7].

In addition to the microbiota, physical and textural properties of sucuk, researches were also carried out on properties such as biogenic amine [8], nitrosamine [7], and volatile compounds [9]. Technologically important lactic acid bacteria and Gram (+) catalase (+) cocci have been isolated and identified from traditional sucuk samples. Among lactic acid bacteria, *Lactobacillus plantarum* is identified as dominant species as well as *L. curvatus*, *Pediococcus pentosaceus,* and *P. acidilactici*. Almost all Gram (+) catalase (+) cocci in traditional sucuk consist of coagulase negative staphylococci. *Staphylococcus xylosus* and *S. saprophyticus* are dominant

species in sucuk. *S. carnosus,* technologically important, has also been identified [6]. Nowadays, starter culture preparations containing *L. sakei, L. plantarum, L. curvatus, S. xylosus,* and *S. carnosus* are widely used in sucuk production. In addition, studies are carried out on the use of autochthonous strains as starter cultures to preserve the traditional flavor [2].

This chapter provides detailed information about the formulation, production stages and quality characteristics of sucuk.

## 2 Materials

According to Turkish Food Codex Communiqué on Meat, Prepared Meat Mixtures and Meat Products [10], sucuk is defined as a non-heat-treated fermented meat product with a mosaic appearance on the cross-sectional surface, which is made by mixing minced meat and fat from beef and sheep carcasses with ingredients, filling into natural or artificial casings, and subjecting to fermentation and drying under certain conditions (*see* **Note 1**).

Choosing the suitable raw material in sucuk production is one of the most effective factors on product quality. Meat obtained from middle-aged slaughter animals that have completed the rigor mortis stage is used in the production of sucuk. The excess fat of the meat to be processed into the sucuk is removed, the very coarse connective tissues are separated as much as possible. Meat with high pH value is not used as raw material (*see* **Note 2**).

Sucuk can only be produced beef meat, but it can also be produced from only mutton. In addition, 50% beef +50% water buffalo meat can be used in production as well as a mixture of 50% beef +50% mutton. In the industrial production, beef is mainly used as a raw material. Beef fat and sheep tail fat are included in the formulation as fat.

In production, the fat content in sucuk batter is adjusted to 20%. When using lean meat, 20% fat is added to the sucuk batter. When using fatty meat (16–18% fat), 10% fat is added to the batter [1]. The fat content has a significant effect on taste, texture, and overall acceptability of sucuk [3].

Sodium chloride is added to the sausage batter in an amount of 2–2.5%. Salt has partial bacteriostatic activity and reduces the water activity of the sucuk batter depending on the fat content in the formulation. Thus, the growth of some undesirable or pathogenic microorganisms is limited or inhibited, and the growth of Gram(+) catalase positive cocci and lactic acid bacteria is encouraged. Moreover, salt increases protein solubility and gives the product a typical flavor [11].

Depending on the fermentation conditions applied, nitrate and/or nitrite are used as curing agent in sucuk. With the amendment made to the Turkish Food Codex Regulation on Food

Additives [12], the nitrite usage rate was reduced and limited to 150 mg/kg. The usage rate of nitrate in sucuk production is also 150 mg/kg. Today, nitrite is generally preferred as the curing agent. Although it is not used in traditional production, sodium ascorbate (300–500 mg/kg) is usually included in the formulation together with nitrite to improve the cure color and aroma in industrial production [11].

In traditional production, sucrose is used as a source of carbohydrates in amounts ranging from 0.4% to 1%. Glucose is also used in industrial production. The rate and type of sugar used affect the rate and extend of acidulation. For this reason, the ratio and type of sugar are very important in terms of controlling the degree of acidification in sucuk [11].

Like other air-dried fermented sausages, intense spices (approx. 3%) are used in the sucuk. In addition to garlic (1%), spices such as red pepper (0.7%), black pepper (0.5%), cumin (0.9%), and pimento (0.25%) are often used in sucuk, however, both the type of spice and its ratio can differ, that is, different spice formulations can be used. The prepared batters are stuffed into air-dried bovine small intestines or collagen casings [4].

The quality of sucuk is related to both the quality of raw materials (meat and fat tissue) and the control of biochemical reactions during processing. The organoleptic characteristics of sucuk are given below:

- External appearance: There should be no layer of grease on the surface of the casing. The surface color should be a reddish-brown color.
- Internal appearance: The cross-sectional surface should be pinkish-red. The fat should be creamy whitish. When sucuk is sliced vertically or horizontally from any direction, the cross-sectional surface should have a mosaic appearance, with well-defined large fat particles. A certain color difference should not be seen between the central part and the outer surface.
- Taste and aroma: Sucuk has a sour taste due to the lactic acid formed during fermentation. Among volatile compounds, terpenes derived from spices dominate in the aroma profile.
- Texture: It should not be too soft or too hard. It should have a texture that does not break when cut with a knife, does not stick to the blade, and does not fiber.
- Shape: It should have standard diameter and dimensions, there should be no punctures or tears on casings.

According to the Turkish Food Codex Communiqué on Meat, Prepared Meat Mixtures and Meat Products [10], sucuk must have a moisture-protein ratio of less than 2.5, a fat-protein ratio of less than 2.5 and a maximum pH of 5.4. Also, according to Turkish

**Table 1**
**The classifications of sucuk**

| Properties | Extra class | First class |
|---|---|---|
| Air gaps | No | The cross-sectional surface in 5 slices may contain up to a total of 4 gaps or cracks smaller than 5 mm or less |
| Protein (Nx6.25) | ≥18% | ≥16% |
| Fat | ≤30% | <40% |

Data obtained by Turkish Standard TS 1070 [13]

Standard TS 1070 [13], the moisture content should be 40%, the salt content should be 5% at most, and a maximum pH of 5.4, and in this standard, features of the classification of sucuk are also given (Table 1). According to Turkish Food Codex Regulation on Microbiological Criteria [14], *Salmonella*, *Listeria monocytogenes* and *Escherichia coli* O157:H7 should not be present in 25 g sample.

## 3 Methods

The production process of sucuk is based on fermentation and drying (ripening) and does not include smoke or heat treatment (*see* **Note 3**). Sucuk batter is prepared in chopping and mixing machines (*see* **Note 4**). Sucuk production with the traditional method is carried out as follows (Fig. 1).

1. Chilled meat pieces are chopped using a meat grinder (1.3–2.5 cm).
2. During chopping, a mixture of spices, salt, garlic, nitrite and/or nitrate is gradually added. At this stage, starter culture can also be added.
3. The mixture is kept at 0–4 °C for 12 h to ensure better penetration of the added ingredients into the meat.
4. This mixture is minced using a meat grinder with a cutting plate (3 mm). The well-chilled fat is also added to the mixture when it is minced. The sliced frozen fat can be also used (*see* **Note 5**).
5. The minced mixture is mixed in a kneading machine to obtain a homogeneous batter.
6. Sucuk batter prepared in this way is then stuffed into bovine small intestine or collagen casings of a similar diameter. It is tied by hand or machine in the form of kangal sucuk or baton sucuk (Fig. 2) (*see* **Note 6**).

- Selection of meat and fat

⇩

- Chopping (1.3-2.5cm cutting plate)

Salt, spice, sugar, garlic, nitrite/ nitrate and starter culture (optional)

⇩

- Conditioning at 0 to 4°C for 12 h

⇩

- Mincing of meat and fat (3mm cutting plate)

⇩

- Mixing

⇩

- Stuffing (bovine small intestine or collagen casing)

⇩

- Ripening (fermentation/drying)

**Fig. 1** The production stages of sucuk

a) Kangal sucuk

b) Baton sucuk

**Fig. 2** Sucuk shapes

7. After the stuffing, they are hung so that they do not touch each other and are subjected to the conditioning process.
8. In traditional production, ripening (fermentation and drying) is carried out under natural conditions. However, in small-scale facilities that make traditional production, the ripening process is also carried out under controlled conditions.
9. The next phase is the fermentation process. The initial fermentation temperature varies between 20 and 25 °C under controlled conditions. The relative humidity is set to 90–92% in the initial phase, and after the fermentation phase, the temperature and relative humidity are gradually reduced (*see* **Note 7**). Initial fermentation temperatures below 20 °C can also rarely be used in sucuk production. In such processes, nitrate is preferred as the curing agent and the ripening time can be up to 15 days. The production time of sucuk in the presence of a starter culture is shorter with temperature applications above 20 °C. However, longer ripened products are preferred in terms of sensory properties.

## 4 Notes

1. Beef meat is the most widely used raw material. Meat should be chilled well and fat should be chilled/frozen.
2. DFD is not a suitable raw material for sucuk production. The high pH value increases the water holding capacity and also enables the growth of undesirable microorganisms [11]. The pH value of the meat to be used should be between 5.4 and 5.8. pH 5.9 should be assumed as the critical value.
3. Heat treatment was included in the traditional sucuk production process in the 1980s and this product is started to be produced industrially over time. This product, which has an important market share today, is called as "heat-treated sucuk" and it is produced in a shorter time than the traditional sucuk. Fermentation, heat treatment and drying are the main processing steps of this product. Heat-treated sucuk may be also produced from poultry meat. Although it depends on the formulation in the heat treatment process, an internal temperature of 60–68 °C is usually applied. Starter culture is very important for product safety and characteristics in heat-treated sucuk [15]. The technical properties of this product are different from those of sucuk; the moisture/protein ratio should be below 3.6, the fat/protein ratio should be below 2.5, and the pH value should be 5.6 at the highest [10].
4. In the industrial production, sucuk batter can be prepared from chilled and frozen raw materials in a cutter. The degree of comminuting of meat must be in the medium level. When using the cutter, care should be taken to ensure that the mosaic appearance should be in the sucuk.
5. Rancid fat can cause sensory and textural defects in the product. The cold storage period of the fat should be short or it should be frozen stored until used.
6. The stuffing should be done as tight as possible, no air gap should be left. The stuffing should be carried out under vacuum to exclude oxygen from the matrix as far as possible and to prevent the development of undesirable color and flavor. The temperature of the ready-to-fill sucuk batter should not exceed 2 °C. Otherwise, a fat film forms under the casing during stuffing. In the production of sucuk, air-dried or brined beef small intestine is used as a casing. When processing natural casings, it is necessary that the fats are well removed. If the casings are used that are not well defatted, some drying problems arise.
7. The low initial temperature of fermentation and thus the slow ripening allow the production of more aromatic products.

## References


1. Gökalp HY, Kaya M, Zorba Ö (1994) Et Ürünleri İşleme Mühendisliği. Atatürk Üniversitesi Yayın No: 786, Ziraat Fak. Yayın No: 320, Ders Kitapları serisi No: 70, Atatürk Üniv. Ziraat Fak. Basımı, Erzurum
2. Kaban G, Kaya M (2010) Volatile compounds and other qualitative properties of sucuk ripened under different process conditions. TÜBİTAK project report, Project 107O769
3. Soyer A, Ertaş AH, Uzümcüoglu U (2005) Effect of processing conditions on the quality of naturally fermented Turkish sausages (sucuks). Meat Sci 69:135–141
4. Kaban G (2013) Sucuk and pastırma: microbiological changes and formation of volatile compounds. Meat Sci 95(4):912–918. https://doi.org/10.1016/j.meatsci.2013.03.021
5. Yıldırım Y, Ülgen MT, Özeren T (1978) Yerli sucukların üretim yöntemleri üzerine araştırmalar. Ankara Univ Vet Fac Derg 25(1): 85–98. https://doi.org/10.1501/Vetfak_0000001198
6. Kaban G, Kaya M (2008) Identification of lactic acid bacteria and gram-positive catalase-positive cocci isolated from naturally fermented sausage (sucuk). J Food Sci 73:M385–M388. https://doi.org/10.1111/j.1750-3841.2008.00906.x
7. Sallan S, Kaban G, Kaya M (2019) Nitrosamines in sucuk: effects of black pepper, sodium ascorbate and cooking level. Food Chem 288: 341–346. https://doi.org/10.1016/j.foodchem.2019.02.129
8. Gençcelep H, Kaban G, Kaya M (2007) Effects of starter cultures and nitrite levels on formation of biogenic amines in sucuk. Meat Sci 77: 424–430
9. Kaban G, Kaya M (2009) Effects of *Lactobacillus plantarum* and *Staphylococcus xylosus* on the quality characteristics of dry fermented sausage "sucuk". J Food Sci 74:S58–S63
10. Turkish Food Codex Communiqué on meat, prepared meat mixture and meat products. Republic of Turkey Ministry of Agriculture and Forestry. Official Gazette Date and Issue: 29.01.2019 and 30670, Ankara, Turkey
11. Kaya M, Kaban G (2010) Fermente Et Ürünleri. In: Aran N (ed) Gıda Biyoteknolojisi. Nobel Yayın, İstanbul, pp 157–190
12. Turkish Food Codex Regulation on food additives. Republic of Turkey Ministry of Agriculture and Forestry. Official Gazette Date and Issue: 27.02.2019 and 30699, Ankara, Turkey
13. Turkish Standard 1070 (2013) Turkish sucuk. ICS 67.120.10, Ankara, Turkey
14. Turkish Food Codex Regulation on microbiological criteria. Republic of Turkey Ministry of Agriculture and Forestry. Official Gazette Date and Issue: 09.10.2018 and 30560, Ankara, Turkey
15. Armutcu A, Hazar FY, Yılmaz Oral ZF et al (2020) Effects of different internal temperature applications on quality properties of heat-treated sucuk during production. J Food Process Preserv 44(7):1–8

# Chapter 17

# Pastırma

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## Abstract

Pastırma is a traditional Turkish dry-cured meat product produced from beef and water buffalo meat. The production process is based on curing, drying, pressing, and çemenleme (coating with çemen-paste seasoning). As a pivotal process, "çemenleme" is an important since it distinguishes pastırma from other dry-cured meat products. This process prevents the product from over-drying and contributes to its microbiological stability and sensory properties.

Pastırma, which was brought to Anatolia by the Turks migrating from Central Asia, is produced in many cities of Anatolia today. Pastırma is traditionally processed under natural conditions where air temperature and relative humidity depend on climate and weather conditions. The period covering late September and October–November, which is called "Pastırma Summer," is preferred for traditional production. The pH of pastırma is between 5.5 and 6.0, and the $a_w$ is usually below 0.90. This product may be stored without refrigeration. Coagulase negative staphylococci and lactic acid bacteria are two important groups of microorganisms that are technologically important for pastırma. Many studies have been conducted on the microbiological, physical, chemical, and textural changes that occur during pastırma production. This chapter describes the manufacturing process and the quality features of pastırma in detail.

**Key words** Traditional meat product, Dry-cured meat product, Pastırma, Manufacture process, Çemen

## 1 Introduction

The oldest known method of meat preservation is the drying of meat by removing a certain portion of its water to through exposing it to direct sunlight under natural conditions [1]. As a matter of fact, pastırma is a traditional dry-cured meat product, produced by Turkish clans living in Central Asia by preserving the meat through drying and salting meat and consumed in the winter, that has survived to the present day [2]. This product is still produced in a traditional way in Turkey. The production is widely carried out in provinces that have climates with cool, dry air and low humidity, and with little temperature differences between day and night [1].

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Methods and Protocols in Food Science, https://doi.org/10.1007/978-1-0716-2103-5_17,

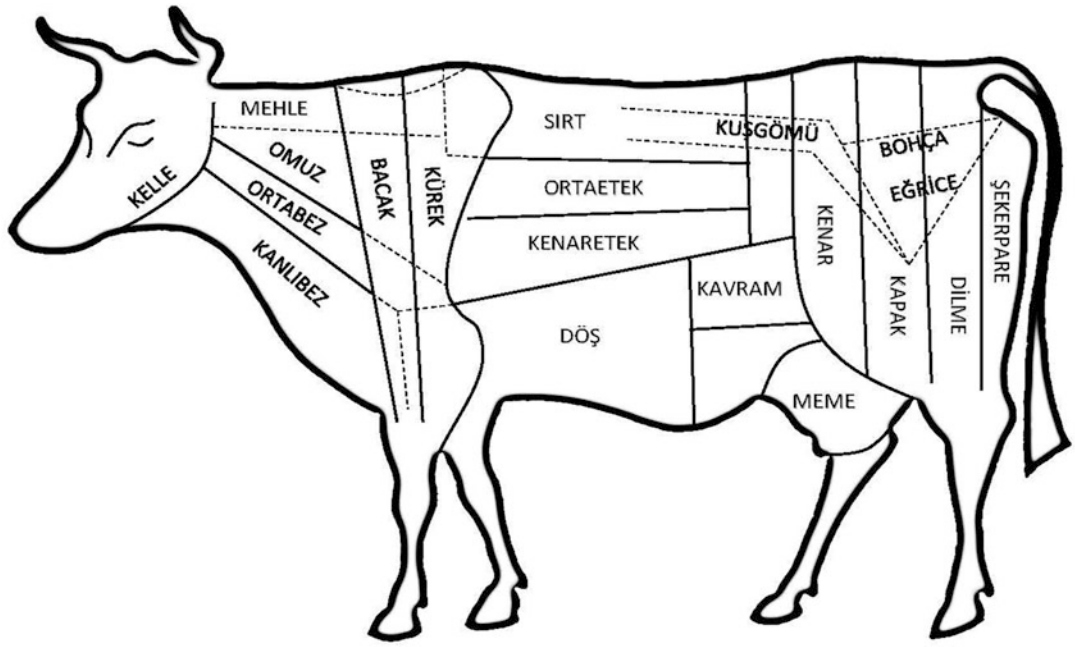


**Fig. 1** Parts of the carcass for pastırma production [3]

Pastırma is a traditional meat product that is highly appreciated by consumers. It is characterized as a high-quality meat product that is ready-to-eat consumed without cooking. Pastırma is a meat product obtained by subjecting meat pieces from whole muscle obtained from certain parts of beef and water buffalo carcasses to the processes of curing, drying, pressing, and covering with çemen, respectively [1]. 16 or more pastırma-suitable meat pieces are obtained from one carcass. Different types of pastırma, which are named as to where muscle and muscle groups used as raw material are obtained (such as şekerpare, kuşgömü, bohça, kürek, sırt, etc.), are produced (Fig. 1). Thus, there are variations in texture and quality characteristics of different types of pastırma [1, 2].

Low water activity values are seen in pastırma due to salt as well as to the drying processes used in production. It is categorized as an intermediate moisture food, and its production does not include heating or smoking processes [4]. After final drying, pastırma is consumed without cooking [5].

Curing is one of the most important stages in pastırma production. The curing mixture contains sodium chloride, nitrate and/or nitrite, and sugar [6]. Dry curing method is applied in production and the salt content can be up to 10% [4, 5, 7]. In addition to salt, nitrate is generally used as a curing agent in the curing process. There is also the use of nitrite or nitrite/nitrate [4, 6–9].

Pastırma is produced with the traditional method based on mastery and experience under natural conditions where air

temperature and relative humidity depend on climate and weather conditions. The period covering late September and October–November, which is called "Pastırma Summer," is preferred for traditional production [4, 7]. In this period, the temperature difference between day and night is about 15 °C [1].

The production process of pastırma approximately extends over a 1-month period. This product may be stored without refrigeration [4]. The product safety and stability in pastırma is mainly due to its low water activity. In addition, covering the final product with çemen creates an edible packaging for the product that paste containing garlic has a protective effect on mold growth and excessive drying of the final product [1].

Many studies have been conducted to determine the microbiological, physical, chemical, and sensory properties of pastırma. In addition, there are studies investigating the effects of starter culture [8, 10] and different production methods [11] on pastırma. The studies have also been conducted on the probiotic properties of lactic acid bacteria isolated/identified from pastırma [12] and the usability of coagulase negative staphylococci as starter cultures [13] (*see* **Note 1**).

This chapter provides an overview on the manufacture of pastırma by the traditional method and on quality parameters of the product.

## 2 Materials

According to the Turkish Food Codex Communiqué on Meat, Prepared Meat Mixture and Meat Products [14], pastırma is defined as the cured and dried meat product that is not subjected to any heat treatment, obtained by first curing and washing meat pieces separated from the bovine carcasses in accordance with the related technology, then subjecting the meat pieces to pressing and drying processes and re-drying after covering with çemen.

Meat from beef and water buffalo carcasses is used in the production of pastırma. Meat from very young animals and old animals is not preferred, due to its high water content and due to its hard and coarse texture, respectively. Pieces of meat with high fat content are also not preferred. Treatment of cattles before and during slaughter is one of the most important factors determining the quality of pastırma and its acceptability for processing. Therefore, before slaughter, the animal is kept away from stress factors and also the blood is shed well during slaughter.

There are many factors affecting the final characteristic of pastırma. The quality of the raw material mainly influences the rate and the extent of biochemical reactions. After the rigor is completed, the meat pieces are separated from the carcass. The initial pH value is one of the most important properties related to the quality of

pastırma. Muscle structure, color, and water holding capacity are characterized by the nature of the decrease in pH. The pH values recommended for pastırma are between 5.4 and 5.8. DFD meat should be avoided due to a higher microbial risk and reduced water diffusion ability. A good microbiological quality of meat should be used. Meat should be well chilled before curing. Visible connective tissue and excessive fat are removed during trimming for faster penetration of salt into the meat [1, 6].

Salt is an important additive in pastırma production. Salt affects microbial stability by reducing water activity. It contributes to the product flavor and promotes the solubilization of muscle proteins. In addition, it also plays a role in chemical and biochemical reactions such as proteolysis and lipolysis. Salt used in pastırma production has a specially defined medium size (called "ant head"). If the salt is too large size, the meat cannot get enough salt, and coarse salt particles negatively affect the texture. Very fine salt causes some problems in meat color and excessive saltiness. High salt content also promotes oxidation. In addition to salt, nitrate, and/or nitrite are added to the curing mixture. Although nitrate was the most preferred curing agent in pastırma production 10–15 years ago, today nitrite is mostly used. Sucrose or glucose is also added to the curing mixture. Sodium ascorbate is added to the curing mixture as a curing adjunct.

At the stage called "çemenleme," dried meat pieces are covered with çemen paste. Çemen paste has an effect on the characteristic taste, aroma, and color of the product. Çemen paste consists of 500 g of flour ground from Trigolella foenum graecum seed, 450 g of smashed fresh garlic, 300 g of red pepper, and 1500 mL of water [4].

The types of pastırma are named according to where they are taken from the beef carcass (Fig. 1) and according to the Turkish Standard TS 1071 [3], pastırma is divided into three classes as first, second, and third class. Pastırma which made of the most valuable parts of beef carcass (round muscles, loin muscles, and tenderloin) is called as first class (sırt, kuşgömü and şekerpare, etc.) (Fig. 1).

The quality parameters for pastırma include:

- Color: A bright red interior color, it should not be color difference.
- Fat: Abundant level of marbling and the least amount of intermuscular fat. Intramuscular fat affects texture of pastırma, high intramuscular fat content has a positive effect on pastırma tenderness and juiciness. Marbling in sliced pastırma affects consumer acceptability and the sensory quality of the product.
- Texture: Easily sliced, not excessively tough or extremely tender, easy to chew when taken into the mouth.
- Çemen thickness: It should be between 1 and 4 mm.

– pH value: It should be between 5.5 and 6.0.
– Water activity: It should be between 0.85 and 0.90.

According to the Turkish Food Codex Communiqué on Meat, Prepared Meat Mixture and Meat Products [14]:

– The moisture content of pastırma should be at most 50% by mass with the exception of çemen,
– The pH value should be at most 6.0,
– The amount of salt should be at most 10% by mass in dry matter with the exception of çemen,
– The amount of çemen in pastırma should be at most 10% by mass.

## 3 Method

The stages of pastırma production consists of raw material selection and handling, curing/salting, washing, first drying, cold pressing (first pressing), second drying, hot pressing (second pressing), coating with çemen paste and final drying [1, 2]. The stages of pastırma production are given in Fig. 2.

Raw material selection and handling: Pastırma is produced using beef or water buffalo meat. After harvest, the carcass is chilled (conditioned) and then broken into primal cuts. Then, pastırma meats are removed from the primal cuts. The rigor must be completed so that the meat pieces can be easily removed from the carcass. Visible connective tissue and excessive fat are removed by trimming. There is the aesthetic purpose of the trimming phase and trimming also increases the effectiveness of salting. After this step, the treatment called "şaklama" is applied to the pieces of meat. In this treatment, incisions are made on the meat surface with a 45° angle by knife in order to accelerate the diffusion of curing components in meat.

Curing: Curing mixture consists of salt, saccharose, and nitrate or nitrite. It is preferred to salt together pieces of similar shape and size. The curing mixture is spread evenly or rubbed on the pastırma. Attention is paid to put large amounts of salt into the incisions (*see* **Note 2**). The meats to which the curing mixture is added are kept at 4°C for 24 h with the incisions on top, and then they are turned upside down and cured for another 24 h.

Washing: After the curing process, excess salt is washed from the surface of meat pieces. The degree of washing varies depending on the amount of salt used. In case of using around 5% salt, washing is either not applied or applied for a very short time.

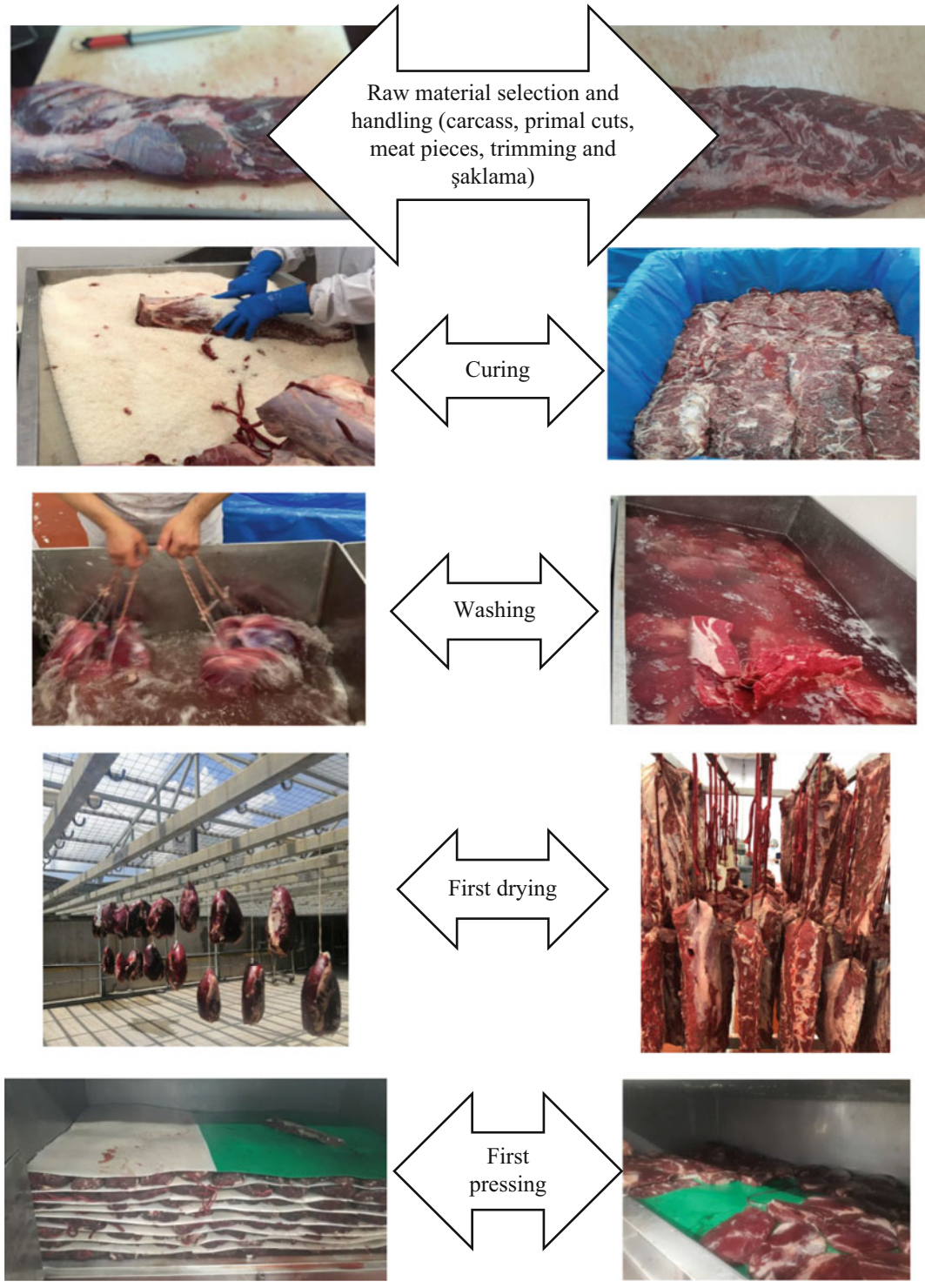


**Fig. 2** Diagram of the different stages of the manufacturing process of pastırma

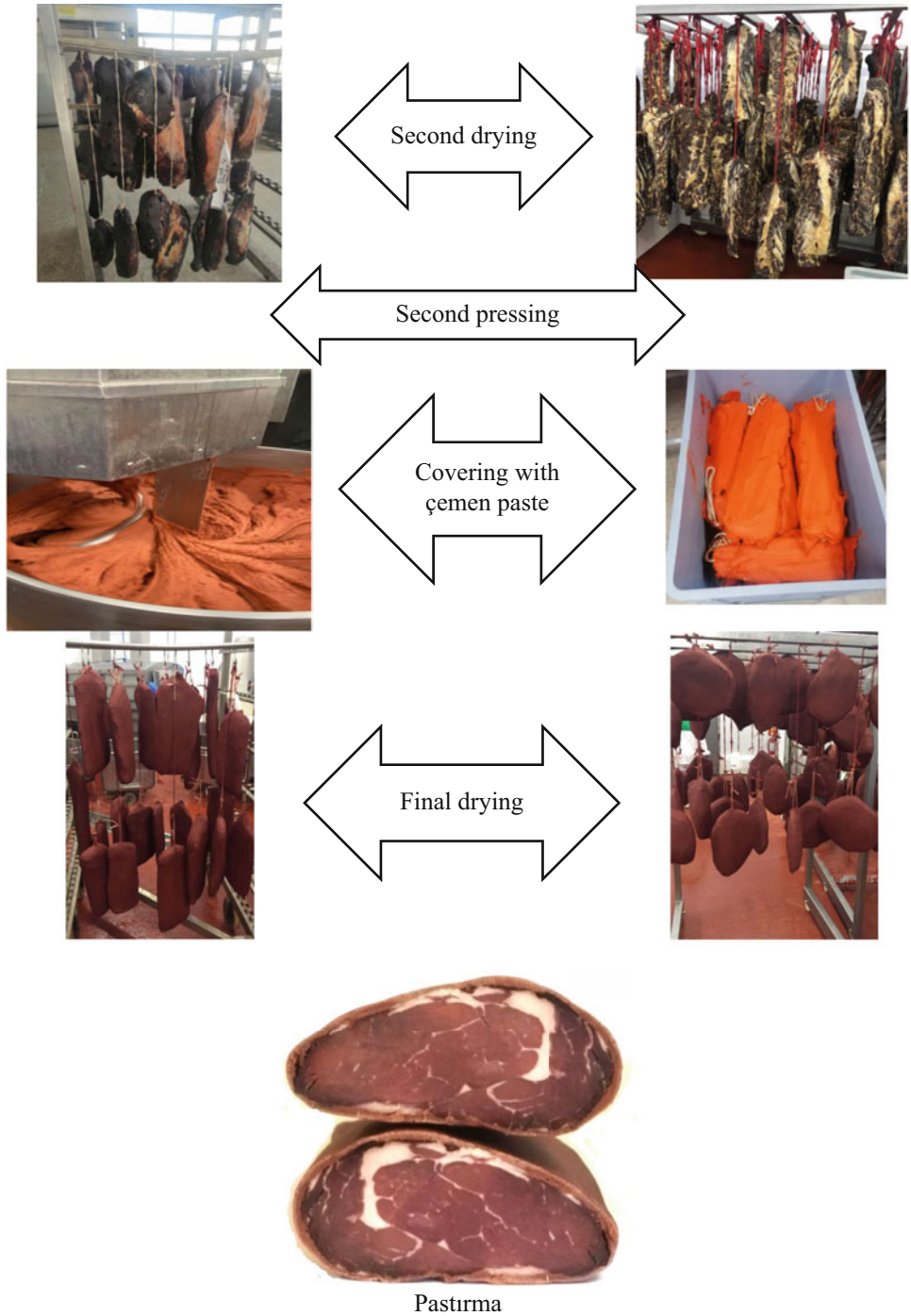


**Fig. 2** (continued)

First drying: After washing, cured meat pieces are hung on hangers and dried under open air conditions (for 4–6 days at 15–20 °C). Controlling relative humidity in drying under controlled conditions (climatized conditions) is very important in terms of preventing mold growth on the surface of the meat.

First pressing: After the first drying, cured and partially dried meat pieces are put into the pressing process for about 20 h at 8–10 °C. In this stage, a pressure of 0.9–1 kg is applied to per $cm^2$ area. In industrial production, hydrolic presses are used for this purpose [2].

Second drying: After the first pressing, meat pieces are hung up and dried for 7–10 days at 15–20 °C under natural conditions. In climatized conditions, for example, at 20 °C, the drying process can be completed within 6 days.

Second pressing: After the second drying process, the meat is subjected to the second pressing process. In this process, the temperature is around 25 °C and the meat can be subjected to this process at durations ranging from 2 to 7 h can be applied (*see* **Note 3**).

Çemenleme: After pressing and drying, meat pieces are kept in çemen paste for 1 day at 4 °C. Then, the çemen on the surface of the meat is thinned to 2–3 mm and the process of drying with çemen starts hereafter. Çemen is prepared from flour ground from fenugreek (Trigolella foenum graecum), mashed fresh garlic and red pepper, which are mixed with water to make a slurry like paste (*see* **Note 4**).

Drying with çemen: After the çemenleme process is completed, meat pieces are dried again. Drying time can vary between 1 and 7 days depending on weather conditions [2].

After pastırma is sliced, it is offered for sale in markets. Nowadays, due to new consumer demands, pastırma is no longer marketed in pieces, but in slices that are usually packaged. The most commonly used packaging technology for pastırma slices is modified atmosphere packaging (MAP) [9].

## 4 Notes

1. The use of starter culture in pastırma production has a positive effect on product characteristics [8, 10]. In recent years, starter culture has been started to be used in industrial production. Commercial preparations consisting of both lactic acid bacteria species and coagulase negative staphylococci and *Kocuria varians* are used as starter cultures.

   In addition, it is found that the strains of lactic acid bacteria isolated/identified from pastırma have probiotic properties

[12]. In a study on coagulase negative staphylococci, which has an important role in pastırma, *S. vitilinus*, *S. xylosus,* and *S. equorum* have been reported to have positive effects on product properties [13].

2. Salt is used in levels of 8–10% in traditional pastırma production. The salt content in pastırma can be reduced up to 5% under controlled conditions [8, 9]. The final salt level of the pastırma can reach up to 9% [15] or more, and the permitted salt level in the Turkish Food Codex Communiqué on Meat, Prepared Meat Mixture and Meat Products [14] is 10% by mass for pastırma. On the other hand, the replacement of NaCl with KCl at the level of 50% was found not to cause a significant alteration in the product, especially for the sensory and volatile profile [16].
3. Before the second pressing, partially dried meat pieces are kept at around 40 °C for a short time in some enterprises and then put into pressure.
4. Çemen gives a characteristic feature to the appearance, color, and flavor of pastırma and also prevents the pastırma from getting too dry. In addition, çemen protects the product against microbial growth, especially against mold growth.

## References


1. Gökalp HY, Kaya M, Zorba Ö (1994) Et Ürünleri İşleme Mühendisliği. Atatürk Üniversitesi Yayın No: 786, Ziraat Fak. Yayın No: 320, Ders Kitapları serisi No: 70, Atatürk Üniv. Ziraat Fak. Basımı, Erzurum
2. Tekinşen OC, Doğruer Y (2000) Her yönü ile pastırma. Selçuk Üniversitesi Basımevi, Konya, Türkiye
3. Turkish Standard TS 1071 (2002) Pastırma. Ankara, Turkey
4. Kaban G (2009) Changes in the composition of volatile compounds and in microbiological and physicochemical parameters during pastırma processing. Meat Sci 82:17–23
5. Akköse A, Ünal N, Yalınkılıç B et al (2017) Volatile compounds and some physicochemical properties of pastırma produced with different nitrate levels. Asian Australas J Anim Sci 30(8):1168–1174
6. Kaya M, Kaban G (2010) Fermente Et Ürünleri. In: Aran N (ed) Gıda Biyoteknolojisi. Nobel Yayın, İstanbul, Türkiye, pp 157–190
7. Kaban G (2013) Sucuk and pastırma: microbiological changes and formation of volatile compounds. Meat Sci 95(4):912–918
8. Aksu Mİ, Kaya M (2002) Some microbiological and chemical properties of pastirma produced using potassium nitrate and starter culture. Turk J Vet Anim Sci 26(1):125–132
9. Hazar FY, Kaban G, Kaya M (2017) The effects of different processing conditions on biogenic amine formation and some qualitative properties in pastırma. J Food Sci Technol 54(12): 3892–3898
10. Aktaş N, Aksu MI, Kaya M (2005) Changes in myofibrillar proteins during processing of pastirma (Turkish dry meat product) produced with commercial starter cultures. Food Chem 90:649–654
11. Aksu MI, Kaya M (2002) Farklı kürleme yöntemleri ve starter kültür kullanılarak pastırma üretimi. Turk J Vet Anim Sci 26:909–916
12. Topçu Çinar K, Kaya M, Kaban G (2020) Probiotic properties of lactic acid bacteria strains isolated form pastırma. LWT Food Sci Technol 134:110216
13. Fettahoğlu F (2019) Characterization of coagulase negative *Staphylococcus* strains isolated from pastırma and possibilities of their usage as starter culture. Ph.D. Thesis, Atatürk University, Graduate School of Natural and Applied Sciences, Department of Food Engineering, Erzurum, Turkey

14. Turkish Food Codex Communiqué on meat, prepared meat mixture and meat products. Republic of Turkey Ministry of Agriculture and Forestry. Official Gazette Date and Issue: 29.01.2019 and 30670, Ankara, Turkey
15. Aksu Mİ, Kaya M (2001) Erzurum piyasasında tüketime sunulan pastırmaların bazı fiziksel, kimyasal ve mikrobiyolojik özellikleri. Turk J Vet Anim Sci 25:319–326
16. Yalınkılıç B, Kaban G, Kaya M (2022) Effect of sodium replacement on the quality characteristics of pastırma (a dry-cured meat product). Food Sci Hum Wellness (in press)

# Chapter 18

# Alheira

**Alfredo Teixeira, Rubén Domínguez, Jorge Felipe Reyes, José Manuel Lorenzo, Marco Antonio Trindade, and Sandra Rodrigues**

## Abstract

Among the processed pork products, one of the most traditional in Trás-os-Montes, Ne Portugal, is the alheira. Being a regional product it is consumed throughout the country, being part of Portuguese gastronomy. There are a large number of different brands, mostly commercial and three with PGI label, which can have different formulations and production conditions that can vary between regions. However, PGI label brands establish a set of guarantees that production methods must comply with. Thus, this chapter describes in detail the formulation processes, stages of elaboration with the analysis of the variability in the centesimal physical-chemical composition.

**Key words** Alheira, Pork, Poultry, Meat, Sausage

## 1 Introduction

Alheira is a typical Portuguese sausage whose main ingredients are poultry meat, bread, olive oil, lard, garlic, and paprika. The original sausage called "the sausage of the Jews," was a horseshoe-shaped sausage like the other sausages, but without pork, manufactured by the Portuguese Jews during the period of the Inquisition (late-sixteenth and seventeenth centuries) to assume themselves as "new Christians" who, in secret, continued to maintain the customs of their renegade Jewish religion, not eating pork [1]. Thus, the first sausages contained several meats alternative to pork, such as turkey, chicken, and other poultry. The popularity of this sausage has grown rapidly over time and today it mixes all types of meat, including mainly fatty pork. The popularity of this sausage has grown rapidly over time and today it mixes all types of meats, including mainly fatty pork. Although today it continues to be a traditional product of artisanal production, in the last decades, due to its great acceptance and demand by consumers, it is produced in an industrial way and incorporating different types of meat, so it offers a great heterogeneity of alheiras (Fig. 1).

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**Fig. 1** Traditional way to dry alheiras (**a**), several commercial and PGI brands of alheira (**b**) three most common types of alheira produced (**c**)

Currently, the production of sausages is essentially an industrial business, with a great heterogeneity of products and ingredients, making it difficult to classify. Since 1996, this sausage has been guaranteed Traditional Specialty Guaranteed (TSG). Some regional and cultural specificities result in different commercial brands some of them with Protected Origin Designation labels [2]. Alheira de Barroso—Montalegre [3], Alheira de Vinhais [4], and Alheira de Mirandela [5] are the protected Geographical Indications (PGI) recognized by EU regulations. However, a great quantity of commercial products without PGI label is produced all over the country, outside the Northeast region of Portugal (Trás-os-Montes) where the original product is (*see* **Note 1**). Despite the great consumption and popularity of this sausage, is essentially a Portuguese product and only a few studies have deserved its attention. Particularly in recent years several studies of physicochemical, sensory characteristics, and processing conditions [6–9] microbiological characterization and safety [10–12] nutritional and novel food trends [1, 13]. The objective of these studies was to contribute to a better knowledge and physicochemical, sensory, and microbiological characterization of a product that, despite being very popular, is practically unknown in these important parameters and nutritional quality. Therefore, the main objective of this chapter is to describe the stages of the manufacturing process, and a detailed analysis of the most critical aspects of the formulation and processing of the alheira.

## 2 Materials

According to Commission Regulations (EC) [3–5], Alheira de Vinhais is a yellow-brownish, horseshoe-shaped smoked sausage, approximately 25–30 cm long, with a diameter of 2 cm and weighing 150 to 200 g, with a mixture of pork meat with poultry meat and may accept other poultry or game meat as partridge (*see* **Note 2**). All meats are previously boiled and after are boned, chopped, or shredded and mixed with slices of bread finely cut and other ingredients: garlic, olive oil, salt, and paprika. The paste has an irregular appearance and consists of a thin and lumpy pulp of bread softened by the broth and the pieces of shredded meat. This paste is then softened with the broth to cook the meats (*see* **Note 3**). The dough is stuffed into a natural casing (pork, cattle) and dried slightly smoked and stabilized and ripened for at least 8 days (*see* **Note 4**). Although it is a cooked sausage, at the end of the maturation period it should be consumed cooked preferably grilled or in alternatively deep fried. With its soft filling and toasted and crunchy natural casing it can be eaten. The sensorial characteristics are:

- Flavor: pleasant taste, slightly smoked, with garlic and olive oil tastes.
- Color: bright brownish yellow. After heat treatment the color changed to red tanned brownish.
- Aroma: slightly smoky pleasant.
- Texture: heterogeneous where pieces of shredded meat stand out.

## 3 Methods

The different stages of the production of the sausage in order to obtain a quality product include from the selection of the meat, salting, cooking, cutting and shredding, mixing of ingredients, stuffing, smoking, and curing (Fig. 2):

1. The reception and selection of the meat (chicken, duck, partridge, pork backbone, bacon, and pork belly) in the industry is carried out in room at a maximum temperature of 7 °C.

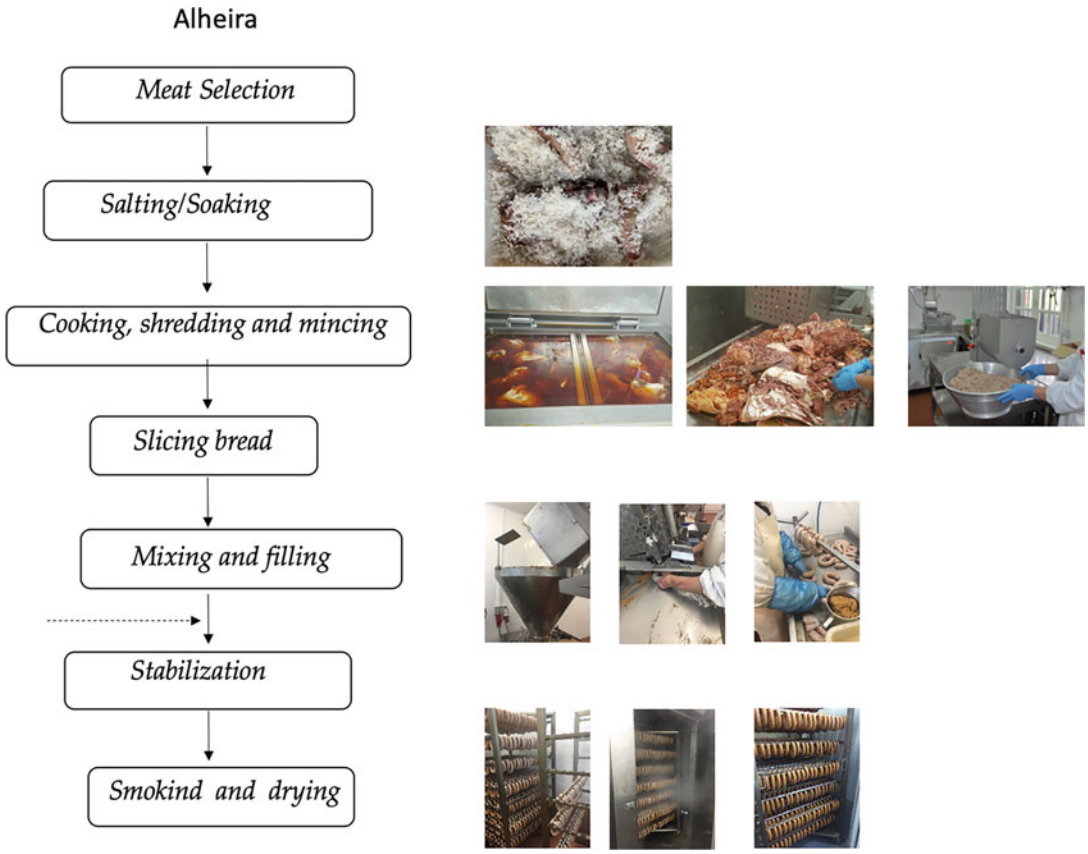


**Fig. 2** Diagram of the different stages of the production process of alheira

2. Pork belly and pork backbone are salting for 1–2 days, with subsequent water soaking the day before manufacture.
3. Cook all meats for 5 h at a temperature above 95 °C (*see* **Note 5**).
4. Hand shreds meat and finely mince the fat.
5. Cut bread into thin slices (*see* **Note 6**).
6. Automatic mixing of bread with the shredded meat (*see* **Note 7**).
7. Mixed the other ingredients: salt, pepper, paprika, olive oil, garlic (*see* **Note 8**).
8. Automatic filling in natural casings and horseshoe shape.
9. Stabilization for 55–58 min in an oven from 23 to 71 °C (5 min).
10. Heat treatment in an oven at a temperature of 60 °C for 6 h during 3 h.
11. Smoking and Drying. Smoking for 30 min at a temperature of 27 °C with subsequent drying in a chamber, the temperature gradually increasing to 10 °C and the relative humidity from 85% to 65–70% (*see* **Note 9**).

The physical-chemical composition of the final products is showed in Table 1. The differences between the traditional manufactured products [6, 10] and the PGI ones [1] are notorious.

**Table 1**
**Proximate composition (g/100 g) and main fatty acids (g/100 of fat) of several types of alheira**

| | References | | |
|---|---|---|---|
| | [1] | [6] | [10] |
| Moisture (%) | 57.9–60.7 | 29.2–60.7 | 43.3–57.2 |
| Protein (%) | 9.9–1 2 | 4.7–14.8 | 6.9–15.5 |
| Fat | 7.6–8.6 | 11.7–35.6 | 10.9–29.6 |
| Carbohydrates (%) | | 11.1–32.7 | 10.2–20.9 |
| Ash (%) | 2.1–2.7 | 0.7–4.9 | |
| Chlorides (%) | 1.6–1.9 | | |
| pH | 5.4–5.7 | 4.3–6.1 | 4.5–6.3 |
| $a_w$ | 0.94–0.96 | 0.90–0.95 | |
| SFA | 28–33 | | |
| MUFA | 51.5–55.6 | | |
| PUFA | 15.4–16.5 | | |

*SFA* saturated fatty acids, *MUFA* Monounsaturated fatty acids, *PUFA* polyunsaturated fatty acids; Data obtained by published articles [1, 6, 10]

## 4 Notes

1. In some cases, they do not even incorporate meat, but products such as cod, mushrooms, which in our opinion should not be allowed to use the designation alheira.
2. Generally the meat mixture is pork and poultry, but it can contain other meats like rabbit, duck, turkey, or game meats as partridge. The primitive sausage designated "alheira of the Jews" did not incorporate pork meat.
3. The alheira with PGI label, the bread and the olive oil are regional products from Trás-os-Montes (NE Portugal).
4. The sausages when are natural smoked, the fire should be made from regional wood like oak, olive, or chestnut.
5. The intensity of the cooking should allow the deboning meat.
6. A traditional wheat regional bread of 2–3 kg in weight and baked with little yeast.
7. The finely sliced bread must be soaked in the meat cooking broth at a temperature between 70 and 80 °C and mixed with meat.
8. The presence of garlic in the alheira is essential to distinguish it from another similar sausage without garlic that is azedo (sour) so named for its acidic and soured taste. The olive oil must be heated to 60–70 ° C, together with the garlic before adding to the mixture.
9. The smoking process can be carried out in an oven or traditionally using oak woods. Never use softwood.

## Acknowledgments

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### References

1. Teixeira A, Fernandes A, Pereira E (2020) Fat content reduction and lipid profile improvement in Portuguese fermented sausages alheira. Heliyon 6:e05306
2. Teixeira A, Rodrigues S (2019) Meat quality, brands and consumer trends. In: Lorenzo J, Munekata P, Barba F, Toldrá F (eds) More than beef, pork and chicken – the production, processing, and quality traits of other sources of meat for human diet. Springer, Cham. https://doi.org/10.1007/978-3-030-05484-7_2

3. Commission Regulation (EC) No 148/2007 of 15 February 2007
4. Commission Regulation (EC) No 676/2008 of 16 July 2008
5. Commission Implementing Regulation (EU) 2016/292
6. Patarata L, Judas I, Silva JA et al (2008) A comparison of the physicochemical and sensory characteristics of Alheira samples from different sized producers. Meat Sci 79:131–138
7. Ramalhosa E, Magalhães AL, Pereira EL (2012) Characterization of regional Portuguese kitchens for alheiras de Vinhais (PGI) production with respect to the processing conditions, final product quality and legal farming. Food Control 26:133–138
8. Campos SD, Alves RC, Mendes E et al (2013) Nutritional value and influence of the thermal processing on a traditional Portuguese fermented sausage (alheira). Meat Sci 93:914–918
9. Gomes A, Santos C, Almeida J et al (2013) Effect of fat content, casing type and smoking procedures on PHAs contents of Portuguese traditional dry fermented sausages. Food Chem Toxicol 58:369–374
10. Ferreira V, Barbosa J, Vendeiro S et al (2006) Chemical and microbiological characterization of alheira: a typical Portuguese fermented sausage with particular reference to factors relating to food safety. Meat Sci 73:570–575
11. Ferreira V, Barbosa J, Silva J et al (2007) Characterization of alheiras, traditional sausages produced in the North of Portugal, with respect to their microbiological safety. Food Control 18:440–463
12. Albano H, Henriques I, Correia A et al (2008) Characterization of microbial population of "alheira2" (a traditional fermented sausage) by PCR-DGGE and traditional cultural microbiological methods. J Appl Microbiol 105: 2187–2194
13. Marcos C, Viegas C, Almeida AM et al (2016) Portuguese traditional sausages: different types, nutritional composition, and novel trends. J Ethnic Foods 3:51–60

# Chapter 19

# Chouriça de Carne

**Alfredo Teixeira, Rubén Domínguez, Andrea Carla da Silva Barretto, Javier F. Rey, José Manuel Lorenzo, and Sandra Rodrigues**

## Abstract

Traditional Portuguese sausages (dried, smoked, fermented) are part of the most consumed meat products, particularly in Trás-os-Montes (Ne Portugal), and Alentejo (South Portugal) but widely in all country. There are a large number of different commercial brands on the market with six IGP-labeled products that may show slight differences in formulations and processing methods according to the specifications of each product and region of production. However, PGI label brands establish a set of guarantees that production methods must comply with. Thus, this chapter describes in detail the formulation processes, stages of elaboration with the analysis of the variability in the centesimal physical-chemical composition.

**Key words** Chouriça, Pork, Meat, Dry, Fermented, Sausage

## 1 Introduction

A great variety of Chouriças are produced in Portugal, particularly in Trás-os-Montes (North), Beira (Center) and Alentejo (South). These meat chouriças as the sausages produced in the Mediterranean area can be classified as dry-fermented meat products.

Generally, raw fermented sausages are made by selecting, chopping, and mincing meat and fat, with or without offal, mixed with seasoning, spices, and authorized additives. After preparation they are submitted to long ripening times, where fermentation and drying (for example, in Portugal curing is usually associated to smoking) processes conduct to low water activity increasing shelf-life.

The Portuguese standard NP-589 (2008) [1] "Meats and meat products—Chouriça (o) de carne. Definition, classification, characteristics and packaging" defines *Chouriça (o) de carne* as "smoked and/or cured sausage of narrow gauge and of variable shape consisting of pork meat and hard pork fat, in macroscopically visible fragments, added with condiments, additives and/or other

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optional ingredients." Excluding in the definition "sausages that result from technological conservation processes based on decreasing the pH value." So, meat sausage, also known as *chouriça* or *linguiça*, is made from minced pork meat and fats and mixed with pepper, garlic, salt, etc. It features a firm consistency, reddish color, and shine.

Regional traditions, variations in environmental conditions, family recipes, and other factors lead to a wide variety of fermented sausages some with quality brands as Protected Geographical Indication (PGI) labels [2]. Almost as many types of sausages can be found as geographic regions or, eventually, manufacturers. Though their production processes always require fermentation and dehydration and/or smoking, there is a great offer of *chouriças* (Fig. 1). Within the designation of meat sausage there are products with PGI: Chouriça de Carne de Barroso-Montalegre [3], Chouriça de Carne de Vinhais [4], Chouriça de Carne de Melgaço [5].

There are traditional products with different designation of *chouriça*, but they are similar products, also with GPI protection, such as: Linguiça do Baixo Alentejo ou Chouriço de carne do Baixo Alentejo [3], Chouriço de Carne de Estremoz e Borba [6], Chouriço grosso de Estremoz e Borba, Chouriço de Portalegre [7] (*see* **Note 1**). However, a great quantity of commercial products without PGI label are produced all over the country [8].

Despite the great consumption and popularity of *chouriça de carne*, it is essentially a Portuguese product and only a few studies have deserved its attention [9–14] were made. Aiming the guarantee of the safety of meat sausages to improve their recognition as quality products the chemical and microbiological characterization of Chouriça de Vinhais was made [9]. Major focus was chemical and microbiological safety. Most of the studies are related to microbiological characteristics and issues related to smoking process [15].

Other studies [16–18] were made in other Portuguese traditional sausages with the objective of contributing to a better knowledge and physicochemical, sensory and microbiological characterization of products that, despite their popularity, are practically unknown in these important parameters and nutritional quality. Therefore, the main objective of this chapter is to describe the stages of the manufacturing process, and a detailed analysis of the most critical aspects of the formulation and processing of the *chouriça de carne*.

## 2 Materials

According to Commission Regulations (EC) [3–5], Chouriça de carne de Vinhais (similarly to Chouriça de carne de Barroso-Montalegre and Chouriça de carne de Melgaço) is a sausage of


**Fig. 1** Traditional way to dry chouriças de carne (**a**), several commercial and PGI brands of chouriças de carne (**b**) three different types of chouriça de carne purchased in a local market (**c**)

pork meat and fat from the Bisara breed or crossbreeding product of this breed, provided that it contains 50% Bísaro blood, filled in pork or cow tripe, of cylindrical section and smoked. The meat and fat used are properly seasoned with salt, red, or white wine from the region, water, garlic, sweet and/or spicy paprika, and bay leaves. It has a horseshoe shape, 30–35 cm long, and reddish brown in color. The gut is tied at both ends with cotton thread and is well adherent

**Table 1**
**Composition values for chouriça de carne [8]**

| | Chouriço de carne de porco, magro (lean pork meat chouriço) | Chouriço de carne de porco, gordo (fat pork meat chouriço) |
|---|---|---|
| Energy (kcal) | 408 | 544 |
| Water (g) | 32.5 | 23.0 |
| Protein (g) | 24.5 | 15.4 |
| Total fat (g) | 34.5 | 53.6 |
| SFA | 11.9 | 18.5 |
| MUFA | 13.6 | 21.2 |
| PUFA | 4.0 | 6.2 |
| Trans fatty acids (g) | 0.1 | 0.15 |
| Linoleic acid (g) | 3.4 | 5.3 |
| Cholesterol (mg) | 85 | 96 |

*SFA* saturated fatty acids, *MUFA* Monounsaturated fatty acids, *PUFA* polyunsaturated fatty acids

to the dough and without breaks. The way of tying is characteristic: two knots are made at the end of the casing, which is then turned, after which one more knot is made. Diameter 2–3 cm, internally well connected to the cut, with bright red to white color, of different shades, not homogeneous. Pleasant taste, very characteristic. Pleasant aroma and sui generis. Smoked flavor and aroma (Table 1).

## 3 Methods

Independently of the *linguiça* type, the stages of the production include the selection of the meat joints and ingredients, mincing lean and fat portions, mixing and emulsification of all material, conditioning, filling, smoking, curing, and airdrying (Fig. 2):

1. The reception and selection of the pork meat. In the industry is carried out in room at a maximum temperature of 7 °C (*see* **Note 2**).
2. Mincing lean and fat into portions of 10–14 and 6–8 mm, respectively (*see* **Note 3**).
3. The lean (70–80%) and fat (20–30%) portions are mixing and emulsification with the ingredients: paprika (20 g/kg),

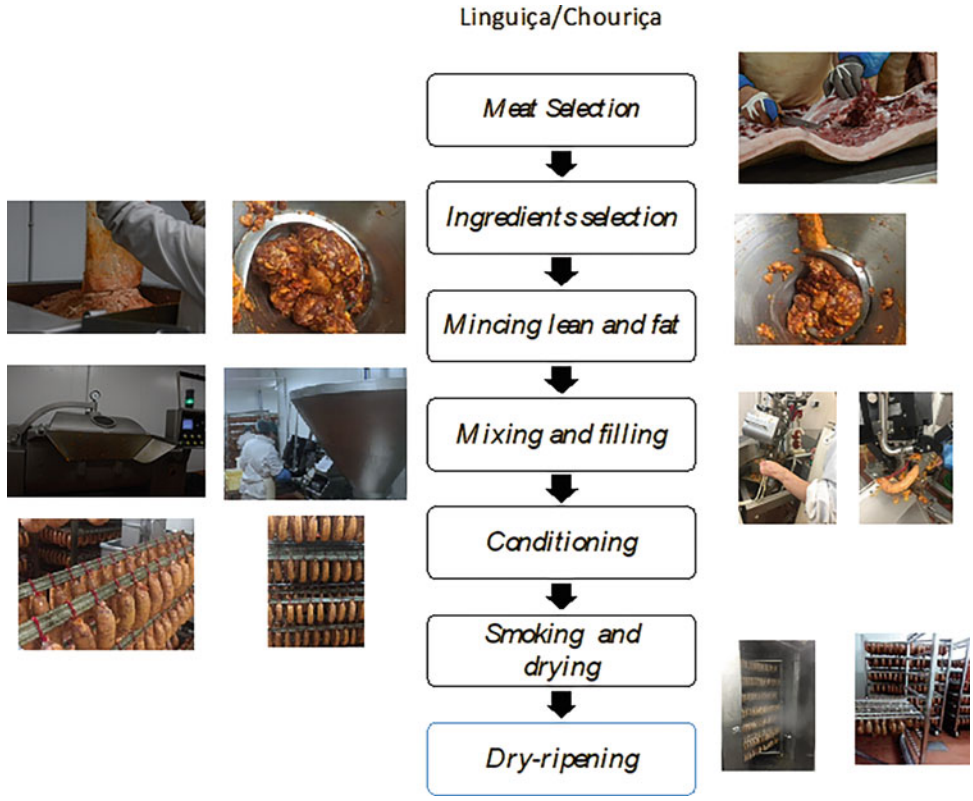


**Fig. 2** Diagram of the different stages of the production process of chouriça de carne

150 mg/kg of nitrite, 150 mg/kg of nitrate, garlic, laurel, pepper, red and white wine, water, orange (*see* **Note 4**).

4. Sausages are conditioning during 24–48 h at 5 °C and 85–90% for product stabilization.
5. The filling of sausages in natural pork casing with 32–40 mm diameter (*see* **Note 5**).
6. Smoking (*see* **Note 6**).
7. Drying and ripening at 10–14 °C and 60–70% moisture for 15 days (*see* **Note 7**).

## 4 Notes

1. Despite the great diversity of names, all products are pork sausages with similar manufacturing methods and curing processes.
2. Although several carcass joints can be used, the belly and shoulder are the most common meat portions in *linguiça*.
3. There may be products more finely minced 2–4 mm.

4. The percentage of lean and fat portions as well as the ingredients could vary according the *linguiça* type or the different GPI.
5. Normally the *linguiças* are filled into natural tripe and with a horseshoe shape, but some commercial products out of DOP or PGI brands could be filled in other kind of casings with different sizes and shapes.
6. The smoking phase is optional and usually depends on the DOP and PGI regulations. Traditionally, oak, olive, chestnut wood fires are used. The industrial process is in a smokehouse during 2–3 h and at 25 °C.
7. The drying and ripening period could vary depending the culinary uses and consumer preferences but never less than 5 days curing.

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### References

1. Norma portuguesa NP-589 (2008) "Carnes, derivados e produtos cárneos - Chouriço de carne. Definição, classificação, características e acondicionamento"
2. Teixeira A, Rodrigues S (2019) Meat quality, brands and consumer trends. In: Lorenzo J, Munekata P, Barba F, Toldrá F (eds) More than beef, pork and chicken – the production, processing, and quality traits of other sources of meat for human diet. Springer, Cham. https://doi.org/10.1007/978-3-030-05484-7_2
3. Commission Regulation (EC) No 148/2007 of 15 February 2007
4. Commission Regulation (EC) No 1265/98 of 18 June 1998
5. Commission Regulation (EC) No 2015/590 of 31 March 2015
6. Commission Regulation (EC) No 1258/2004 of 8 July 2004
7. Commission Regulation (EC) No 1875/97 of 26 September 1997
8. Marcos C, Viegas C, de Almeida AM et al (2016) Portuguese traditional sausages: different types, nutritional composition, and novel trends. J Ethn Foods 3:51–60
9. Ferreira V, Barbosa J, Silva J et al (2007) Chemical and microbiological characterisation of "Salpicão de Vinhais" and "Chouriça de Vinhais": traditional dry sausages produced in the north of Portugal. Food Microbiol 24: 618–623
10. Ferreira V, Barbosa J, Silva J et al (2009) Microbiological profile of Salpicão de Vinhais and Chouriça de Vinhais from raw materials to final products: traditional dry sausages produced in the north of Portugal. Innov Food Sci Emerg 10:279–283
11. Barbosa J, Ferreira V, Teixeira P (2009) Antibiotic susceptibility of enterococci isolated from traditional fermented meat products. Food Microbiol 26:527–532
12. Barbosa J, Gibbs PA, Teixeira P (2010) Virulence factors among enterococci isolated from

traditional fermented meat products produced in the north of Portugal. Food Control 21: 651–656

13. Roseiro LC, Gomes A, Goncalves H et al (2010) Effect of processing on proteolysis and biogenic amines formation in a Portuguese traditional dry-fermented ripened sausage "Chourico Grosso de Estremoz e Borba PGI". Meat Sci 84:172–179
14. Meftah S, Abid S, Dias T et al (2018) Effect of dry-sausage starter culture and endogenous yeasts on Aspergillus westerdijkiae and Penicillium nordicum growth and OTA production. LWT Food Sci Technol 87:250–258
15. Matos TJS, Bruno-Soares A, Jensen BB et al (2008) Growth inhibition of bacterial isolates recovered from two types of Portuguese dry smoked sausages "chouriço". Meat Sci 80: 1352–1358
16. Roseiro LC, Gomes A, Santos C (2011) Influence of processing in the prevalence of polycyclic aromatic hydrocarbons in a Portuguese traditional meat product. Food Chem Toxicol 49:1340–1345
17. Roseiro LC, Gomes A, Patarata L et al (2012) Comparative survey of PAHs incidence in Portuguese traditional meat and blood sausages. Food Chem Toxicol 50:1891–1896
18. Gomes A, Santos C, Almeida J et al (2013) Effect of fat content, casing type and smoking procedures on PHAs contents of Portuguese traditional dry fermented sausages. Food Chem Toxicol 58:369–374

# Chapter 20

# *Entremeada* and *Paia de Toucinho*

**Marta Laranjo, Miguel Elias, Luís Patarata, and Maria João Fraqueza**

## Abstract

*Entremeada* or pork belly is a fatty cut of meat from the underside of the pig belly. The breeding of autochthonous pig breeds, such as the Portuguese Alentejano pig and Bisaro pig, has always provided alternative nourishment and counteract the deficit caused by bad agricultural years. Several meals and sausages are prepared with the less noble meat cuts obtained from these animals, such as the *entremeada* or pork belly with a higher valorization and improving the sustainability of small family and middle-size industries. Traditional manufacturing processes differ hugely between countries and regions, but also between different manufacturers. Thus, specific characteristics have been established to ensure the quality of these meat products.

The present chapter presents the *entremeada* or pork belly as a meat cut that has been valued in the form of different meat delicatesses such as artisanal bacon or *Paia do Toucinho* or other different meat products with either Protected Geographical Indication (PGI) or Protected Designation of Origin (PDO) made in different Mediterranean countries. Additionally, the formulation and the different stages of manufacturing of the Portuguese meat-based product *Paia de Toucinho de Estremoz e Borba* is described in detail.

**Key words** Traditional meat products, Pork belly, Salted meat products, Smoked meat products, Portuguese traditional meat products, Mediterranean diet, Manufacturing process

## 1 Introduction

*Entremeada* or pork belly is a fatty cut of meat from the underside of the pig belly. Fresh pork belly can be consumed grilled as the Portuguese style grilled *entremeada*, which is a tasty crisp bacon-like grilled meat, due to the rendering down of the fat during grilling. It can also be salted, cured, and smoked to make an artisanal bacon or salted and cured, but not smoked, which differs from the industrial cooked bacon, available in every supermarket.

This type of artisanal bacon (*barriga de porco*) (Fig. 1) is still manufactured in some small industries, particularly in the North of Portugal. The artisanal bacon can be manufactured from pork belly, obtained from the carcasses of Bísaro pigs. It is dry-salted, in a process similar to that used to salt the hams. The salted bellies are

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**Fig. 1** (**a**) Sliced *Paia de Toucinho de Estremoz e Borba*-PGI; (**b**) Artisanal bacon

then desalted and smoked with the other meat products. The curing and drying allows the lean part of the belly to acquire the characteristic red of cured products, and the chemical modifications on the fat and on the lean results in a very rich aroma. In some regions, small producers use the unboned belly, still with the ribs attached. In certain small industries the process evolved to a salting in brine, and aromatization can be done with the traditional ingredients used for dry-cured sausages, as garlic, wine, and laurel. In any case, the smoking occurs by exposing the bellies to smoke obtained by slow-burning hardwoods, like holm oak. Nowadays, the cured belly available in the big distribution is mostly a pasteurized product, injected with the brine to achieve high production yields.

Furthermore, several Protected Geographical Indication (PGI) or Protected designation of origin (PDO) pork belly meat-based products have been registered (https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/

quality-labels/geographical-indications-register/) in European Mediterranean countries, namely:

- *Paia de Toucinho de Estremoz e Borba* (PGI-PT-0156), Portugal (Fig. 1).
- *Pancetta di Calabria* (PDO-IT-1567), Italy.
- *Pancetta Piacentina* (PDO-IT-1497), Italy.
- *Dalmatinska pancetta* (PGI-HR-02455), Croatia.
- *Kraška pancetta* (PGI-SI-0833), Slovenia.

Although the Spanish *panceta* has no recognized PGI or PDO status, it is also largely produced and highly appreciated by consumers [1].

According to the EU Regulation (PGI-PT-0156), the meat and fat used to produce *Paia de Toucinho de Estremoz e Borba*-PGI are exclusively from the carcasses of Alentejano pigs (*Sus ibericus*). The Alentejano pig is part of the Mediterranean group, which also includes the Iberian breed pig, with origin in the ancestral *Sus scrofa mediterraneus* [2]. Raised in agrosilvopastoral extensive systems, such as the Portuguese *Montado* or the Spanish *Dehesa*, and fed on acorns under the *Montanheira* regime [2], their meat has particular organoleptic characteristics, highly appreciated by consumers [3]. Their meat-based products are highly valued, have specific sensory traits, and are manufactured throughout the Mediterranean, in countries such as Portugal, Spain, and Italy, among others, being highly appreciated by consumers.

The *Paia de Toucinho de Estremoz e Borba*-PGI is obtained from the transformation process of a whole pork belly meat cut of Alentejano pig (*see* **Note 1**), in which the fat content must be not less than 50% (*see* **Note 2**). After selecting and cleaning (*see* **Note 3**) the meat, the remaining ingredients (salt, red pepper, garlic) are added. After the preparation of the meat cut and the addition of seasonings, the product undergoes a maturing process, and then the piece is curled, so that it takes the shape of a "snail." Once the *Paia* is formed, the next step is bagging, tying, and curing using regional holm oak wood.

The characteristic flavor of *Paia de Toucinho de Estremoz e Borba*-PGI is largely due to the influence of the region's oak orchards. The Alentejo breed's diet is rich in acorns and holm oak wood is used in smoking. The *Paia de Toucinho de Estremoz e Borba* (PGI-PT-0156) is produced in Portugal, in the Évora region, specifically in Alandroal, Borba, Estremoz and Vila Viçosa.

Thus, the main aim of the present chapter is to describe in detail the distinct manufacturing stages of the salted and smoked pork belly, taking all the above mentioned into account.

## 2 Materials

The traditional cured belly is made from the pork belly, in some regions still with the ribs. The meat is dry-salted intercalating the bellies and salt in a salting box, which allows the excess liquid to drain. After a few days, the meat is withdrawn from the salt, the excess of salt on the surface is washed out or brushed, and the bellies are hanged in the smoking house. During this phase, the piece dries, acquiring a golden-brown characteristic color. These pieces might continue in the traditional smokehouse with almost no smoke or are transferred to a drying room for several weeks, and several modifications occur resulting in final flavors and in a color of the lean part of the belly similar to cured ham.

The raw materials used to produce *Paia de Toucinho de Estremoz e Borba* are exclusively the following:

- Pork belly, obtained from the carcasses of Alentejano pigs, born, reared, fed, and slaughtered under the conditions laid down in the Product Specification File (Council Regulation (EEC) No. 2081/92 and Commission Regulation (EC) No 1258/2004 [4, 5].
- Table salt (*see* **Note 4**).
- Water (*see* **Note 4**).
- Red pepper paste (*see* **Note 3**).
- Non-germinated garlic cloves (*see* **Note 5**).

The *Paia de Toucinho de Estremoz e Borba*-PGI has a cylindrical shape with a length of 20–45 cm and a diameter of 6–15 cm (Fig. 1a).

This meat-based product has a pleasant aroma, a pleasant, mild, garlicky flavor, smoked and with a balanced sweet/salty ratio. The fat is aromatic and has a pleasant taste. The texture is not very fibrous and is reasonably smooth.

The following characteristics of the *Paia de Toucinho de Estremoz e Borba*-PGI are covered by the Protected Geographical Indication (PGI):

External Characteristics

- *Color*: light brown.
- *Appearance*: smooth and glossy.
- *Consistency*: semi-soft.
- *Casing*: unbroken, completely filled with the mixture and adhering closely to it.
- *Tying*: sewn in the meat joints, tied with red and white cotton twine at the ends with a double knot, and wrapped with the

twine in a spiral along its length (every 3 cm) around the entire outer surface of the product.

Internal Characteristics (When Cut Obliquely)

- *Color*: the fat is predominantly white in color with a reddish snail-shaped phase for the streaky meat.
- *Paste*: perfectly bound, with a perfectly defined distribution of meat and fat.
- *Appearance*: heterogeneous, marbled, with brightness and intramuscular fat infiltration.
- *Fat*: white in color.

Chemical Characteristics

- *Moisture content of the meat fraction*: <65%.
- *Total fat*: >50%.
- *Chlorides*: <7%.

The manufacturing process of the *Paia de Toucinho de Estremoz e Borba*-PGI as defined in the "Product Specification File," will be described in the next section of the current chapter.

## 3 Methods

The different steps of the manufacturing process will be carried out in accordance with the ancient traditional knowledge of local producers to obtain a high-quality product.

The manufacturing process of the *Paia de Toucinho* includes several steps (Fig. 2), namely meat selection, meat cut cleaning, addition of ingredients, ripening, curling of the meat cut, bagging, tying, and curing, which will be carried out as described below.

The *Paia de Toucinho de Estremoz e Borba*-PGI is obtained from the processing of whole pieces of pork belly from Alentejano pigs, in which the quantity of fat must never be less than 50%. After the selection and cleaning of the meat cut (*see* **Note 3**), the remaining ingredients, previously listed in the Subheading 2 (Materials) of this chapter, are added (without the *Paia* losing the original designation).

After preparation and seasoning of the meat cut, the product is left to mature for approximately 2 days, after which it is curled, so that the *Paia* takes the shape of a snail. Once the *Paia* is formed the following steps are bagging, tying, and curing.

To obtain the final product, the technological parameters shown in Fig. 2 must be taken into account. The chemical composition of the final product (after the drying-ripening period) is specified in Table 1.

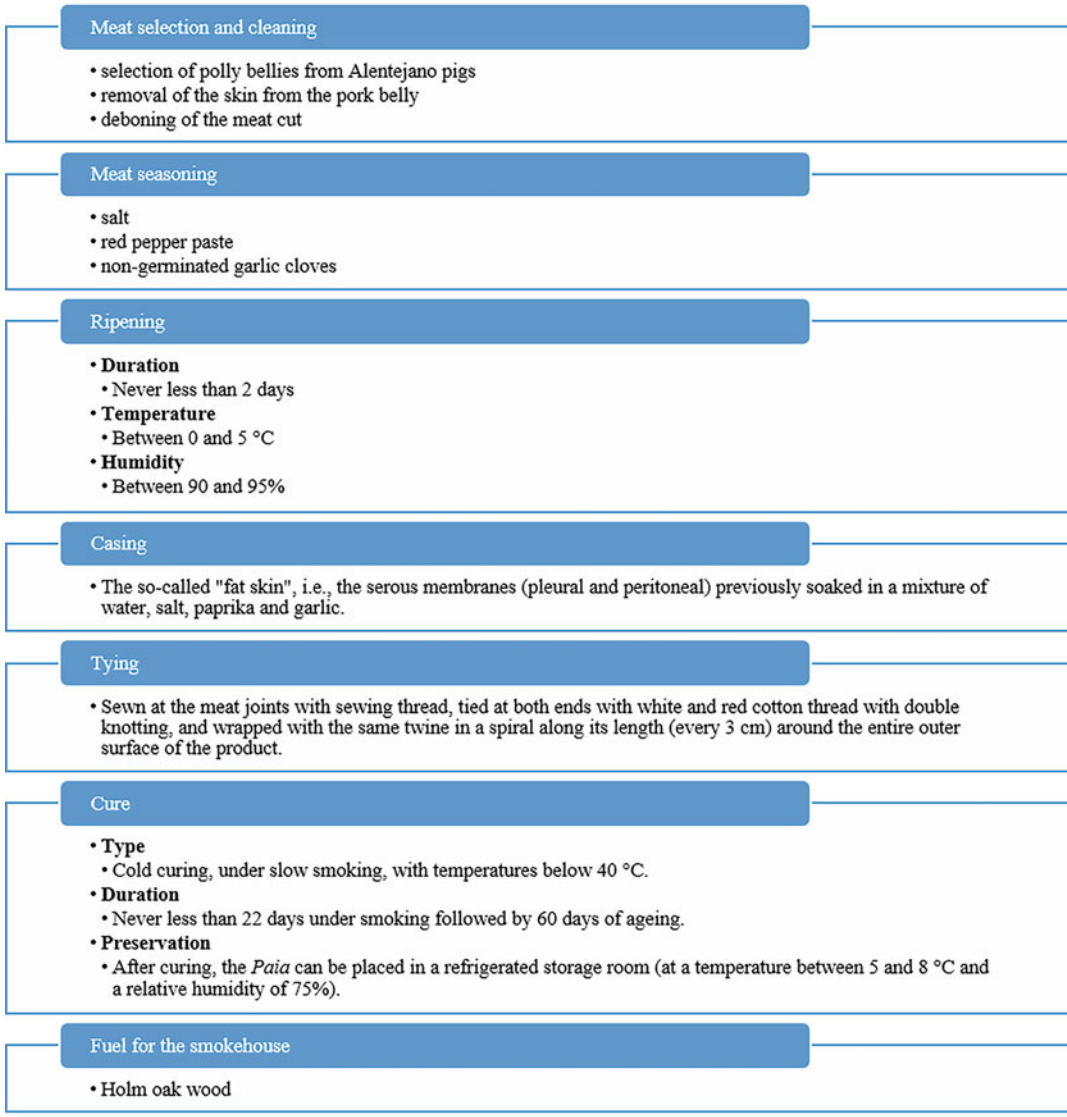


**Fig. 2** Manufacturing diagram and technological parameters of the *Paia de Toucinho de Estremoz e Borba*-PGI

Regarding the commercial presentation of the *Paia de Toucinho de Estremoz e Borba*-PGI is available to the consumer in whole piece, in pieces or sliced (*see* **Notes 6** and **7**).

About the consumption of this meat-based Alentejano pig product, the *Paia de Toucinho de Estremoz e Borba*-PGI is particularly appreciated raw. It can be eaten as snacks, titbits or as appetizers at meals, lunch, or dinner (*see* **Note 8**).

To sum up, it can be said that the *Paia de Toucinho de Estremoz & Borba*-PGI has a great reputation associated to its region of origin and has quality characteristics that are indistinguishably

**Table 1**
**Chemical composition of the *Paia de Toucinho* and the artisanal bacon, according to the Food Composition Table (http:/portfir.insa.pt/) [6]**

| | *Paia de Toucinho* | Artisanal bacon |
|---|---|---|
| Energy (kcal/100 g) | 361 | 500 |
| Energy (kJ/100 g) | 1500 | 2090 |
| Water | 37.9 | 32 |
| Fat | 30 | 50.1 |
| Saturated fatty acids (SFA) | 13.7 | 16.8 |
| Monounsaturated fatty acids (MUFA) | 15.7 | 19.4 |
| Polyunsaturated fatty acids (PUFA) | 4.6 | 7.6 |
| Protein | 22.8 | 13.7 |
| Carbohydrates | 0 | 0 |
| Ash | 9.1 | 4 |
| Salt content | 4.4 | 3.6 |
| Cholesterol (mg/100 g) | 77 | 55 |

All values are given as g/100 g, except where otherwise indicated

linked to both the region where it is produced and to the traditional ancestral know-how of the people of that region.

## 4 Notes

1. The meat and fat raw material used in the manufacturing of the *Paia de Toucinho de Estremoz & Borba*-PGI are exclusively obtained from carcasses of Alentejano pigs.
2. The fat content of the pork belly meat cut must not be less than 50%.
3. The meat cuts are carefully selected, the skin is removed, and the meat cut is deboned.
4. There are no specific amounts for water and salt, so each manufacturer mixes these ingredients according to their own criteria.
5. The garlic must be dried as referred to in the Annex to Council Regulation (EEC) No 10/65 [7].
6. When the *Paia de Toucinho de Estremoz e Borba*-PGI is commercially presented in pieces or sliced, it must be pre-packaged at the manufacturer.

7. When presented as whole pieces, the *Paia de Toucinho de Estremoz e Borba*-PGI does not need to be labeled with the net quantity, provided that it is weighed in the sight of the consumer.
8. It is advisable to keep it stored in a cool and dry place, in order to enhance its *sui generis* qualities.

## Acknowledgments

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### References

1. Bejarano SM (2001) Enciclopedia de la carne y de los productos cárnicos. Martín & Macías, Plasencia
2. Charneca R, Martins J, Freitas A et al (2019) Alentejano Pig. In: Candek-Potokar M, Linan RMN (eds) European local pig breeds - diversity and performance. A study of project TREASURE. IntechOpen, Londres
3. Albuquerque A, Neves JA, Redondeiro M et al (2017) Long term betaine supplementation regulates genes involved in lipid and cholesterol metabolism of two muscles from an obese pig breed. Meat Sci 124:25–33
4. EC (2004) COMMISSION REGULATION (EC) No 1258/2004. In: EC (ed)
5. EEC (2002) COUNCIL REGULATION (EEC) No 2081/92. In: EEC (ed)
6. INSA (2019) Food composition table. http://portfirinsapt/
7. EEC (1965) Regulation No 10/65/EEC of the Council. In: EEC (ed)

# Chapter 21

# *Salpicão* and *Paio*

**Maria João Fraqueza, Marta Laranjo, Miguel Elias, and Luís Patarata**

## Abstract

Salpicão and Paio are traditionally cured meat products made preferentially from pork loin. Still, it can use meat from the leg, in a single piece, or from grossly cut meat. Salpicão is produced mainly in the North of Portugal, while Paio is in the South, with its most significant expression in Alentejo. The meat is salted and seasoned, according to the regional or even producer's recipes. In the production of salpicão, the wine is frequently, but not always, used to season the meat, while in paio, it is the red pepper paste and garlic paste that impart the *sui generis* aroma and color to the product. The seasoned meats are filled into casings and dried. Smoking is always used in salpicão, while paio might or might not be smoked. The drying process combined with the salt contributes to a sliceable texture and reduced water activity that ensures its preservation.

**Key words** Traditional meat products, Dry-cured products, Dry-fermented sausages, Cured loins, Mediterranean sausages, Manufacture process

## 1 Introduction

The loin is a noble pork cut that can be preserved by curing. Different meat products are prepared from pork loin in Portugal according to regional specificities on meat preparation and seasoning. Salpicão and Paio are cured meat products from the north and the south region, respectively. These products have a long tradition of manufacturing and are highly valued by the consumers due to their exquisite sensory characteristics and attractive nutritional value due to the relatively low-fat level [1, 2].

Salpicão might be manufactured with a whole piece of loin, cut transversally to the muscle fibers orientation, or with the loin cut in pieces around 3–6 cm. Besides the salt that is always present, the seasoning is variable and linked to the production location. In wine-making regions, red wine combined with salt, garlic, and lauryl is used to marinate a whole piece of loin for several days. In the other areas, manufacturers still use wine, red or white, but with more discrete importance. In these recipes, sweet and spicy paprika is

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always present, combined with garlic, laurel, and other seasonings that each producer might use to impart their particular sensory notes to their recipes [3]. From the nineties of the XX century, an effort was made to recover a pork breed at risk of disappearance—Bísaro. The aptitude of that pork to transform into cured meat products is excellent due to its intramuscular fat that results in juicy and flavor-rich salpicão. Meat from that breed, pure or with at least 50% of Bísaro blood, is used for protected geographic indication (PDI) products [4]. Due to the specific environmental conditions, as well to preserve the cultural heritage of the traditional manufacturing processes, there are three types of salpicão with a PDI: *Salpicão de Vinhais*, *Salpicão de Barroso-Montalegre* and *Salpicão de Melgaço* [5].

Paio is a cured sausage from the Alentejo region, and the loin used is from the Alentejano swine breed, a variant of the Iberian breed [6, 7]. The meat from these animals has outstanding proprieties to transform into cured paio. The amount and composition of the fat result in a controlled oxidation process resulting in a characteristic-rich odor. Paio is made from a single piece of loin, cut in the direction of the muscle fibers, or local variants that might be prepared with meat grossly cut into pieces [1].

In both salpicão and paio, the extensive maturation that might be from 4 weeks to more extended periods, depending on the sizes of the product, results in a slow drying process. As a result, the products acquire a sliceable texture and reduce the water activity to ensure their microbiological safety. The aroma formation is a complex interaction between enzymatic, chemical, and microbial modifications of the fat and protein and fat, combined with the aroma of the seasonings and the smoke when that operation is used [2].

The traditional recipes have been adapted to industrial production, using nitrite, combined or not with nitrate, to increase microbial safety. In some industries, the products are subjected to a mild heat treatment (55–60 °C), viewing the elimination of low-infective-doses pathogens [3]. That operation might occur concomitantly with the smoking or at the beginning of the drying process. As expected, heat treatment modifies the product considerably, resulting in more flawed aroma products, characterized mainly by seasonings and smoke notes [8].

The main objective of this chapter is to make a detailed description of the formulations of Salpicão and Paio and the different stages of their manufacturing processes.

## 2 Materials

1. Main ingredients: Pork loin and tenderloin (*see* **Note 1**).
2. Common salt, sweet and spicy paprika, garlic, red or white wine, red pepper, laurel, water, optionally nitrite salt can be used (Table 1).
3. Casings: the casings used are from large swine intestine.
4. Final products characteristics (Table 2):
   (a) Salpicão (Fig. 1).
      - Shape and external appearance: It has a dark brown exterior color, eventually reddish when paprika is used.
      - Weight: given that the casing in which it is stuffed is natural, the weight will be variable, ranging from a minimum of 0.2 kg to a maximum of 0.5 kg.
      - Diameter: 5–8 cm.
      - Internal appearance: The lean part of salpicão is the characteristic bright red of cured meat. It can have an orange tone from the paprika or a purplish one due to meat marination in red wine. The fat is white or pale beige. It has a *sui generis* cured flavor, smoky notes, and discrete aromas from the seasons used, namely the wine, garlic, and red pepper paste.
      - Sensory characteristics: It has a *sui generis* cured flavor, smoky notes, and discrete aromas from the seasons used namely the wine, garlic, and red pepper paste. The texture is firm and juicy.

   (b) Paio (Fig. 1)
   Other common designations: *Paio do lombo*, *paio*, *painho*, *paiola*.
      - Shape and external appearance: broad sausage, cylindrical in section and straight with a length between 12 and 20 cm. Appearance: shiny, slightly rough. Stuffed on natural salted pork casings twisted and tied with cotton thread at both ends. Reddish and white color with semi-hard to hard consistency.
      - Weight: 300–500 g.
      - Diameter: 6–15 cm.
      - Internal appearance: meat Reddish pink color, with some white streaks. Perfectly connected mass, homogeneous in appearance. The fat is pearly white and shiny,
      - Sensory characteristics: Flavor and aroma: Pleasant, smooth and delicate flavor, slightly salty, and

**Table 1**
**Example of recipes of Salpicão and Paio ingredients (curing ingredients and condiments per kg of meat)**

| | Salpicão | Paio |
|---|---|---|
| Refined salt | 15 g | 15 g |
| Nitrite salt (optional) | 0.10 g | 0.10 g |
| Sweet paprika | 10 g | |
| Spicy paprika | 5 g | |
| Garlic pasta (*Allium sativum L.*) | 10 g | 10 g |
| Red pepper paste (*Capsicum annuum L.*) | | 25 g |
| Powder laurel | 0.05 g | |
| Red wine | 0.5 dl | |
| White wine | – | 0.3 dl |
| Water | – | 0.2 dl |

**Table 2**
**Chemical composition of Salpicão and Paio**

| Parameter | Salpicão | Paio |
|---|---|---|
| Energy [kcal]/100 g | 319 | 436 |
| Lipids: [g]/100 g | 20.4 ± 9.7 | 40.1 ± 4.6 |
| Saturated fatty acids | 8.0 | 16.1 |
| Monounsaturated fatty acids | 9.3 | 18.5 |
| Polyunsaturated fatty acids | 2.7 | 5.4 |
| Protein [g]/100 g | 33.7 ± 6.4 | 18.7 ± 1.6 |
| Moisture% | 39.2 ± 9.5 | 31.5 ± 3.9 |
| Salt% | 4.1 ± 2.1 | 5.0 ± 0.4 |
| Ash% | 5.3 ± 2.0 | 6.0 ± 0.8 |
| pH | 5.4 ± 0.3 | 5.5 ± 0.4 |

Data obtained from [9–11]

sometimes aftertaste slightly spicy. The pleasant flavor developed from the non-protein fraction and the limited oxidation of fat. When meat from acorns' finished pork is used, the products develop an exquisite aroma thanks to the compounds formed from the oxidation of polyunsaturated fatty acids. When smoked, discrete notes are perceived.


**Fig. 1** Salpicão at a curing house and sliced product appearance (**a**) and Paio final product and slices appearance (**b**)

## 3 Methods

The different steps of the manufacturing process (Fig. 2) are carried out in accordance with the traditional knowledge.

The loins (or eventually meat from the leg) are mixed with condiments and macerated for several days at low temperature, afterward are stuffed in large pork natural casings.

– Preparation of loins. For Salpicão, entire loins can be used or cut on large pieces.

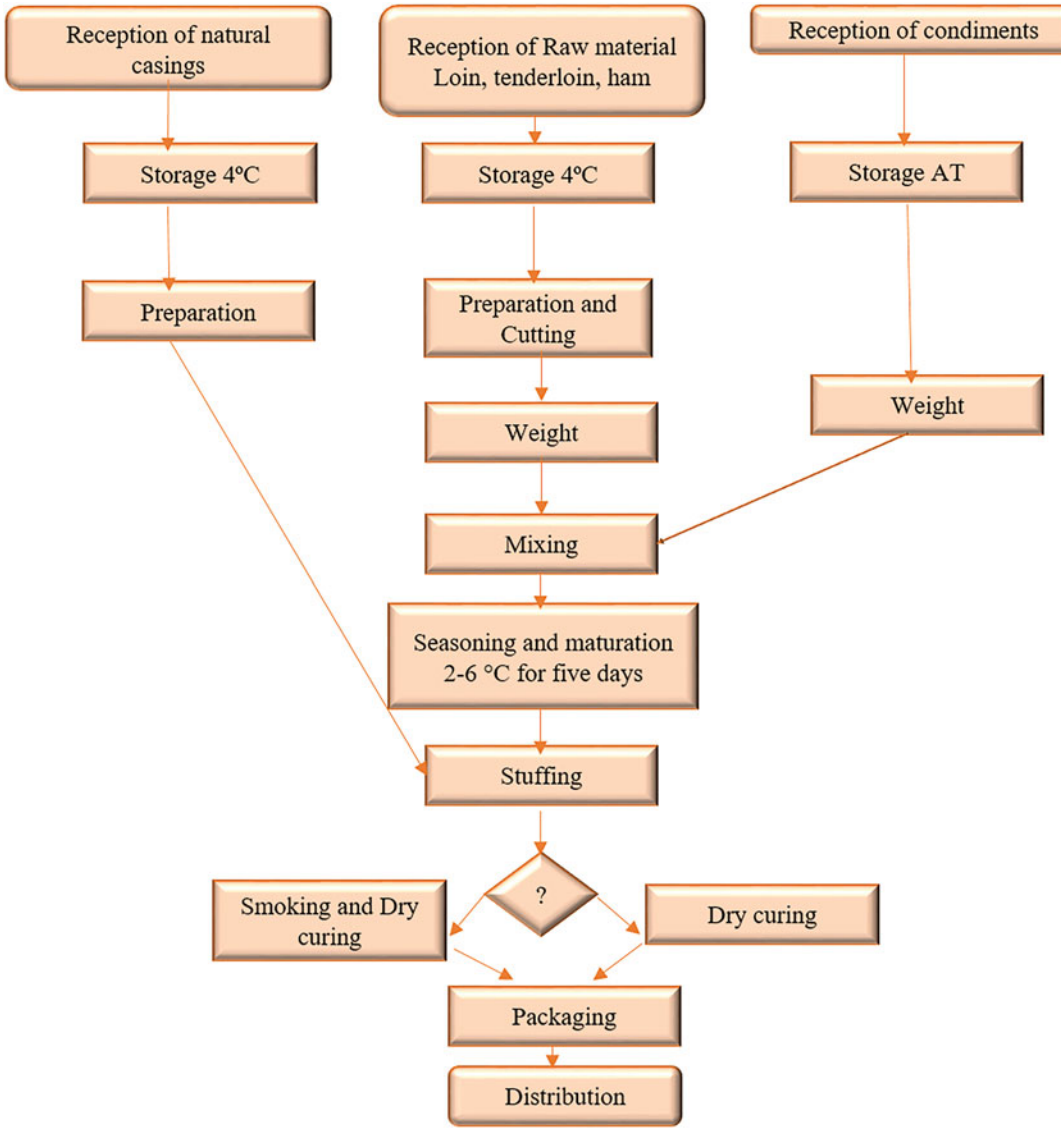


**Fig. 2** Flow diagram of salpicão and paio manufacture

For Paio will be used pork loin, tenderloin, but also could be use leg and shoulder and fat obtained from the cutting of carcasses of Alentejano swine breed (*Sus ibericus*), the fragments of meat and fat (70–90% thin and 30–10% fat) can be obtained mechanically or manually.

- Weigh all ingredients according to formulations (Table 1) (*see* **Note 2**).
- Mix the ingredients and condiments with the meats.
- Leave to mature at 2–6 °C for 2–5 days (*see* **Note 3**).
- Fill the meat in natural large pork casings (*see* **Note 4**).

- Smoking in the traditional smokehouse at low temperature with oak or chestnut wood (*see* **Note 5**).
- Curing period in the traditional smokehouse or drier: The cure will be done for approximately 1 month, and the weight break will be 30% on average. The sausages are considered cured when the weight breaks are in the order of 30%.

## 4 Notes

1. The meat must be of high hygienic Quality; meat with abnormal quality traits, as PSE (pale, soft, and exudative) or DFD (dry, firm, and dark) should be avoided to produce salpicão or paio, due to the abnormal drying kinetic and preservation.
2. When nitrite and nitrate is used, this additive should be used mixed in common salt, as it is commonly sold in the meat industry. The amount of this additive must be carefully monitored to reduce the potential adverse effects it represents.
3. During this phase at low temperature, there are the growth of lactic acid bacteria and coagulase-negative gram-positive cocci that contributes to the preservation and sensory characteristics of the product.
4. When natural casings are used, they must be adequately disinfected. Ancient traditional procedures included, after a thorough washing, salting for several days, marinating the casing in water with lemon and or spirit.
5. Smoking is done with slow-burning of hardwood, like *Quercus ilex*, *Q. faginea* L., *Castanea sativa* M., *Olea europeae* L. The burning must be done without a live flame (<500 °C) to avoid the accumulation of harmful polycyclic aromatic hydrocarbons. There is a trend to reduce the extension of smoking to the strictly necessary period to the minimum coloring and flavoring of the sausages.

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## References


1. Elías M, Carrascosa AV (2010) Characterisation of the Paio do Alentejo, a traditional Portuguese Iberian sausage, in respect to its safety. Food Control 21:97–102
2. Fraqueza M, Patarata L (2020) Fermented meat products: from the technology to the quality control. In: Sankaranarayanan A, Amaresan N, Dhanasekaran D (eds) Fermented food products. CRC Press, Boca Raton, FL, pp 197–237
3. Silva R, Pereira J, Rouxinol M et al (2020) Sensory changes and Listeria monocytogenes behavior in sliced cured pork loins during extended storage. Foods 9:621
4. Monteiro RA, Fermandes P, Afonso R et al (2019) Saber (a) Vinhais. Contributo para uma carta gastronómica. LEYA, Lisbon
5. DGADR Produtos tradicionais portugueses. Produtos agrícolas, géneros alimentícios e pratos preparados
6. Laranjo M, Gomes A, Agulheiro-Santos AC et al (2017) Impact of salt reduction on biogenic amines, fatty acids, microbiota, texture and sensory profile in traditional blood dry-cured sausages. Food Chem 218:129–136
7. Laranjo M, Talon R, Lauková A et al (2017) Traditional meat products: improvement of quality and safety. J Food Qual 2017:2–4
8. Fraqueza M, Patarata L (2018) Produtos cárneos tradicionais. O regresso ao passado como caminho para o futuro. Rev da ACPA X:36–41
9. Colaço-do-Rosário C, Patarata L, Esteves A et al (2000) Salsicharia tradicional transmontana: Caracterização, monitorização e experimentação da tecnologia artesanal. Relatório Final do Projecto PAMAF 3056, UTAD, Vila Real
10. Elias M (2005) Caracterização, conservação e produção biotecnológica de paio de porco alentejano
11. INSA Tabela da composição de alimentos 2019.

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