

Chapter 15

Factors Influence the Quality and Safety of Fermented Sausages



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Abbreviations

EC	European Commission
FAO	Food and Agriculture Organization
IFPRI	International Food Policy Research Institute
ISO	International Organization for Standardization
SDS	Sudanese Standard
WHO	World Health Organization

15.1 Introduction

The international request on harmless food free from physical, chemical, and biological hazards (organic food) is on scaling in particular consequently the outbreaks of diseases such as cow-madness, Foot and mouth disease(FMD), Swine flu, Middle East Respiratory Syndrome (MERS) and Dioxin and dioxin-like compounds (DLCs) (WHO 2018). The world populace to be 8 billion people in 2020 (IFPRI 2020). This public overstatement winds up in citified areas, to some extent than rustic, which means that the demanding ramble in merchandise food leftover is in the developing world. Pointless, urbanization, and globalization of the market enumerate another threat in food manufacture and trading (Osman 2017).

Globally, meat expenditure: pork dominated the maximal (15.8 kg/capita/year), pursued by poultry (13.6 kg/capita/year), beef (9.6 kg/capita/year) consequent sheep and goat meat (1.9 kg/capita/year) (FAOSTAT 2014). There is an increase in global meat production expected to be 15% higher in 2027. The demand for cuts, ready to eat, easy to prepare, and distinctive meat products (FAO 2018).

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Fermented sausage, or dry sausage, is a type of sausage created by salting comminuted or ground meat and fatty tissues to remove moisture, while allowing beneficial bacteria to break down sugars into delicious particles. The bacteria comprise *Lactobacillus* species and *Leuconostoc* species, which breakdown these sugars to produce lactic acid, which not only affects the flavor of the sausage, but also decreases the pH from 6.0 to 4.5–5.0, which inhibits the growing of bacteria that can spoil the sausage. These effects are multiplied during the drying process, as salt and acidity are concentrated as moisture is extracted (Nikolic et al. 2020). Fermented sausages are meat products of high quality and are really valued among customers. Dry fermented sausages ought to contain under 30% moisture and over 20% meat proteins, while the collagen content in meat proteins ought to be under 15%. The fermentation process additionally has numerous advantages as it improves the practical worth of meat because of biochemical changes. Meat fermentation prompts the splitting of protein into peptides and amino acids (Kononiuk et al., 2020).

The technological process of production creation incorporates arrangement of the stuffing, filling into casings, smoking and drying, trailed by maturing that incorporates physical, chemical and enzymatic processes that empower shelf life and give tangible properties product Gazette of the Republic of Serbia, 2019) (Regulation on the quality of minced meat 2019) (Fig. 15.1).

15.2 Meat Term Contextual

Yardımcı (2019) declared that meat is the eatable part of any slaughtered animal, whether the same is in its crispy state that has been freezing, chilling, salting, canning, or other additives. For the utmost part, meat re-counts to skeletal muscle and combined fat and additional tissues. On the other hand, it may include the meat of mammalian (cattle, lambs) processed for human consumption, also represent other edible tissues such as offal.

15.3 Influence of Meat Product

Meat is critical in economy and development, even though its stock production and dissipation have been decisive to affect human health and the environment (Aberle et al. 2012). The same author reported that mammalian meat entails around 75% water, 19% protein, 2.5% intramuscular fat, 1.2% carbohydrates, and 2.3% other soluble non-protein constituents. The essential amino acids in meat are vital ingredients of proteins. On the other hand, plant food has no Vitamin B12, while animal food is indispensable for children to establish B12 deposits. Animal /food, in particular meat, are rich in iron, which is of utmost importance to prevent anemia, especially in children and pregnant women (Fig. 15.2).

Fig. 15.1 Fermented sausage production flow chart

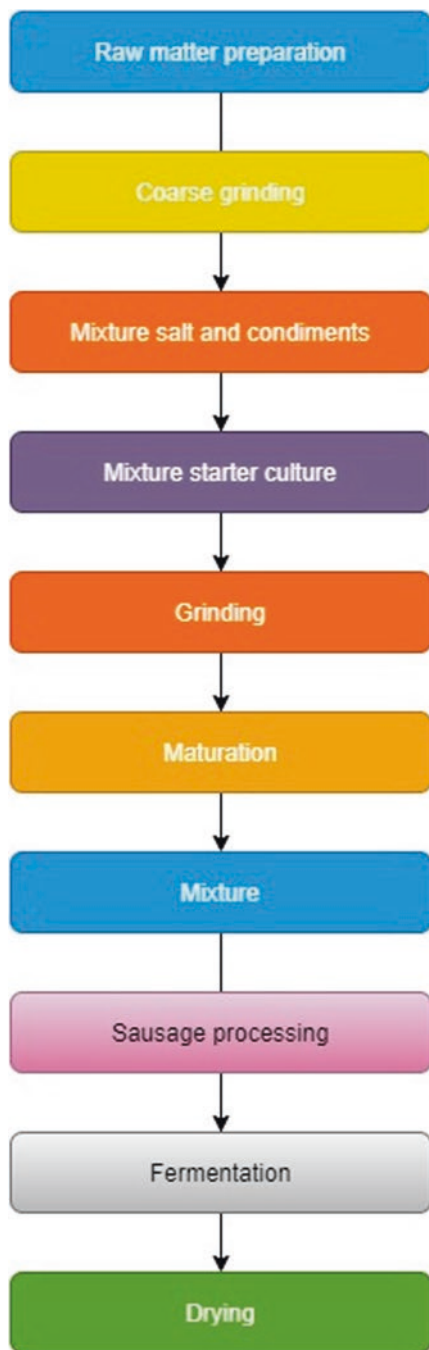




Fig. 15.2 Fermented sausage pictures. (Source: <https://commons.wikimedia.org/>)

15.4 Meat Quality

Meat quality is generally distinct by the compositional eminence (lean to fat ratio) and the palatability features such as appearance, smell, firmness, juiciness, tenderness, and flavor. The nutritious quality of meat expected by the customer is very subjective (Legako et al. 2015).

15.5 Meat Safety

The methodology of food safety is that food will not induce detriment to the customer when it is processed or consumed according to its stated use. In addition, it is correlated with the incidences of food safety hazards like: biological, chemical, or physical agent in food, or quality of food, with the likely to cause an awkward effect. (ISO 22000:2005 - E). The WHO implements five significant values for harmless food; avoid polluting food with pathogens dispersal from persons, animals, and pests. Isolate raw and cooked foods to stop contaminating the ready-to-eat foods. To kill pathogens by cooking food for a suitable extent of time and temperature. Store the food at the required temperature. Do use safe water and safe raw ingredients (WHO 2006).

15.6 Fermented Meat

According to Demeyer and Toldrá (2004), the development of fermentation is one of the hoariest procedures used for reservation of meat and meat products. The fermented meats are conserved products resultant of microbes with fats and salt, spices, herbs, and additional components (Zhao et al. 2011).

15.7 Fermented Sausage Classification and Categories

Rust, (1979) detailed that sausage is a cylinder-shaped meat product usually prepared from minced meat, regularly pork, beef, or veal, diversified with salt, spices, additives, and bread crumbs, sheathed by a skin. Generally, a sausage is shaped in an exterior conventionally prepared from the intestine, however sometimes prepared from artificial ingredients. Sausages that retailed raw are cooked in various ways comprising pan-frying, steaming, and roasting (Pearson and Gillette 1999; Acton and Dick 1975, 1976).

15.7.1 *Categories of Fermented Sausage*

Fermented sausages are a set of minced meat produced by microbial fermentation and have been subjected to drying/aging practice to eliminate 15–25% humidity. They are related to moisture amount dry or semi-dry and summer sausage Stanley and Adam (2012)). The same author mentioned that fermented sausages are produced from lean meat from pork and beef and mixed with fat, spices, salt, sugar, sodium nitrite (sometimes nitrate), and a starter culture. The combination is stuffed into natural or synthetic casings and expose to a fermentation procedure.

15.7.1.1 Dry Sausage

Dry sausage is an old-style dominant South African meat commodity the majority recognized is dry sausages. It contains a pH of 5.0–5.3, lactic acid 0.5–1.0% and an MPR of <2.3:1. The moisture loss is around 25–50%, and the final moisture percent is <35% water activity (aw) range between <0.85 to 0.91. The manufacture of ultra-marine of dried or semi-dried sausage regularly includes a fermentation process (Charles et al. 1970). The same writer recounted that the preparation of dried sausage in South Africa, preliminary safeguarding to amount acquired by resources of the remedial constituents (about 0,8f sodium chloride in addition to seasonings such as coriander and cloves).

15.7.1.2 Semidry Sausages

Semidry sausages are stiffer than fresh sausage, excluding not hard in material as a dry sausage. The *aw* approximately 0.90 and 0.95 (Demeyer et al. 2000). The American type dry sausages enclose 25–40% moisture, are greatly spiced, are not heated above 26.7°C, have a dense texture, and are frequently shelf-stable (Ricke and Keeton 1997).

15.7.2 The Requirement of Fermented Sausage

According to the Sudanese Standard for fermented sausage, a significant proportion of meat should not be less than 55% of the total mixed weight before cooking. The quantity of added fat should not exceed 25% of the total mix weight. The proportion of filler, extender, or binder individually or mixed should not exceed 10% of the total mix weight. The amount of ice or water added should not exceed 10% of the whole mix before cooking. The products should be cooled to the core temperature of (–1)°C to less than (5)°C or should be frozen at (–30)° to (–40)°C to a core temperature of (–18)°C (SDS 2017).

15.8 Factors that Affect the Sensory and Physicochemical Characteristics of Fermented Sausage

The organoleptic features of foodstuff, such as color, and flavour, are critical for consumer acceptance of fermented sausage (Lisa et al., 2016). Meat can also exhibit desirable and undesirable characteristics that can discourage or encourage fermentation.

15.8.1 Nature of Raw Meat

The fermented sausage must be of excellent quality with a negligible bacterial load. The required color of lean and fat is imperative, and the yellow fat is unpleasant while strong red lean desirable. The pH of raw tissue is also vital in the initial stage, and low pH is necessary (Campbell-Platt and Cook 1995).

15.8.2 Type of Food Additive

Clients and manufacturers are worried about synthetic food additives in particular foodstuffs to disguise or expand sensory features (Pokorný 1991a). The same author mentioned natural antioxidant, like rosemary, has some detriments like their impact in a sensual quality instant: color, after-taste or off-flavors. Though, the use of additives in fermented sausages can advance sensory appearances. Customers generally believed on fresh (fermented) sausages prepared of sheep and goat meat, with an average of 6 on a scale of 10. No noticeable favorites detected for sheep, goat, or flavor, used to cover some offensive appearances as the palate, odor, and taste (Leite et al. 2015).

15.8.3 Storage Interval and Temperature

According to many authors, Baker et al. (1972^b); Beckert (2002) Osman et al. 2020 and Pham et al. 2013), the storing temperature is a standpoint for meat and meat foodstuffs production. The chilling storage expressively decreased scores of color in the semi-dry fermented sausages (Ahmad and Amer 2013). Hussein et al. (2017) reported that the flavor scores lessened significantly in all tasters of semi-dry fermented sausage inoculated with *L. casei* (range 6.83–5.63) during storage for 45 days at icy temperature. Osman (2017) suggest that despite food stored according to principle (first in -first out), it will lose the color, texture, flavor, and nutritional quality and become a substandard product.

15.8.4 Type of Culture

Gilliland (1985) submits that the necessities for meat starter culture: non-pathogenic, phage-resistant, free from any microbial or chemical residues that may cause healthiness risk or limit manufacturing, salt-tolerant, and matures fast in a 6% brine, grows well in the presence of 80–100 ppm nitrite, has a growth temperature range from (80 to 109 °F), produces lactic acid from dextrose. A worthy starter culture must also be non-proteolytic. Probiotics are microorganisms mostly related to the strains Bifidobacterium and Lactobacillus ssp., used for human and animal feeding to improve their healthiness (Hempel et al. 2012). The distinctive flavor of fermented sausages mainly creates from the itemization of carbohydrates, lipids, and proteins by microbial and meat enzymes (Ahmad et al. 2012). The starter cultures guarantee food safety and supercilious quality characteristics such as sensorial, nutritive, and technical features. The use of dissimilar starter cultures in the manufacturing of goat meat fermented sausages formed an average value range between

5.5 and 5.9 for comprehensive sensory adequacy, using a 9 points hedonic scale (El-Adab et al. 2014).

15.8.5 Effect of Spices

Flavorings used in fermented sausage for many purposes instant: taste, an antioxidant, improving the progress of lactic bacteria. They can result in a faster rate of lactic acid production and also influence the concluding pH. Particular spices reported having an interesting consequence on fermentation like pepper, mustard, garlic, allspice, nutmeg, ginger, mace, cinnamon (Zaika et al. 1978).

15.8.6 Influence of pH Drop

Dry fermented sausages include two groups with dissimilar acidity, specifically northern-type and southern-type products (Ravyts et al. 2012). The pH in the northern-type drops below 5.0 throughout fermentation and remains more or fewer at that level during ripening. On the other hand, the pH in the southern-type drops only 4.69 moderately during fermentation and increases during the drying phase, resulting in a final pH of 70 between 5.5 and 6.0 (Demeyer et al. 2000). The rate and extent of pH decline influence both sausage texture and gel formation. Saltsolubilizes muscle proteins during comminuting, which later denature due to lower pH (5.3 with 3% salt, (Solignat and Durand 1999). The release of moisture causes coagulation and forms a gel around fat and meat particles. The proteolysis is releasing enzymes from microbial origin. This procedure is of elementary significance since it affects dry fermented sausage taste. The resultant miniature peptides and amino acids, also considered as substrates for microorganisms that renovate them into taste compounds.

15.8.7 Influence of Smoking

Smoking is an old-style usage of Northern-type fermented sausages (Sikorski and Sinkiewicz 2015). It is advantageous to various sorts of semi-dry sausages throughout the dehydrating stage to increase a required smoky taste to delay lipid oxidation and improve color (Price and Schweigret 1987). There is significant progress in the color of the fermented sausage once it is smoked. The interaction among carbonyls and amino groups is comparable to the Maillard reaction and is improved due to the deposit of these compounds on the surface and diffuses inward cause a dark red color (Tóth and Potthast 1984).

15.8.8 Rancidity Development

Approximately 36–40% of the total calories in the food supply originated from fat, half of which is from meat intake. The unsaturated fatty acids are entirely involved in oxidative deviations in the fat of fermented sausages. Hydrogen peroxide and hydrogen sulfide can cause off-color and taste problems (Sheard et al. 1998; Ruiz et al. 2012). Proteolysis and lipolysis usually improve flavor. The same author suggests a particular inherent such as nature of fat in the diet, others extrinsic instant light, temperature, impairment to muscle structures caused by freezing temperatures, and grinding. Judge et al. (1989) mentioned that polyunsaturated fatty acids are significantly predisposed to out-oxidation than monounsaturated or saturated fatty acids due to high moisture. The elimination of fermented sausage fat affects the sensual and technical appearances since fats donate intensely to flavor, texture, and overall acceptance. (Kamal Eldin 2010). Integrating hydrophobic oils can be demanding as meat comprises 75% water and is hydrophilic. Likewise, increasing the content of unsaturated fatty acids increases the potential of lipid oxidation, which shortens the shelf-life. The progress of oxidative rancidity in meat is pretentious by several features (Enser 1974; Morrissey et al. 1998).

15.8.9 Salt Content

WHO (2016) stated that salt provides many functions in fermented sausages, instant: taste, texture, microbiological safety, and overall acceptability. Sodium chloride is an additive that will permit lactic acid bacteria to cultivate and will constrain several undesirable microbes. Fermented sausages comprehend a high salt amount, which subsidizes the bacteriological safety and shelf-life by making water inaccessible for microbes. Also, it influences the industrial quality of the sausages by enabling the proteins to expand the texture and raise the viscosity. Furthermore, potassium ions can afford an improved flavor. No deviations in organoleptic physiognomies of fermented sausages noticed after KCl replacements intended for NaCl were lesser than 40%. An insignificant lessening in the aroma detected when adjudicated the sausage control by 2.7% NaCl (Gelabert et al. 2003; Corral et al. 2013).

15.8.10 Drip Loss and Moisture Defeat

The sensual qualities of fermented sausages depend on the degree of dehydrating of the product. A significant factor after drying sausage is that the amount of moisture loss from the superficial of the product must be equivalent to the rate at which moisture transfers from the sausage's inner (Ambrosaidis et al. 1994). The same author reported that speedy drying is only likely when the pH is low, and the respectively

low solubility of proteins permits moisture downfall. The drying of sausages is occurring at low temperatures, usually less than 20°C. Drip loss is a critical influence in meat production, at customers' desire for meat tenderness of drip loss favored in many countries. Barringer et al. (1995) and Alizadeh et al. (2007) re-counted that drip loss is a distinct concern in the packed meat for reducing temperature instability. Meat with high drip loss, because of the release of water, might be stiff and declined juicy and, subsequently, none putative by clients.

15.8.11 Effect of Packaging Materials

Modified atmosphere packaging (MAP) is a very substantial and efficient conservation procedure practiced for prolonging the shelf life of food, particularly for fresh or emporium manufactured foods. The MAP extends the shelf-life of meat products by 50–400%, specifically at chill temperatures (Action et al. 2000). Smolander et al. (2004) mentioned that MAP beef steaks were favored by customers in as much as of their increased tenderness and juiciness in comparison with steaks packaged in traditional tray packaging. Jeremiah et al. (1992). The expenditure of meat package in the atmosphere has <0.5% CO merely consequences in an insignificant quantity of carboxyhemoglobin incoming into the bloodstream, and it is unlikely that the CO will cause a toxic hazard to customers (Vainionpää et al. 2004).

15.9 Factor Affecting the Safety of Fermented Sausages

According to Redman, (2007), food-borne contamination and poisoning are grave problems for human healthiness. Osman et al. (2007) stated that The HACCP system ranks hazards into three domains: biological, chemical, and physical hazards. In the past, fermented sausages were considered non-hazardous foods. The consumption of fermented sausages nowadays may show health threats due to the high contents of saturated fats and NaCl, nitrite, and degradation products such as nitrosamines, toxic compounds as a by-product of smoking instant: polycyclic aromatic hydrocarbons in the products (Lucke 1998).

15.9.1 Potential of Physical Hazards

A physical hazard defined as material not frequently originated in a portion of food creates sickness or injury to an individual consuming the product. It caused risk for a limited number of consumers (Osman et al. 2007). Instances of familiar physical dangers: bones and plastics packaging materials (Osman 2017). The same author mentioned that it appears from various points of supply polluted raw materials,

beneath par designed or maintained facilities and equipment and imperfect procedures during processing, and unfitting employee training and manner.

15.9.2 Potential of Chemical Hazards

Chemical hazards may also induce foodborne illnesses, despite the fact generally affecting minority people. Chemical hazards can originate from four general sources: Accidentally added chemicals like Agriculture chemicals (pesticides, herbicides, animal drugs, fertilizers). Environmental contaminants (lead, cadmium, mercury, and arsenic). Naturally-occurring chemical hazards products of plant, animal, or microbial metabolisms such as aflatoxins. Intentionally added chemicals such as preservatives and food additives (Osman 2017).

15.9.2.1 Nitrates and Nitrites

According to the International Agency for Research on Cancer (IARC) nitrates and nitrites are doubtless carcinogenic to humans in some circumstances conditions approving nitrosation where an NO group is covalently bound to carbon, sulfur, oxygen, or nitrogen atoms in a carbon-based molecule. Throughout curing in an acidic atmosphere, disassociated nitrous acid picks up a hydrogen ion and splits off a water molecule. The consequential positively stimulating nitrosonium ion might then react with amino groups to form N-nitrosamines. Some of these N-nitrosamines are carcinogenic (Andree et al. 2010).

15.9.2.2 Hydrocarbons Compounds

A number of hydrocarbons formed in smoke process are hazardous to human health, particularly, the polycyclic aromatic hydrocarbons (PAHs). These hydrophobic compounds include two or further bonded aromatic rings, primarily of hydrogen and carbon atoms. Complexes with four or more rings are less volatile and adsorb on soot and other incineration particles (Singh et al. 2016).

15.9.3 Biological Hazards

Reviews have revealed bacteriological Hazards related to fermented sausages include: *Escherichia coli*, *Salmonella Typhimurium*, *Staphylococcus aureus*, and *L. monocytogenes* in dry fermented sausages (Pierre 2015).

15.9.3.1 Resistant Bacteria

The increasing resistance to antibiotics in bacteria dowries grave anxiety to human and animal health and presents economic and communal charges. Antibiotic resistance (AR) in food microbes is of worry since they may act as reservoirs for AR genes. This rise may indicate the misapplication of antibiotics in animal farming for years, foremost to the great puddle of AR genes existing in the bacterial populace, dispersal likewise to bacteria in the food sequence (Fraqueza 2015).

15.9.3.2 Biogenic Amines (BAs)

High levels of biogenic amines (BAs) may occur in fermented meat products (EFSA 2011). The contented of BA in the food is a signal of spoilage or hygiene malpractice in the management of the uncooked material (Latorre-Moratalla et al. 2012). According to the same author the utmost importance (BAs) existing in fermented sausages of food safety apprehension are tyramine, phenylethylamine, and histamine, with tyramine regularly being the greatest plentiful.

15.9.3.3 Histamine Producers

Histamine inducers are uncommon amongst sausage LAB and histamine, once at hand in sausage, may be formed by essentially toxin enterobacteria (Molenaar et al. 1993). On the other hand, definite strains for instant, *L. buchneri* and *L. parabuchneri* harbor the histidine decarboxylase enzyme and are considered spoilage organisms in cheese (Wuthrich et al. 2017).

15.10 Conclusion

Food quality means that all the requirements set and concerned with the characteristics and recipes of food have been fulfilled (related to taste, smell, appearance, nutritional value and microbial load), while food safety means that all the requirements that are set and concerned with food safety have been met and that the causes of food pollution (physical, chemical or microbiological) has been excluded or controlled. Many factors can influence quality and safety of fermented sausages. However, if these factors are monitored this will enhance consumption of these products and make benefits of their high nutritive value.

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