Chapter 8
Lactic Acid Bacteria and Fermented Meat Products

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8.1 Introduction

8.1.1 The Types of Fermented Meat Products

Fermented meat products are a kind of meat products with special flavor, color, texture, nutrition, and prolonged shelf life, which are produced from livestock or poultry meat with a series of natural or artificially controlled processing methods (such as curing, fermentation, drying, or smoking). Fermented meat products are an important branch of traditional Chinese meat products. They have a long history of production and consumption. Due to their unique flavor and rich nutrition, they are deeply loved by consumers. The types of fermented meat products mainly include fermented sausage, fermented ham, cured products and smoked meat, etc.

At present, there has been no inherent standard for the classification of fermented meat products, and different countries and regions have different standards. Fermented meat products in China mainly refer to fermented sausages and fermented hams, while foreign ones are mainly filled meat products (sausages), such as Lebanese big sausages, Cervelat sausages, and salami sausages.

According to the degree of fermentation, meat products can be classified into low-acid fermented meat products and high-acid fermented meat products. Low-acid fermented meat products refer to the fermented meat products with a pH of >5.5, such as Spanish ham, salami sausage, and other dry fermented sausages, which are produced by curing, fermentation, drying, etc. at a low temperature of 0–25 °C. High-acid fermented meat products refer to the products with a pH of <5.5, of which the production generally needs the addition of starters and fermentation at >25 °C.

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W. Chen (ed.), *Lactic Acid Bacteria*,
https://doi.org/10.1007/978-981-13-7283-4_8

8.1.2 Lactic Acid Bacteria Commonly Used in Fermented Meat Products

In 1919, Cesari discovered the presence of yeast in naturally fermented meat products and began the study of microorganisms in fermented meat products. In 1955, Niven et al. isolated *Pediococcus acidilactici* from fermented meat products and successfully applied it to Summer sausages. In modern technology, commercial starters are generally added to ensure product stability. In the production of traditional fermented meat products, the bacteria from the environment compete with the microorganisms in the raw materials for growth, completing the fermentation process. Lactic acid bacteria become the main microflora in the later stage of fermentation. Different kinds of microorganisms produce various substances in the fermentation process. These by-products react to form unique flavors and nutrients. To some extent, the sensory properties of fermented meat products can be considered to be determined by fermenting microorganisms (Cocolin et al. 2011).

The microorganisms in the fermented meat product mainly include bacteria, molds, yeasts, and so on. In general, lactic acid bacteria are an important class of microbial species required for production and play a leading role in the fermentation stage. In addition, *Micrococcus* and *Staphylococcus* in *Micrococcus* family, although not belonging to the lactic acid bacteria, have a strong ability to decompose nitrous acid and have an important influence on the color formation of the fermented meat product. Yeast is generally resistant to high salt and has a strong fermentation capacity and grows on the surface of fermented meat. In the fermentation production of meat products, yeast is rarely used alone, and most of them are combined with lactic acid bacteria, microspheres, and the like to complete the fermentation. Some of the commonly used strains in fermented meat products are shown in Table 8.1.

Table 8.1 Commonly used strains in fermented meat products

Genus	Name
Lactobacillus	*Lactobacillus plantarum*
	Lactobacillus sakei
	Lactobacillus casei
	Lactobacillus curvatus
Mold	*Penicillium chrysogenum*
	Penicillium nalgiovense
Pediococcus	*Pediococcus lactis*
	Pediococcus pentosaceus
Streptococcus	*Streptococcus thermophilus*
	Streptococcus lactis
	Streptococcus diacetilactis
Yeast	*Debaryomyces hansenii*
	Candida famata
Micrococci	*Staphylococcus xylosus*
	Staphylococcus carnosus

8.1.3 The Nutritional Value and Functional Properties of Fermented Meat Products

Fermentation of raw meat has a long history and has formed distinctive products based on regional climatic conditions and consumer preferences. Typical representatives of fermented meat products in China are fermented sausages and fermented ham. In a broad sense, some salted products (such as sausage, bacon, and sour meat) also belong to fermented meat products. Fermented meat products undergo a series of biochemical reactions during fermentation. Some properties of the raw meat are changed. For example, the decomposition of protein will make the fermented meat more nutritious than the raw meat (Steinkraus 1994), because proteins are degraded into amino acids and peptides by the enzymes during the fermentation process, improving the digestibility of the product and increasing the nutritional value of the product (Guo et al. 2009). Some characteristics of fermented meat products have the following aspects.

1. Beautiful color

Color is an index to evaluate the quality of meat products. Chromogenic agents (such as nitrite) are often used in the processing to improve the color of meat products, but residual nitrite is carcinogenic. Studies have shown that lactic acid produced by lactic acid bacteria can low the pH of meat products in the fermentation process, resulting in the production of free nitrite, which is decomposed into NO. NO combines with myoglobin in meat to form nitroso-myoglobin, which remains stable under thermal conditions, giving the product a bright red color. The contaminated bacteria in the meat will produce hydrogen peroxide, which can form biliary myoglobin with myoglobin, making the meat green.

2. Unique flavor

On the one hand, organic acids such as lactic acid, acetic acid, and propionic acid produced by *lactic acid bacteria* during the fermentation process give food a mild acidity and form flavor substances, giving fermented meat products a unique flavor, by interacting with other fermented substances (such as alcohols, ketones, aldehydes, etc.). On the other hand, lactic acid Fe can also eliminate some peculiar smell in raw materials.

3. High nutritional value

The proteins in meat are decomposed to peptides and amino acids by protease from the metabolism of lactic acid bacteria, which greatly increases the digestibility of fermented meat (Steinkraus 1994). And some essential amino acids, vitamins, and bifidoxin in the process of fermentation can be produced, which further enhance the nutritional value of the product.

4. Long shelf life

Lactic acid bacteria produce a large amount of acids in the fermentation process, making the pH lowered. Under these conditions, some spoilage microorganisms cannot grow and reproduce, so that the shelf life of the products has been greatly improved. Other lactic acid bacteria may produce bacteriocin, which can also effectively inhibit the growth of spoilage bacteria and pathogenic bacteria in meat.

8.2 Fermented Sausage

Fermented sausages are prepared under natural or manual conditions. Fresh raw meat is chopped, then added with accessories (such as spices), mixed evenly, and then poured into the casings, which are then fermented and air-dried at a low temperature for a long period. Fermented sausages, with good preservation, typical fermentation flavor, beautiful color, and unique flavor, are the largest category of fermented meat products in China. The types of fermented sausages are complex. According to the shape of stuffing, they are divided into coarse sausages and finely twisted sausages. They are divided into semidry fermented sausages and dried fermented sausages based on the moisture content of the products. The water content of the former is 40–45%, while one of the latter is 25–40%. According to the degree of fermentation, they are divided into low-acid fermented sausages and high-acid fermented sausages. Low-acid fermented sausages refer to sausage products with pH >5.5 and prepared at 0–25 °C, such as Salami sausages in France, Italy, and Hungary. High-acid fermented sausages refer to fermented sausages with pH <5.5, most of which are prepared by inoculating an external starter. The final water content and water activity of some fermented sausages are shown in Table 8.2.

8.2.1 *Microecology of Fermented Sausages*

The microecosystem of traditional fermented sausages is complex, mainly including bacteria, yeast, and mold. Among them, bacteria mainly refer to lactic acid bacteria. The number of LAB in chilled fresh meat is relatively small. LAB gradually

Table 8.2 Water content and water activity of fermented sausage

Name	Processing cycle	Moisture content	Water activity	Typical products
Smear type	3–5 days	34–42%	0.95–0.96	Germany
				Teewurst frisch, Mettwurst
Sliced type (short-term fermentation)	1–4 weeks	30–40%	0.92–0.94	America Summer sausage
				Germany Thuringer
Sliced type (long-term fermentation)	12–14 weeks	20–30%	0.82–0.86	Salami of Germany, Denmark, Hungary
				Genoa in Italy
				The French Saucisson

become dominant bacteria with fermentation. This is because the low oxygen content and low pH in meat stuffing are not conducive to the growth of some enterobacterium in raw meat but beneficial for the growth and reproduction of LAB, *Staphylococcus* and *Micrococcus*. The LAB in traditional fermented sausages mainly include *Lactobacillus sake*, *Lactobacillus campylobacter* and *Lactobacillus plantarum*, etc., as well as some *Streptococcus enterococcus*, *Staphylococcus*, and *Kocuria* (Fontana et al. 2016).

8.2.1.1 Diversity of Yeasts and Molds in Fermented Sausages

The flavor of some fermented sausages in Southern Europe is affected by yeast and mold. Yeast plays an irreplaceable role in the process of sausage fermentation, which can inhibit rancidity by utilizing residual oxygen in minced meat. Hydrogen peroxide produced by yeast fermentation can prevent oxidative discoloration of meat. Yeast can also decompose fat and protein in meat and produce flavor substances (Li and Meng 2010). *Debaryomyces hansenii* is a kind of common yeast, which is salt-tolerant and gas-tolerant and can grow on the surface of sausage.

Mold is a fungus commonly used in dry fermented sausages. Most of these molds belong to the genus *Penicillium* and *Scopulariopsis*. The two common fungi are *Penicillium flavus* and *Penicillium natripenicillium*. They grow on the surface of sausages and form a film on the epidermis that prevents oxygen from entering and prevents rancidity. In addition, the aroma of fermented sausage is partly dependent on the production of aromatic substances by lipase and protease secreted by molds that degrade fats and proteins. However, it should be noted that many molds have the ability to produce toxins, so the molds used in meat products must be strictly screened (Talon and Leroy 2011).

8.2.1.2 Diversity of Bacteria in Fermented Sausages

The main bacteria in fermented sausages are *Lactobacillus*, *Streptococcus*, *Micrococcus*, and *Staphylococcus*. *Lactobacillus* in fermented sausages include *Lactobacillus plantarum*, *Lactobacillus campylobacter*, and *Lactobacillus sake*. The genus *Planococcus* mainly includes *Pediococcus pentosaceus*, *Pediococcus bacillus*, *Pediococcus lactici*, and so on. *Micrococcus* mainly includes *Micrococcus* and *Staphylococcus* (Nan 2008). *Staphylococci* commonly found in fermented sausages include *Staphylococcus carinii*, *Staphylococcus xylose*, *Staphylococcus amber*, and *Staphylococcus equi*. *Staphylococcus carnosus* is the key bacteria for flavor formation of fermented sausage. *Staphylococcus xylosus* does not exist throughout the fermentation period. *Staphylococcus succinus* and *Staphylococcus equorum* play important roles in the maturation process (Simonová et al. 2006). In fermented sausages, there are also a small amount of *Leuconostoc* (such as

Leuconostoc gelidum), *Weiss* (such as *Weissella viridescens*), and *Enterococcus* (such as *Enterococcus faecium* and *Enterococcus faecalis*). Rare lactobacillus such as *Lactobacillus brevis* and *Lactobacillus rhamnosus* were isolated from fermented sausages (Rebucci et al. 2007; Chen et al. 2015). Lactic acid bacteria mainly form acidic environment, which can inhibit the growth of pathogenic bacteria and spoilage bacteria and accelerate the formation of color and luster. The main function of cocci is to form bright color, remove excess nitrate, and form fragrance and special flavor. Lactic acid bacteria ensure product stability, while coccus determines the product color and flavor. Some studies have shown that *Staphylococcus aureus* can improve the color and aroma characteristics of the product (Stahnke et al. 2002).

8.2.2 Lactic Acid Bacteria (LAB) in Fermented Sausages

The content of LAB in raw meat was relatively low, which is 10^2–10^4 cfu/g. They grow rapidly in the fermentation process and soon become the dominant strain of fermentation in the environment of anoxic and high-salt cured meat. LAB in fermented sausages mainly include *Lactobacillus sake*, *Lactobacillus campylobacter*, and *Lactobacillus plantarum* (Urso et al. 2006). Generally, LAB selected for sausage fermentation are homofermentative LAB, which ferment the carbohydrates in meat stuffing to produce lactic acid, while heterofermentative LAB produce lactic acid, acetic acid, carbon dioxide, and peroxide. These metabolites have side effects on the color and flavor formation of sausage. *Lactobacillus sake* is the dominant LAB in fermented sausages, because of its special metabolic system, the arginine deiminase pathway (ADI), which has strong competitiveness and adaptability (Ravyts et al. 2012). *Flaccoccus* is a facultative anaerobic LAB, which can ferment glucose to produce L-lactic acid and D-lactic acid by the Embden-Meyerhof-Parnas pathway (EMP). *Lactococcus* lactic acid and *Streptococcus* pentose are commonly used.

8.2.3 The Role of LAB in Sausage Fermentation

LAB play two main roles in sausage fermentation: one is favorable to the formation of flavor substances and the other is conducive to reducing the acidity of meat products and prolonging the shelf life. LAB can produce large amounts of lactic acid in fermented sausages. Meat proteins and fats are more likely to undergo a series of physical, chemical, and biological reactions under acidic conditions, increasing the content of free amino acids and fatty acids while improving the digestibility of protein.

8.2.3.1 Fermentation

8.2.3.1.1 Reduce the Content of Nitrosamine

In the processing of meat products, the added nitrite interacts with the dimethylamine in raw meat to produce dimethyl nitrosamine, which is carcinogenic. LAB produce a variety of organic acids by fermentation to form a low-acid environment, which makes nitrite reduction and reduces the formation of dimethylnitrosamine, improving the safety of fermented sausages and being beneficial to health.

8.2.3.1.2 Increase Nutritional Value

During fermentation, LAB metabolize to produce different hydrolytic enzymes, which degrade the proteins, fats, and other macromolecules in muscle into small molecular substances (such as amino acids, peptides, etc.) and improve the digestibility and absorptivity of the products. In addition, proteins in muscle gradually produce colloids in acidic environment, promote meat elasticity, and improve meat structure.

8.2.3.2 Physiologic Function

8.2.3.2.1 Improve the Color and Flavor of the Product

In the meat processing and manufacturing, chromogenic reagent, such as nitrate and nitrite, is often added in order to make meat products rose red and increase consumers' desire to buy, chromophore. Fermentation by LAB can not only give bright color to meat products but also reduce the formation of dimethylnitrosamine. LAB can produce organic acids by fermenting carbohydrates, such as propionic acid and acetic acid. The organic acids interact with ketones and alcohols produced in fermentation process and produce various flavor substances which improve the flavor of fermented sausages. In addition, organic acids improve the sensory evaluation of the product, of which the sour taste is soft and not pungent (Xiong et al. 2013).

8.2.3.2.2 Reduce Cholesterol and Delay Senility

The probiotic LAB in fermented sausages can reduce cholesterol levels and prevent heart disease and atherosclerosis to some extent after entering the digestive tract (Schiffrin et al. 1995). LAB can produce a superoxide dismutase that removes excess free radicals from the body and delays senility.

8.2.4 Processing Technology and Characteristics of Fermented Sausage

The production of fermented sausages originated in the Mediterranean. The Romans began to prepare fermented sausages using ground meat more than 2000 years ago. Through development of 2000 years, the production process of fermented sausage is gradually mature. The process methods are similar in different regions, and the process is similar. Selection of raw meat → Mince and mix → Filling → Fermentation → Dry and ripening → Inspection and packaging → Finished product. Traditional fermented sausages are mainly matured by natural fermentation. Drying is accomplished by natural weather. Due to the uncontrollable factors of fermenting seeds and weather during the fermentation process, fermented sausages vary in quality. With the development of modern meat processing technology and the comprehensive study of fermentation microorganisms, some European countries have developed non-dry sausages that are fermented but do not need to be ripe (Wang 2006).

8.2.4.1 Pretreatment of Filling

Pig, beef, and mutton are generally chosen to make fermented sausages. The best choice is a site with more muscle and less connective tissue (such as rump or leg meat). The back fat is chosen as the auxiliary adipose tissue. Lean meat and adipose tissue are cut separately. The process of meat grinding is that lean meat is twisted into relatively large particles at 4 °C and the fat part is cut up at 8 °C. After the meat is minced, they are mixed in a certain proportion according to the processing requirements. Salt, sugar, cooking wine, and spices are added, and the mixture is chopped at low temperature. A small amount of nitrates and sodium ascorbate are added to industrial products. Chopping directly determines the quality of fermented sausage. On the one hand, chopping can make salt and other spices evenly distributed in meat fillings; on the other hand, it can also exclude part of oxygen.

8.2.4.2 Filling

Filling refers to stuffing mixed ground meat into the prepared natural or artificial casing. The casing can affect the maturity and quality of the sausage. The temperature of meat filling should be less than 2 °C.

8.2.4.3 Fermentation

Fermentation refers to the stage in which under natural or artificial conditions, LAB in sausage grow and metabolize vigorously with rapid drop in pH and the formation of sausage flavor and color under the action of other microorganisms. In traditional processing, sausage fermentation is mainly completed by LAB naturally existing in raw meat. Although the content of LAB in raw meat is not high, it will reach a high level after 2–5 days under normal circumstances. However, if the fermentation of LAB is delayed and the pH decreases slowly, *Staphylococcus aureus* will grow in large amounts and produce enterotoxin as well as other miscellaneous bacteria, which will lead to worse flavor of sausage (Li and Meng 2010). Because of the uncontrollability of traditional fermentation methods, starter cultures are gradually used to control the fermentation process in modern processing technology. Commercially available starter cultures generally conclude LAB, *Micrococcus*, and mold.

8.2.4.4 Drying and Maturation

Drying is the process wherein water in fermented sausages evaporates under natural or artificial conditions. Traditional drying methods generally use natural environmental conditions for drying, such as air-drying, sun drying, or shade drying. So it is also called natural drying. In modern production, artificial technology is often used to adjust the temperature and humidity of the drying chamber to effectively dry fermented sausages. The final moisture content of different types of fermented sausage products varies greatly. The final characteristics and flavor of fermented sausage products largely depend on the changes of its properties during drying period. All fermented sausages need to control the rate of dehydration during the drying stage, so that the rate of water transfer from the inside of the sausages to the surface is equal to the rate of water loss from the surface, thus ensuring that the fermented sausages are stable and dry and the surface will not form dry skin (Xu 2011). The changes in chemical properties of fermented sausages during drying and molds or yeasts growing on the surface even go on to the consumption stage and are all a process of continuous maturation. The maturation of fermented sausages affects the final sensory properties of the product, especially flavor and aroma.

In recent years, some domestic and foreign scholars began to study the effects of enzymes on fermentation and maturation of fermented meat products. These enzymes are mainly lipases derived from microorganisms. Fat degradation in fermented sausage is the main source of its special flavor. Lipase secreted by fermentation microorganisms plays an important role in the production of fatty acids through lipase hydrolysis and lowering pH. Adding extraneous enzymes can shorten the fermentation time and reduce production cost. Endogenous lipase in meat also has the effect of degrading fat (Hierro et al. 1997). It has been reported that adding exogenous fat enzymes can promote the formation of flavor substances in the fermentation of sausages, but it does not shorten the fermentation time (Zalacain et al. 1997; Liu et al. 2014). Studies have found that compared with the control group, the sensory characteristics of fermented sausages with exogenous streptomycin protease or papain have no obvious difference, and some proteases could improve the sensory characteristics of sausages (Diaz et al. 1997; Benito et al. 2004).

8.3 Fermented Ham

8.3.1 Types of Fermented Ham

The fermented ham is divided into traditional dry-cured ham and Western ham. The traditional dry-cured ham is made from the pork's fresh hind or front legs (with skin, bone, and claw), belonging to a kind of fermented meat product that is dry-cured at low temperature (0–4 °C) and dried, fermented, and matured at higher temperature (15–20 °C). The production technology of fermented ham in most countries and regions of the world is similar. The representative of dry-cured ham in China are Xuanwei ham in Yunnan, Xianning ham, Jinhua ham in Zhejiang, Enshi ham and Rugao ham in Jiangsu, and so on. Western fermented ham is also divided into boned ham and boneless ham. Typical representatives are country-cured ham in the United States, Iberian ham in Spain, Westphalian ham in Germany, and Parma ham in Italy. Parma ham is especially famous among Western hams.

8.3.2 The Microecology of Fermented Ham

Traditional fermented ham has a long history in China. Due to the differences in climatic conditions, raw meat and processing techniques and the number and species of microorganisms in different hams are obviously different. The microorganisms in different kinds of ham produced by different factories in the same area are also different. Even if the same type of ham is produced by the same factory, the microbial species and quantity will change greatly at different stages of production. The microorganisms in traditional fermented ham mainly depend on the extraneous bacteria existing in the natural environment. The extraneous bacteria compete with the microorganisms of raw meat, and the fermentation microorganisms gradually occupy the dominant position. Under natural conditions, the fermented ham is formed after a long period of fermentation. In modern production, the starter cultures with known ingredients are used to the product stable and easy to control. The main components of the starter cultures are LAB, *Staphylococcus*, yeast, and other microorganisms, which form special flavor through complex biochemical reaction during fermentation process.

The species and quantity of microorganisms in different positions of the same kind of ham in the same period are different, such as muscle tissue and ham surface. Anaerobic microorganisms easily reproduce in muscle tissue, while aerobic microorganisms easily grow on the surface of ham.

The molds in fermented ham are a kind of important microorganisms in the fermentation ecosystem, mainly distribute on the surface of the ham and the lower part of the adjacent surface. During the ripening period of ham, mold grows rapidly on the surface of meat products and forms a protective film, which endows the product with a unique appearance, due to that the temperature and humidity of the environment are suitable for the growth of mold. The protective film has the function of blocking oxygen, avoiding light, and preventing rancidity, which is conducive to the formation of the product's unique flavor. Most of the molds on the surface of ham are *Penicillium*, *Aspergillus*, and *Eurotium*. Some studies have found that the dominant mold in fermented ham at mature stage is *Eurotium*, *Penicillium*, and *Aspergillus*. The quantity and species of molds are mainly determined by the temperature and relative humidity of mature environment, but some molds are also found to be capable of producing toxins (Comi et al. 2004). For example, the predominant molds in the early stage of maturation of Iberian ham are mainly *Penicillium* and in the later stage are *Microcystis* (Núñez et al. 1996).

In the process of ham processing, *Micrococcus* bacteria is an important part. *Staphylococcus* is the dominant species, which mainly include *Staphylococcus xylose*, *Staphylococcus equinus*, *Staphylococcus saprophyticus*, and *Staphylococcus squirrel.* Ham fermentation is a process in which microorganisms of *Micrococcidae* gradually grow from the surface of ham to the muscle (Zhu 2009). At the late stage of maturation, the number of micrococci and staphylococci decreased, while the number of molds and yeasts increased. Yeast mainly distributes on or near the surface of ham. During ham processing, cleaning can reduce the amount of yeast on the surface of muscle and fat, but the number of unskinned muscle tissue increases sharply during maturation. Yeast has a strong ability to hydrolyze protein and fat and has an influence on the sensory properties of ham, especially the formation of volatile substances. The common yeasts in the fermented ham include *Debali* yeast, *Hansen* yeast, *Candida*, *Rhodotorula*, *Pichia pastoris*, etc. Simoncini et al. (2007) screened and identified 261 strains of yeast from 40 mature Italian hams, of which *Debaryomyces hansenii*, *Candida zeylanoides*, and *Debaryomyces maramus* were the dominant bacteria. The amount and species of yeast in different fermented hams were not exactly the same due to the influences of processing operation, production environment, and external factors (Gu and Lian 2007).

8.3.3 LAB in Fermented Ham

The amount of LAB in fermented ham is significantly less than that of yeasts and molds. In the production of ham, the main LAB are *Pediococcus acidilactici*, *Pediococcus pentosaceus*, *Pediococcus cerevisiae*, and *Lactobacillus*. *Pediococcus acidilactici* is the first LAB used in meat fermentation. They play an important role in the process of ham fermentation. *Pediococcus* can rapidly ferment glucose to produce lactic acid (Bartholomew and Blumer 1977).

8.3.4 The Processing Technology and Characteristics of Traditional Fermented Ham

Ham has a long history in China. Jinhua ham, Rugao ham, Xuanwei ham, etc. are famous ham products in China. Ham is mainly made from the front or back legs of pigs and is processed by curing, washing, drying, hanging, fermentation, etc. The process of making ham in different regions is slightly different, but the main operations are similar. The processing technology of traditional fermented ham mainly includes raw material selection, dressing, curing, washing, drying, shaping, hanging, fermentation, dressing and finished products, etc. Jinhua ham is briefly introduced as an example.

8.3.4.1 Raw Material Selection

Different types of ham generally choose different types of pork raw materials, such as Jinhua ham choose two black pork in Jinhua City. Raw material legs should be fresh, undamaged, full of muscles, fat and thin and white, and suitable size. They should be fully cooled, spread, or suspended for natural cooling at least. The selected pig legs are also required to meet hygienic standards.

8.3.4.2 Raw Material Dressing

Raw material dressing mainly includes removing hair, repairing bone, trimming legs surface, and removing blood stasis.

8.3.4.3 Curing

Curing is an important operation in ham processing technology. The curing process has certain requirements on ambient temperature and humidity, which is an important factor affecting product quality. If the curing period is not well controlled, the ham will deteriorate. The curing process of Jinhua ham is the key step. Although the amount and intervals of salt used are not identical, the basic principles are the same (Han 2007). Different hams differ slightly in times and duration of salting. Traditionally, the production of Jinhua ham is usually cured between the beginning of winter and the beginning of spring. The winter natural climate in Jinhua area is used to control the curing temperature. Generally, it needs to be salted about seven times, and the curing time is controlled about 35 days.

8.3.4.4 Washing and Drying

The cured ham is immersed in water, soaked, and cleaned, and the excess salt of meat and skin was removed. The ham was cleaned with bamboo brush. The water temperature is controlled at 5–10 °C and the soaking time is 4–6 h. After the main washing is finished, the ham should be re soaked in clean water for 18 h and then dried after washed for two times.

8.3.4.5 Shaping and Hanging

Shaping means that the meat is extruded to the middle with the help of tools to make the muscles bulge. After the shaping is finished, the ham is hung in pairs.

8.3.4.6 Fermentation

The ham is fermented for about 25 days. The mold begins to grow on the muscle surface. In general, the surface of normally fermented ham is mainly yellow and green, also known as “oil flower,” due to the dominant green mold. This indicates that fermentation temperature, salt content, and water content are normal. If the salt content is too high, no mold grows on the surface of the meat, which is called “salt flower” (Huang 2009).

The fermentation stage is an important period for the formation of ham flavor. It is generally required that the temperature in the early stage of fermentation should be low (15–25 °C) and in the late stage should be raised to 30–37 °C. The relative humidity in the fermentation chamber should be between 60% and 70%. During the whole fermentation period, muscle and fat tissues are degraded and oxidized under the action of enzymes, resulting in the formation of small molecular substances (such as polypeptide, amino acid, and fatty acid), thus forming the unique smell of ham (Yang and Liu 2008).

8.3.4.7 Dressing

During fermentation, the evaporation of water makes the ham muscle dry and shrink, which affects the appearance of the ham. Therefore, it is necessary to trim the ham, to flatten the bones that protrude from the meat surface, to cut off the excess fat and skin, and to trim the meat surface, so as to make it flat to the two sides of the meat surface and arc, reaching the standard shape of Jinhua ham. After dressing, which usually begins in early April, is finished, the fermentation will continue until mid-August.

8.3.4.8 Finished Products

After the fermentation, the ham muscles are dried and hard. Coating a layer of vegetable oil on the surface of the meat, on the one hand, softens the muscle and, on the other hand, prevents the fat from oxidizing. Then the ham is transferred to the product store for stacking and ripening.

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