NEW PRODUCTION TECHNOLOGIES FOR TRADITIONAL GREEK MEAT PRODUCTS

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Abstract: Going back in time, in Greece, as with other European countries, the research on preservation methods of meat had been of great importance. And that was such because preservation provided the only way for the necessary stock of meat to become available in periods of sufficient supplies. Since the appropriate chilling technology was simply not existing, there was a need to develop bacteriological stability based on the aw, pH and Eh values, as well as on thermal processing and the use of some preservatives. Resulting from this necessity, a combination of several empirically applied bacterial hurdles provided the appropriate safety and stability as well as the sensory and nutritional quality of the preserved meat products, were used. With these technologies, a quite large product variety could be produced which reflects on local habits, customs etc. The most common of them in Greece are dried fresh sausages, xidato lassithiotiko a traditional fresh sausage of Crete, a coarsely comminuted fermented salami of Lefkada, soutzoukia a fermented fresh sausage with added starch, pastirma and sun dried pastirma, kavourmas and sandirmas, singlino a cooked dry ham preserved in olive oil, apaki, which is lean pork meat deeped into acetic acid and many other products such as omathies, mathies, salted pork back fat, tsigarides ect.

Key words: traditional Greek meat products, hurdle technology

Introduction

Meat products are essential components of the human diet since the prehistorical time. They were developed through traditional or village-art methodologies, which were preserved over the years, in order to maintain the uniqueness and identity of these foods. All these technologies, during the old times, allowed the preservation of meat that could not been consumed immediately. Additionally they made it possible to use some other edible and nutritious animal parts such as organs, blood, fat and different meat pieces that were not particularly appealing. With these valuable raw materials was produced different kind of sausages, which belongs to the oldest prepared foods. It is often assumed that the Sumerians in what is Iraq today, around 3000 B.C invented sausages. The Chinese sausage Lachang, which consisted of goat and lamb meat, was first mentioned in 589 B.C. Greek poet Homer mentioned a kind of blood sausage in the Odyssey (book 20, verse 25) and Epicharmus (ca. 550 B.C. – 460 B.C.) wrote a comedy titled “The sausage” (http://en.wikipedia.org/wiki/saw-sage). Evidence suggests that sausages were already popular both among the ancient Greeks and Romans. During the reign of the Roman Emperor Nero, sausages were associated with the Lupercalia festival. The early Catholic church outlawed this festival and made eating sausages a sin. Same other incidences, which caused a reduction in the consumption of sausages, were reported early in the 10th century, when the Byzantine emperor Leo VI outlawed the production of blood sausages following cases of food poisoning. It became also a necessity from the very beginning, to find out methods to preserve better this kind of foods. The methods applied to prevent spoilage were based mainly on the inactivation of microorganisms or on the delay or prevention of their growth. In traditional foods empirical hurdles were employed and the procedures had to be inexpensive and simple but robust and reliable. Over the centuries, a treasure of knowledge of food preservation methods that fulfill these requirements has been accumulated in different regions of the world. The employed techniques acted by slowing down the growth of microorganisms rather than by inactivating them. The most common of these methods involved drying, salting and curing, fermentation, acidification, smoking, addition of natural preservatives, decreased oxygen availability, competitive flora, and decontamination. Chilling and freezing could be used for the same purpose only in the cool periods of the year. Later, a great number of the meat products were produced by techniques that act by inactivating microorganisms rather than by inhibiting them. These techniques were based on the thermal processing which kills almost all vegetative microorganisms. The major preservation technologies,

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alone or in combination with each other, secure microbial safety and stability as well as sensory and nutritional quality of these foods.

Salting is the oldest method for preserving foods (Cassens, 1994). Ancient man was well aware of the preservative action of salt, which was probably discovered by accident. Early dry salted meat products were extremely variable in quality, often being too salty and lacking in uniformity. Salt acts by dehydration and altering of the osmotic pressure so that it inhibits bacterial growth and subsequent spoilage. Only fatty cuts containing little if any lean tissue such as clear plates, fat backs, jowls or heavy bellies were suitable for dry salting. In recent years salt is generally used in combination with both sugars and nitrite or nitrate.

Drying is also a very old method for preserving meat and meat products (Praendl, 1988). It is very possible that the first type of processed food was sun-dried meat. Later, the process was carried out over a slow-burning wood fire to produce dried, smoked meat. Preservative effects of dehydration are due to reduction of water activity (a_w) to such a level that microbial growth is inhibited. The so produced meat was stable without refrigeration. Extremely lean meat is the most desired for drying. Fat is subject to oxidation and the production of off-flavors, especially if heat is used in the drying procedure. The preservative action of drying process in some products is supported by acidity developed by fermentation. Other products such as cooked semi-dry sausages are produced with a combination of heating and drying procedures.

Fermentation is another old method of food processing. Fermented foods are very popular because of their attractive flavor and their nutritional value. It is a low cost technique and can be easily carried out at the house-hold level, often in combination with simple methods such as salting, sun drying or heating (Nout 2001). The microbes that may be involved include molds, yeasts and bacteria. The desirable effect of microbial activity may be caused by its biochemical activity. Microbial enzymes breaking down carbohydrates, lipids, proteins and other food components can improve food quality and safety (Adams 2001). Carbohydrates are the most important component for a successful fermentation. The addition of salt, nitrite, as well as some extent of dehydration provides a better preservation effect to fermented meat products. The drawback of natural fermentation can be reduced when a large quantity of microorganisms that occur in the final product are added. Traditionally, a small quantity of previously fermented product is mixed into the new one to achieve dependable fermentation.

Acidulation or the addition of acid to lower the pH of a food is a historical method of preservation (Cassens, 1994). A common way to acidulate a meat product is the fermentation procedure. Direct acidification has been used to make some pickled types of meat products. Vinegar contains about 4% acetic acid and is used to make pickled pigs feet. The acid has a sour flavor and if it is used as the only preservative factor in high concentrations makes the product too sour for consumption.

Smoking is also a process, which highly contribute to meat preservation (Praendl, 1988). This method has been practiced since the beginning of recorded history. It seems probable that nomadic man first discovered the preservative action and the desirable flavor imparted to meat that was hang near his fire. Curing and smoking of meat are closely interrelated and are often practice together. The primary purpose of smoking meat is development of flavor and color, preservation, and protection of oxidation.

Heating of meat and some meat products before consumption was always done to improve palatability and appearance. It is a nearly universal event for meat and there are very few instances where fresh meat is consumed without being cooked. The additional aspect of stability and preservation of these products through cooking was also intended and this method has been consequently used for food preservation since the beginning of the 19th century. Nicholas Appert, in 1810, won a 12.000-franc prize for successfully preserving a variety of perishable food products by heat processing them in glass jars and bottles (Stumbo 1973). For many decades heat has been the most widely used agent in food preservation. At the end of the nineteenth century, the pioneering work of Pasteur, Prescott, Underwood and others, on the microbiology of heat processed foods make it possible to understand why and how heating can preserve food. Some other methods for the production of traditional meat products are the decrease of oxygen availability by covering them with oil or melted fat, the competitive flora through the mixing of an old finished products in the mass of the new one and the decontamination by processing the surface of the meat product with hot water or organic acids. Preservatives are occasionally used in excessive amounts through the addition of natural substances with an antibacterial action. The most common of these “natural preservatives” are spices, herbs and their extract. Some of them present also a good antioxidant activity.

With these technologies a quite large product variety could be produced which reflects local habits, customs etc. The most common of them in Greece are:
Traditional dried fresh sausages

Traditional sausages are well-known and very popular meat products in Greece. In the past, most rural families produced them on Christmas day using pork meat and fat. Every year in August or September the family bought their “weavers”. They were then fattened and killed the day before Christmas. Most part of this meat had to be preserved in order to cover the needs of the family till June or July. Some of this meat was used for the production of traditional sausages, which consist of minced meat and fat, mixed with salt, seasonings and nitrite and stuffed into natural casings (Papadima and Bloukas, 1999; Papadima et al, 1999).

Processing techniques

The production technology of these products was almost the same. Pork meat and fat were chopped by hand or in a mincer and thoroughly mixed with salt and seasoning, which differ from region to region. In some parts of Greece, onion, celery and leek were used to produce a special kind of fresh sausages called “prassato” (with leek). In others, such as in Mani of Peloponnesse, orange peels, red wine, oregano and cumin were the main additives of the sausages of this region. In the region of Lassithi in Crete the chopped meat was marinated in acetic acid for 24 hours, before mixing and stuffing, to provide an additional hurdle for its safety (low pH). The prepared sausage mixture was stuffed in natural casing from the cleaned small intestine of pigs and stored in cool rooms with sufficient air circulation for drying purposes. In some regions the sausages, immediately after stuffing, were put for 1-2 minutes in very hot water (85-90°C) in order to improve their preservation and external color. In other regions an olive oil was applied externally to protect them from fungi development on the surface. Sometimes, they were smoked in open fireplaces. Before starting the fire the sausages were “blazed” with a bush of burning thyme that has been collected from the mountain and dried. This hot smoking process provides in a short period of time a sufficient stable product. After drying for 1-2 weeks in the low temperature of the wintertime and having lost about 30% their initial weight, the products could be preserved without chilling. For better preservation, they were placed in big pots, and covered with melted pork fat or olive oil and stored in a cool room.

Microorganisms associated with these products

Traditional sausages were found to have a rather high population of lactic acid bacteria, pseudomonads, B. thermophacta and yeasts (Grigoriadis et al. 1988, Samelis and Metaxopoulos, 1998). The high LAB count confirms the assumption that a limited fermentation takes place during storage. In many cases the high population of LAB in traditional sausages could not inhibit the growth of pathogenic bacteria especially that of St. aureus, E.coli, Salmonella spp, Listeria spp and Sulphite reducing bacteria, which was found in 12% to 25% of the examined samples (Soutos et al, 2003). In the same study the results have shown that the higher the flavor score of traditional sausages the higher the Br.thermophacta and pseudomonads count and the better the external appearance (Ambrosiadis et al. 2004). Freshly produced sausages as well as sausages with a medium fat content (15-35%) have higher flavor intensity. Moisture content and high water activity as well as Br. thermophacta, pseudomonads and yeast count are considered as the “freshness index” for traditional sausages (Ambrosiadis et al. 2004). Most of these products are considered as perishable and have to be kept until consumption under cold storage (Leistner and Roedel 1975). Although the presence of pathogenic bacteria was rather high, there are no many food poisoning incidences associated with them since they are always consumed after thermal processing. The most important hazard is the presence of St. aureus toxins.

Hurdles involved with storage stability and safety of these products

Salt acts as one of the first hurdle against the growth of unwanted microorganisms and is also an important flavor component of the end product. Nitrite acts as another hurdle from the beginning on. For some other special products like “xidato lasithiotiko” with the acetic acid marinated lean meat the low pH value is the most important hurdle, which is incorporated to them from the very beginning of the production time. These products are often hot smoked and can be considered as very stable and safe. Spices traditionally used, have an impact on flavor and they may also have antioxidative and antimicrobial effects (Florou-Paneri et al., 2005). Drying during the cold period of the wintertime reduce the a,w-value which acts as the most important hurdle of these kind of products. In some regions other hurdles such as heat processing, acid decontamination of their surface and decreased oxygen availability through covering them with oil or melted fat contribute in a good way to their safety.

Scope for technological improvement

Equipment requirements for the production of traditional fresh sausages are relatively simply and widely available. These include a mincer, a mixer and a stuffing machine. Therefore the current research is
focused on correlating the quality (texture, color and flavor) and biochemical attributes (pH, aw, rancidity) to the safety, storage stability, and sensory properties of the product. This correlation will be applied in the establishment of guidelines for the development of a quality control program for traditional Greek sausages. Risk assessment analyses must be also conducted in order to evaluate the survival of pathogen during production and distribution. Studies on the microbiological processes involved in their production are required in order to extend storage stability and to develop new protective cultures. The use of new hurdles such as bacteriocins, sodium lactate (Brewer et al. 1991), chitosan (Darmadji and Izumimoto, 1994; Sagoo et al, 2002) and natural antibacterial substances (Koidis et al 2000) must also be studied. The self-life and stability of this product can also be extended through new packaging methods. MAP improved significant the storage stability and the external color of the product. Further studies are needed in this area.

Fermented salami of Lefkada

This is typical fermented, coarsely comminuted dry salami, produced traditionally since the end of the 19th century in the Ionian island of Lefkada. It is a indigenous fermented sausage of Greece prepared from ground pork meat, pork back fat, salt, nitrite, nitrate, sugar, seasonings and local herbs. The meat and fat are coarsely comminuted and stuffed in natural casing from the pig small intestine. It is a stable product and therefore has a mild not too sour taste and is rich in aroma. At the beginning it was produced only at the wintertime and consumed at the summer time without heat treatment (Soultos, 1990).

Processing techniques

The sausages were formulated by fresh pork meat and pork back fat in ratio 4:1. Spices and natural herb and a mixture of sugars (sucrose, fructose, lactose and dextrose) were used together with salt (2.5-2.8%), garlic, sodium nitrate, sodium nitrite and sodium ascorbate. The coarsely ground meat, the fat (cut in 6-8 mm cubes) and the other ingredients were mixed and stuffed in natural casings with a diameter of 45-50 mm. The fermentation started in a special place of the building under unstable condition. The most important factors were the low temperature and the low air humidity. Under these conditions the product loss in weight, the aw, was decreased and through the later growth of the LAB the pH value was also decreased. Because of the slow pH decrease the main factor that prevent the product from spoilage at the beginning was the low temperature of the environment. This product derives its long shelf life from a combination of hurdles, such as dehydration, acidification by LAB, added salt, and nitrate and nitrite. Through the long drying period and the high losses the product is rather expensive. Due to its low aw can have a rather high pH, which makes it much more flavorful.

Microorganisms associated with the product

The initial microbial load of the raw material greatly influences the fermentation process and the sensory quality of the final product. They were found to have at the beginning of the ripening process a rather high population of pseudomonads, coliforms and yeasts. The counts of micrococci, enterococci and LAB were at this stage of processing rather low. After 1 to 2 weeks the LAB count are increased which is important for acid production and the decrease of pH. Studies on fermented sausages of Lefkada microflora have identified lactobacilli (L. sakei, L.plantarum and L. curvatus). Micrococi-staphylococci increased at a level of 10^7 cfu/g during early fermentation. By day 7-10 LAB outnumbered Micrococccaceae, since they exceeded 10^8 cfu/g. Yeasts remained below 10^6 cfu/g during the whole process (Samelis et al 1994, Samelis et al 1998, Papamarinol et al 2003).

Hurdles involved with the storage stability and safety of the product.

The low temperature is one of the first hurdle at the early stages of the ripening process that, except other microorganisms, also inhibits the growth of the LAB. Thus the pH-value remain above 5.5 for a long period of time. This fact gives the opportunity to the most phylchetrophic bacteria (pseudomonads and other Gram-negative oxidative bacteria) to stay alive and to produce the characteristic aroma of these products, which is due to their proteolytic and lipolytic activities. These bacteria use up the oxygen, and thus decrease the redox potential (Eh) of the product. The Eh hurdle together with salt and nitrite inhibits at least these aerobic microorganisms, which can lead to the spoilage of the product and favor the selection of LAB, which metabolizing the added sugars cause a decrease in pH value and an increase of the pH hurdle. During this period of time and due to the drying process, the water activity hurdle is strengthened and is then largely responsible for these long-ripened raw sausages (Leistner, 1987a).
Scope for technological improvement
Since this sequence of hurdles was revealed, the production of this type of fermented sausage became less empirical and more advanced and the knowledge has been used to achieve the required inhibition of the most pathogenic microorganisms (L. monocytogenes, St. aureus, Cl. botulinum, Salmonella spp. EHEC) during fermentation and ripening. The introduction of pure cultures cannot only improve process efficiency, but also improve product quality and stability (Papamanoli et al 2003). These cultures have to be tailored for this special product. The localised authenticity might be preserved through the production of starter microorganisms by isolating them from the respective fermentation processes. The tailoring of starter cultures would however necessitate more precise identification of microbial strains involved in the production of Lefkada dry sausages. Molecular typing methods are applicable in the precise identification of dominant genetic groups for starter culture development.

Soutzoukia
It is a fermented dry sausage with added wheat flour produced only with beef and sheep meat and fat. The use of pig meat is strictly prohibited. It has a strong taste due to the addition of garlic, red pepper and cumin. It can be consumed in raw stage as a condiment, or is served cooked on its own, or as part of main meal. Contamination of the product with pathogenic microorganisms poses a safety risk for its consumption in the raw stage. Soutzoukia are prepared by combining a mixture of wheat flour and garlic with dry ingredients, which include ground red and black pepper, cumin, salt, sugar and sodium nitrite. The mixture thus obtained is thoroughly mixed with ground beef and sheep meat and fat and tightly stuffed in natural casings of 26-32 mm caliber. The product is allowed to ferment at ambient temperature over a 5 to 7 day period, during which it attains a final pH of 5.3 to 5.6 and an aw-value below 0.930. This product is characterized by the rapid decrease of the aw-value and the moderate decrease of pH. In many regions of Greece this product undergo a hot smoking process so that the hurdle of heating is involved to its production. An important hurdle is also the antimicrobial activity of the added natural spices.

Pastirma
Pastirma is a traditional and highly esteemed intermediate-moisture beef product of Moslem countries, widely produced also in Greece. Pastirma is storable for several months at ambient temperatures even in warm and humid climates (El-Khateib et al. 1987). It consists of 50 to 60 cm long meat strips with a thickness of 5cm. These salted and dried meat pieces are covered with an edible paste consisting of spices and water.

Processing techniques
Pastirma was produced during the cold months of the year. During this season, the air temperature is not too high and the relative humidity is moderate due to the rainfalls. The meat used for pastirma is taken from the hindquarters of beef cattle. Small scale and cottage level industries use almost all meat pieces from old cows. The meat is cut into 50 to 60 cm long strips, 15 to 20 cm wide and 5 to 6 cm thick, to facilitate the salt penetration. The strips are rubbed and covered with salt containing potassium nitrate. The salted strips are kept in piles for 6-8 days at low temperature (4-6°C). After curing the products are soaked in water dried in air for 12-14 days and then pressed with heavy weights for 12 hours to remove more water. The production of pastirma requires a few weeks. Finally, the entire surface of the meat is covered with a 3 to 5 mm thick layer of an edible paste containing 34-35% freshly ground garlic, 20% helba (Trigonella fenum graecum), 6.5% hot red pepper, 1.5% ground coriander and some other spices (e.g. cumin, mustard) and 38-40% water. The amount of used paste is about 20% of the weight of meat. The so coated meat pieces undergo a final drying process for 3-4 days. The finished product contains about 30-35% moisture, 5% salt, and its aw is 0.90-0.85 and the pH about 5.5.

Microorganisms associated with the product
Pastirma is produced by a mixed bacterial fermentation during which biochemical changes in the microenvironment promote the successive growth of microorganisms. Studies on pastirma microflora have identified Lactobacilli (LAB) (10^2-10^7 cfu/g) and micrococcaeae (10^3-10^6 cfu/g) as the predominant microorganisms. Other microorganisms identified at early phases of the fermentation include enterobacteriaceae, yeasts and molds (Katsaras et al. 1996).
Hurdles Involved with the storage stability and safety of the product.

Salting and drying i.e. by reduction of the water activity to 0.90-0.85 in the final product accomplish the microbial stability and safety of pastirma. Besides aw, at least four additional hurdles are important for the stability of pastirma and these are nitrite, pH, competitive flora and garlic (Aktaş et al. 2005). The initial count of microorganisms and the pH of the raw material are very important. Low bacterial count and pH less than 5.8 secure a successful production. An important hurdle is also the curing temperature, which must be less than 5°C. The low temperature must be maintained until sufficient salt has penetrated from the surface in all parts of the product. After the aw in the interior of the meat has decreased below 0.96, microbial growth is inhibited and the product can be further dried at ambient temperatures.

The garlic in the paste is also an important hurdle, because it inhibits salmonella inside the meat and molds on the surface even at higher humidity and temperatures. To secure that the hurdles inherent to this product can be effective, the lean meat must have low initial bacterial counts, pH bellow 5.8 and the meat cuts must be of not more than 5 cm thick in order to allow a quick penetration and equilibration of salt (Leistner 1987, 2000). Aw of the meat must be decreased quickly by addition of sufficient salt and by pressure applied to the meat. Salt content of the finished product should be 4.5-6.0 % and aw 0.90-0.85. Addition of nitrite (about 600 ppm) which after reduction to nitrite fosters inhibition of undesirable bacteria and growth of LAB up to 10^7 cfu/g is desirable as competitive flora and for pH reduction.

Scope for technological improvement

The current research for improving the production technology of pastirma is focused on the study of the microbiological processes involved in their production in order to optimise the safety, storage stability and sensory attributes of the final product. The introduction of improved equipment can also contribute to standardise and secure the production technology. Newly fabricated stainless steel pressing machines and ripening chambers with controlled humidity and temperature not only reduce the time required for salting and drying but also increase the uniformity of the quality attributes of the final product. The application of pure culture inocula of L. curvatus plus Staph. carnosus and M. varians improved the scores for internal color but taste and aroma panel scores indicated little difference between control and inoculated samples (Katsaras et al. 1996). Considering that the saltiness of pastirma plays the major role for taste and aroma evaluation it could be of interest to study the use of specific starter and protective cultures for the production of low salt products (Hammes and Hertel, 1998, Aksu and Kaya 2002).

Cavourmas

Cavourmas is a traditional cooked meat product of Northeast Greece. It is produced from pork, beef, mutton and goat meat during the cold period of the year (October-March). It consists of fried meat pieces covered with melted fat and can be preserved without chilling (Arvanitoyiannis et al, 2000).

Processing techniques

The raw meat is rich in fat and connective tissue from neck, shoulder and breast. It is cut with the bones into pieces of the size of a fist and is slowly cooked in the presence of a small quantity of water. Extra water is added if needed until the meat becomes tender. After the water is evaporated the meat begins to fry into its own melted fat in temperatures of 150-175°C. Salt (about 16-18 g/kg of fresh meat) and seasoning are added to the meat and in some cases, finely chopped onion or leek just before the water is completely evaporated. Traditionally the fried meat pieces were placed in big pots, covered with the melted fat, stored in a cool room and consumed over summer or later on, either alone or cooked with other foods. Nowadays, Cavourmas is produced in small sausage manufacturing factories, following the above-described traditional technology of heat processing. After cooking the meat is stuffed into artificial casings, with a diameter from 100 to 120 mm, and melted fat is added into the casing for filling the voids between the meat pieces. The product is vacuum packaged and cooled in chilling rooms. No further cooking is required.

Microorganisms associated with cavourmas

Because of the used production technology, cavourmas is a sterilized product. It can be considered as an F-SSP product. The heating process is sufficient to inactivate all vegetative microorganisms and some spores of bacilli and clostridia. However from the scientific view point these products look risky and therefore, their microbial stability and safety have to be guaranteed through other hurdles such as pH, aw, salt, nitrite, Eh and decontamination. The pH values of cavourmas range from 6.1 to 6.7 and these values can not guarantee self-stability and safety. Only if the aw is decreased to below 0.95 the product should be stable at
ambient temperatures (Leistner, 1992). In a recent study, Arvanitoyannis et al. (2000) found an $a_w$ of 0.88 for one sample of cavourmas only, while the $a_w$ of all other samples ranged from 0.94 to 0.96.

Hurdles involved with the storage stability and safety of the product.

Microbial stability and safety of cavourmas is mainly accomplished through the heating process. That is sufficient to inactivate all vegetative microorganisms. Through the frying process in the melted fat high temperature were able to kill the spores of bacilli and clostridia. The only problem is whether the temperature, which in most cases is not controlled, is not high enough to inactivate the spores of the above-mentioned microorganisms. Some other times the temperature of the product is decreased bellow 50°C to make the stuffing easier. Any recontamination of the processed meat at this point, make the final product very risky. In this case the addition of salt, the absence of oxygen and the reduction of the water activity bellow 0.95-0.93 are the most important additional hurdles for the stability and safety of the final product. Because of the use of PVPC casing a low Eh can be secured (Hechelmann and Leistner 1984). In the same time the added fat reduces the Eh by removing the oxygen left between the meat pieces. A reduced redox potential inhibits the growth of $a_w$-tolerant bacilli. The count of Bacillus and Clostridium spores in the raw meat batter must be as low as possible. Spice extracts instead of natural spices should be used. $a_w$ must be adjusted to below 0.95 through cooking losses, salt addition and fat proportion. The cooked mixture had to be filled in a temperature of above 110°C to avoid recontamination. The fat added into the stuffed meat for filling the voids between the meat pieces must have a high temperature in order to act as a decontamination hurdle. The pH should be adjusted below 6.0.

Scope for technological improvement

Knowing better the hurdles involved in the safety and storage stability of this product, production can became less empirical and more advanced based on the knowledge of the required inhibition factors for the most pathogenic microorganisms. The introduction of quality insurance systems (e.g. HACCP) can improve the safety of the product. The use of appropriate casings with a higher heat resistance allows the introduction of the melted fat in temperatures above 150°C in order to achieve a better decontamination or resterilisation effect. Another scope for research is to study the correlations between the quality and physicochemical attributes to the safety and storage stability of the product. These correlations can be applied in the establishment of new production techniques (e.g. aseptic stuffing), the application of new hurdles such as repasterisation after stuffing and the use of some antibacterial substances (e.g. Na-Lactat or organic acids).

Siglina

In old times, when people of the islands used to slaughter a pig every winter, one of the most important cured meat products they prepared was the siglina. Siglina is similar to cavourmas and consists of small pieces of lean pork meat cured, cooked, smoked and preserved in fat or oil (www.cycladesbest.org/diet/diet.htm).

Processing techniques

The lean pork meat is salted for 24 to 48 hours. In some regions they use pork fillets that remains in coarse salt for 4-6 days and then it is marinated in red wine for some days. Following this process they are smoked for 4-6 hours and some times over-night in open fireplaces burning vine twigs. In the morning they are rinsed with warm water, dried and then cut into pieces of approx. 150 grs. These pieces are placed in a pot full of fat, which is already boiling, and remained there for a period of time enough to be browned. In some regions of Peloponese the pieces are placed in boiling water containing some spices (e.g. pepper corns, cinnamon, cloves and orange peels) and stay there until thoroughly cooked. After this process, the pieces of meat are removed from the pot and placed in a ceramic container, which is filled with the melted fat (gлина) or with olive oil. Siglina does not need to stay in the refrigerator and is consumed as a condiment or cooked with other foods.

The microorganisms associated with singlino and the hurdles involved with its storage stability and its safety are the same mentioned in cavourmas. The only difference between these two products is that singlino is made from the most expensive meat pieces of the animal which are the muscle l. dorsi, the fillet or ham.
Apaki
This is the local cured pork meat of Crete. It is similar to louza, which is a traditional product of some Cycladic Islands since it is made from the fillet. It is produced from lean pork meat, which is cut into thick strips of 2-3 cm, and from the fillet usually of the pork saws. After the fillet is cut, it is placed in salt for one day and then soaked in vinegar for two to three days. When removed from the vinegar, it is dried with towels and covered with cinnamon. It stays with the cinnamon for six hours during which time the spice sticks to the meat surface. Following this, it is covered with ground black pepper, dry savory and more cinnamon and hung to dry for many weeks. In other regions the meat pieces undergo a drying process for few days and then they are hot smoked for one day. It is a very stable product through the low pH and $a_w$.
(www.cycladesbest.org/diet/diet.htm). It can be consumed with fresh salads or cooked with other foods.

NOVE PROIZVODNE TEHNOLOGIJE ZA TRADICIONALNE GRČKE PROIZVODE OD MESA

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Rezime

Ključne reči: tradicionalni grčki proizvodi od mesa, tehnologija

References