DRY-CURED MEDITERRANEAN HAMS: LONG PROCESS, SLOW CHANGES AND HIGH QUALITY: A REVIEW

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ABSTRACT

The term “curing,” in the Mediterranean region of Europe, means a long period of aging where an intense enzymatic action develops the distinctive flavor of dry-cured hams. The traditional process consists of rubbing a mixture of dry curing ingredients over the entire surface of the hams allowing time for uniform distribution of the curing ingredients, and finally, a ripening stage where the product is submitted to different cycles of temperature, humidity, and time. The final unique taste and flavor (a complex of sensations resulting from the stimulation of odor and taste) are achieved by proteolytic and lipolytic action. This lipolytic and oxidative degradation joined with the catabolism of amino acids produce volatile compounds, particularly during ripening under high temperatures, which are responsible for the typical aromas of dry-cured hams. Raw material, the use of Duroc genetic material in growing pigs and feeding of acorns) and ripening conditions play an important role in dry-cured ham production in this area of the world.
INTRODUCTION

As meat consumption in most European countries has widely expanded, particular interest has been directed toward developing a quality pork product. Lately, Spain has become the leading European country in the production of dry-cured hams (Ferrer-Falcón 1990). The ham production began in the 2nd century BC. History suggests that Catalania and Cordoba were the first and most important ham producing regions, and exports were directed to Rome and the Orient (Gonzalez Blasco 1988).

The dry-curing process was originally used as a preservation method, but has been improved to develop a more desirable flavor and a firm texture producing the characteristic Mediterranean Ham. In the Mediterranean regions of Europe, the term “cured” is used when they produce hams utilizing a long period of aging (usually between 6 and 12 months) when enzymatic action occurs and a distinctive flavor is developed. However, in the northern region, the term “cured” is limited to products that receive nitrite during processing (Flores 1997). A dry-cured product is one subjected to drying and ripening for the addition of dry ingredients and a time for these ingredients to equalize throughout the matrices (Flores and Toldrá 1993).

The quality of the dry-cured ham depends on multiple factors, such as animal breeding, animal age, feeding, environmental conditions, previous to slaughter (curing factors) and refrigeration and transportation of the product (post-curing factors). However, the most important factors that influence the sensory properties of hams are the raw materials and the ripening conditions (Toldrá et al. 1997; Toldrá 1998). Spanish (Iberian and Serrano) hams, Italian (Parma and San Daniele) hams and French (Bayonne) hams are representatives of high-quality dry-cured hams of the Mediterranean areas.

Dry-cured Ham Technology

The Spanish Iberian hams are produced from the Iberian breed of pigs from the southwestern region of Spain that were finished in pastures with acorns. The product achieves a high degree of marbling, firm texture and typical dry-cured-ham flavor. The term flavor is defined as a combination of taste and aroma sensations (Duty et al. 1981; Toldrá 1998). The Serrano hams are produced from crossbred white pigs with a low marbling score, firm texture and a typical dry-cured-ham flavor, which depends on the length of ripening (Toldrá et al. 1997). In both Iberian and Serrano hams, the high degree of marbling and amount of outside fat reduce the moisture loss during drying which increases the tenderness (Aznar 1998).

The Iberian breed of hogs, in contrast to the methodology applied for breeding white pig crossbreeds arrive at their final weight due to a procedure system called “Montanera.” Briefly, Iberian pigs are placed in “Montanera” at 8-10 months of age, weighing between of 85-90 kg. During this period (6-9 weeks) the hogs are fed a diet of acorns (Quercus ilex, Quercus rotundifolia and Quercus suber) on pastures. The gained weight during this period ranges from 57-69 kg, which results in a final weight of 140-160 kg. The acorn is composed of 70-72% carbohydrates and 6-8% of fat, and is considered a high-energy nutrient. Acorn fat is rich in oleic acid (> 60% of the fatty acids) and low in linoleic acid (< 16-18%). As a consequence of the high energy level of the acorn, the age of slaughter is 10-12 months. Also, this diet has a tendency to deposit fat between the muscles and results in the Iberian breed of hogs having a high subcutaneous and intramuscular fat content (Vestanas et al. 1998).

The traditional dry-curing process consists of a mixture of curing adjuncts that are applied to hams without any added water. In this process, the curing mixture is permitted to penetrate by diffusion aided by the original moisture of the meat. A long ripening procedure is utilized and the product is not smoked. For the first four months, the hams are held under controlled low temperature and high relative humidity, but during the last 14-20 months they are exposed to the same natural environmental conditions found in the mountain ranges of Spain (Cardoso et al. 1994a). The current steps involved in the dry-curing procedure are briefly explained in the following outline (Flores and Toldrá 1993; Cardoso et al. 1994a, b; Flores 1997; Toldrá et al. 1997, Aznar 1998).

1. Slaughter Stage: Hams are placed fat side down in the salting chamber, entirely covered by a mixture of curing ingredients, that includes sodium chloride, potassium nitrate (or) nitrite (trace amount), sugar (sucrose and dextrose) and acetic acid. Then, the hams are arranged in a single layer, to avoid touching each other, or stacked in piles in the curing mixture. The room is held at 2-4°C for several days (depending on the size of the hams) of 1-3 days/kg for usually, 8-10 days. The curing mixture and the procedure utilized varies according to the type of ham and location of the production. As an example, hams could be pre-salted with 20% of a mixture of sodium chloride: dextrose nitrate (40% 50% 4%) for 24 h at 3°C, and then covered with sodium chloride and smoked for a period depending on the weight of the Iberian ham (Olive et al. 1994).

2. Post Salting Stage 1: After removing the excess salt, the pieces are placed under refrigeration (1.4° C) at 90% relative humidity for 20-60 days to get a more uniform distribution of the cure adjuncts.

3. Post Salting Stage 2: The hams are taken to a chamber for 45 days, where temperature is progressively raised to 18°C and the relative humidity decreased to 80%.

FLAVOR AND TASTE OF DRY CURED HAMS
(5) Drying Stage: During the summer, hams are kept at environmental conditions for 45 days in drying rooms, at 30°C with a relative humidity of 45 to 70%.

(6) Ripening: The hams are left in natural or air-conditioned drying chambers and subjected to a relative humidity of 80–70%. Different temperature and humidity are also used depending on the time of the year. The ripening stages vary with the type of ham. The longer the period the wider the variations in process conditions. Usually the longer the ripening period the better the quality of the final product. Half-ripened hams (rapid process), require at least 6 months at 14 to 16°C, but for fully ripened hams (slow process) require another 6 to 8 months at 16 to 22°C. The Serano ham is opened for 9 to 12 months while the Iberian ham may be held for 18 to 24 months. The complexity and combination of biochemical reactions occurring during the ripening stage determine the sensory characteristics of the hams (Verpaulese 1994; Flores 1997).

Development of the Final Flavor and Taste

Proteolytic Action: The intense proteolysis observed during the dry-curing process in Spanish cured hams is, in part, a result of the action of muscle proteinases, especially calpains and cathepsins. Both proteolytic systems have been widely studied in fresh and aged meat from different species (Zeece et al. 1986; Eberth et al. 1987; Ouali et al. 1987; Koohmaraee 1988; Koohmaraee et al. 1988; Zeece and Kato 1989; Eberth et al. 1990; Whipple et al. 1990; Koohmaraee et al. 1990; Ouali et al. 1992; Whipple and Koohmaraee 1992). The volume of research during the last ten years on dry-cured hams has been rapidly increasing (Toldrá and Eberth 1988; Parreño et al. 1990, 1990; Gil et al. 1991; Rico et al. 1991; Toldrá et al. 1991, 1992, 1993; Sarrága et al. 1991; Virgili et al. 1995).

The calcium-dependent protease system involves cysteine endopeptidases located mainly in the cytosol and in the Z-disc area of the muscle sarcomere. The protease system is composed mainly of Calpain 1 and Calpain 2 enzymes, which require low and high calcium concentrations, respectively, for activation. Calpains are another component of this system, the endogenous calpain uchlasin, activated by Z-disk, and may also play a part in this process. Maximal enzyme activity is achieved at neutral pH. Thus, it is postulated that only a little enzyme activity occurs in the hams at a pH of 6.0. The enzyme system is responsible for the fragmentation of myofibrils along the Z-line by acting primarily on troponin T and I, tropomyosin, C-protein, filaments, vinculin, desmin, titin and nebulin (Groll et al. 1987; Krooomaraee 1988, 1989; Dransfield et al. 1992; Ouali 1992). Studies focused on the incidence of calpains in the curing process revealed that calpain activity could not be detected in hams after 2.5 months of treatment, and that the activity level during the salting stage was significantly lower than in fresh muscle (Sarrága et al. 1993). It is postulated that the instability of the proteases involved is an important key in this long salting process.

Lysosomal proteinases include mainly cathepsins B, D, H and L. They are cysteine proteinases (B, H and L) and aspartyl proteinase (D) which are responsible for the degradation of different myofibrillar proteins in vitro. At acidic pH values.

Cathepsin D is stable at high temperatures and exhibits maximum activity with myofibrils at 45°C and a pH of 5.5. The enzyme rapidly degrades myosin heavy chains (MHC), titin, and C- and M-proteins. Actin and myosin light chains are also degraded but at a much slower rate (Zeece and Kato 1989). The proteolysis of the myofibrillar regulatory complex, actin, tropomyosin and troponin T and I are cleaved by cathepsin D but in the area of pH 3 (Matsunou et al. 1983). In fact, only one part of MHC degradation could be due to the enzyme since only a low percentage of the initial enzyme activity level remains at the end of the curing process and this almost disappeared after 5–10 months of processing. In general, enzyme activity is strongly affected by both salt and pH during the dry-curing process (Ouali et al. 1987; Toldrá and Eberth 1988; Toldrá et al. 1991, 1992, 1993; Sarrága et al. 1991).

Similarly, cathepsin B can degrade myosin and actin (Schwartz and Bud 1977, Noda et al. 1981), although this protease usually degrades only low molecular weight protein such as troponin I and C (Ouali et al. 1987). A decrease in enzyme activity has been found from 2.5 to 3 months of curing in the Semitendinosus (SM) muscle (30–40% of residual activity). While in the Biceps Femoris (BF) muscle, the decrease has been detected at a later stage of the curing process (approximately 5.5 months), probably due to an irregular salt distribution in this heterogeneous muscle (Toldrá and Eberth 1988; Sarrága et al. 1993). Nevertheless, enzyme activity has been recovered in part (10–15%) at the end of the curing process in both muscles (Sarrága et al. 1993).

A comparison of this activity in the same two muscles but in two different processes; short aging (4 months) and long aging (8 months), has revealed that the ratio of cathepsin B to cystatin in the short process increases, probably because cystatin falls faster than cathepsin B activity. However, in the long process this ratio decreases slightly suggesting a modification of cathepsin B activity according to the curing process used (Parreño et al. 1994).

Cathepsin L produces myosin heavy chain (MHC) degradation giving peptides, which also disappears during the process (Ouali et al. 1987). In fact, it is postulated that the disappearance of the MHC could be due to both cathepsins B and L although D has the handicap of an earlier and greater reduction of its activity. Actin, α-actinin and troponin T and I can also be degraded by cathepsin L (Matsunou et al. 1981, Toldrá et al. 1993). The combined cathepsins B+L activity shows a similar pattern to cathepsin B activity described previously (Toldrá and Eberth 1988, Sarrága et al. 1993). However, when this activity is compared in different length processes, the results indicate that cathepsin L loses its activity more rapidly than cathepsin B, which is more stable throughout the curing process.
In contrast, cathepsin H degrades very few of the myofibrillar proteins (Ouali et al. 1987). The range of pH activity is 5.5 to 6.5 and cathepsin H is commonly defined as an endo-aminopeptidase (Koohmaraie 1988). Results of cathepsin H are controversial since some scientists have found no difference between the activity of cathepsin H and that of the other cysteine proteinases studied (Toldrá and Fiherrering 1988, Toldrá et al. 1991). Furthermore, Toldrá et al. (1992) have demonstrated that cathepsin H has low activity (16.5%) in the first stage of the dry-curing process due to the inhibitory action of the salt used, but when the activity is recovered during the drying stage. On the contrary, Parreño et al. (1994) have shown that the activity in fresh muscle falls sharply and is practically negligible (less than 4%) throughout the rest of the curing process.

The profile of cystatin-like activity (cystatin proteinases inhibitor) decreases slowly but progressively during the curing process and this might result in an underestimation of the cystatin activities. However, both have a similar developmental pattern and it seems that the inhibitor has little influence on this proteinolytic action during ripening (Parreño et al. 1994).

The slow losses of enzyme activity during the ripening process, and the recovered activities of the cathepsins B, H, and L at the end of the process indicate that enzymes proteinolytic action remains active at the final stage of the curing process (in some cases even after 15 months). This observation is attributable to the stabilized action of the curing salts against further denaturation (Toldrá and Fiherrering 1988; Toldrá et al. 1993).

According to the evolution of enzyme activity and to the protein degradation profiles, cathepsins B and L play an important role throughout the processing of dry-cured hams. Cathepsin L acts mainly in the initial stage with fresh muscle to the postsalting stage and cathepsin H has an intermediate role in degrading low-molecular-weight proteins into amino-acids. Cathepsin H seems to display little activity during the ripening process and it is not known if it participates in protein degradation. Participation of cathepsin D would be restricted to the first few months of processing when it is still active (Toldrá et al. 1993; Parreño et al. 1994).

Changes in muscle proteins and structure during the dry-curing process can be explained by considering a synergistic action of both lysosomal and calcium-dependent proteinases. The contribution of cathepsins to the proteolytic action is restricted to the earlier breakdown of myofibrillar proteins either by cleaving only the large peptides (Goll et al. 1983, 1991) or by degrading muscle to small peptides and amino acids (Harris et al. 1995). The most important action performed by cathepsins during the dry-curing process is to collaborate with the initial muscle protein degradation exerted by the calcium-dependent protease system.

Cathpsins and calpains are not thought to be entirely responsible for the final taste and flavor of the product since protein degradation occurs mainly in the first steps of the dry-curing procedure. Nevertheless, they could supply the substrate for the consequent action of other enzymes, which are able to produce greater degradation.

Muscle amino peptides (metallo-proteinases) seem to be involved in the latter stages of the proteolytical degradation. Studies with amino peptides (brady, anguill, alanyl, pyroglutamyl, and tyrosyl-enzymes) demonstrated that they are localized in the cytosol, are activated at neutral pH (optimal at 6.5-7.5) and at a temperature range of 30-35°C; however, the optimum temperature is 37°C (Toldrá et al. 1992, 1997). Enzymes are much more stable during the dry-curing process even though salt principally, and then ascorbic and nitrite, have inhibitory effects on most enzyme activities (Toldrá et al. 1991, 1992, 1993). Muscle amino peptides act on many different substrates (proteins and peptides) which would support their participation in the free amino acid liberation and account for most of the desirable flavor of dry-cured hams (Toldrá et al. 1997).

The effect of proteolytic enzymes on flavor and texture of dry-cured hams depends on the quantity of free amino acids and low molecular-weight compounds produced. However, when proteolysis is in excess it imparts a bitter and metallic taste, develops abundant white crystals on the cut surface and increases softness (Virgili et al. 1995, 1998a).

The peptide generation pattern analyzed by different methodologies showed a substantial change in peptide mapping during curing as evidenced by the presence of components ranging in molecular mass of 160 kDa and by the increase in low-mass peptides (160-1200) after 1.5-5 months (Rodríguez-Norie et al. 1995). Further studies with electrophoresis in the presence of SDS revealed progressive reduction of the 220 kDa to the 17 kDa bands until there was an almost disappearance of the 220 kDa during the ripening period, indicating intense proteolytic activity (Córdoba et al. 1994b).

Most of the amino acids detected in the first period increased significantly during ripening, particularly alanine and glutamic acid followed by leucine, glycine, and lysine. However, the fastest increase in the concentrations of all the amino acids was achieved during the drying stage (Toldrá et al. 1992; Córdoba et al. 1994a). This period and also the salting step were the stages of maximal NPN (nonpeptide nitrogen) increase and also there was a marked reduction in myofibrillar proteins (Córdoba et al. 1994b). Later in the ripening process, amino acids nitrogen was the major source of NPN, probably due to further proteolytic activity induced by the relatively high temperatures maintained at this stage (Ventanas et al. 1992; Córdoba et al. 1994a).

Also, amino (putrescine, histamine, and tyramine) increased during ripening, while spermine decreased. Yet the concentrations of these biogenic amines are neither in the range of toxic levels nor enough to reach values that can be a problem in dry-cured hams (Córdoba et al. 1994a).

Those NPN, nonvolatile amino acids and peptides produced under controlled
Lipoytic Action

Due to the high level of fattening of the Spanish hogs, flavor variation has been attributed to the lipid composition of fatty tissues and to the degree of lipid breakdown during processing. The enzyme lipoytic system is distributed in both adipose and muscle tissues. The most common adipose enzyme (Miller et al. 1981, Motulsky et al. 1993 a, b) is lipoprotein lipase which is responsible for the uptake of triglyceride fatty acids from the circulation (hydrolysis primary reactions at unsaturated monoacylglycerides), hormone-sensitive lipase which regulates fatty acid mobilization in the tissue (sterol ester of triglyceride and diacylglycerol affinity) and monoacylglycerol lipase, responsible for the final production of free fatty acids and glycerol (any monoacylglycerol as a substrate). Neutral or basic pH is optimal for maximal activity. Maximal activity is present at the beginning of processing but the processing temperature (Motulsky et al. 1993 a, b) restricts this activity. Esters from adipose tissue seem to be quite stable even after 7 months of processing and ante-mortem activity has also been reported in tissue in both raw and dry-cured hams (Tolstik et al. 1991, 1992).

Muscle lysosomal acid lipase hydrolyses principally neutral lipids, such as cholesterol esters and primary ester bonds of free glycerides at pH 4-5 (Tomaschke et al. 1964). Lipoxygenase is responsible for the hydrolysis of the d- and m-
acylglycerol components of the very low-density lipoproteins and cholesteryl esters at an optimal pH of 3.9. Acid phospholipase (A2) is also involved in lipid degradation (Flores et al. 1985, Torrejon et al. 1994). In general, muscle lipases have shown better stability than those from adipose tissue during the dry-curing process (Tolstik et al. 1991).

A progressive increase in the concentration of free nonvolatile fatty acids has been reported in the first stages (up to 4 months) along with the high lipoytic activity during this same period (Motulsky et al. 1992 a, 1994). This free fatty acid production constitutes a first step of precursors for secondary reactions (oxidations, interactions with proteins, etc.) to achieve flavor development. Neutral and basic muscle lipases are more active at the beginning of the curing process and are affected by changes in curing conditions, while lysosomal acid lipase seems to be active through the entire process (Motulsky et al. 1993 a, b).

Muscle estersases show an excellent stability during processing. However, it seems that the enzyme does not play a key role in the lipoysis of dry cured ham in view of the absence of adequate substitutes and the low amount of volatile free fatty acids produced (Motulsky et al. 1993; Buscaino et al. 1994; Tolstik et al. 1992).

Volatile Components

Typical aroma of dry cured ham is correlated with the lipolytic and oxidative degradation of unsaturated fatty acids or with the catalysis of amino acids. Consequently, these reactions generate volatile compounds especially during the latest stages of ripening, due to high temperature developed along with long processing of Spanish hams (Flores et al. 1985, López Bote et al. 1990, Buscaino et al. 1994; Vélez et al. 1994). The chemical reaction involved in the Maillard reaction, in which a polyol compound (peptides, amino and carboxylic acids reacts with a sugar compound, followed by different chemical reactions such as condensation, dehydration, degradation, etc., to form furans, furfural, aldehydes, ketones, etc. Finally, they react among themselves or with products of lipid reactions to produce volatile compounds (Tolstik 1994).

Capillary gas liquid chromatography most spectral chromatograms show more than 70% of the peaks ranging from Mw of 84 to 128. The compounds identified belong to aldehydes, branched alcohols, ketones, aldehydes, ethanol, alcohols, carboxylic acids, esters, lactones, furans and sulfur compounds and other miscellaneous groups (Berdoulat et al. 1991; García et al. 1991; Drücke et al. 1997).

Ketones, aromatic compounds and branched alcohols are present in these hams. They may be products of the antioxidation of breakdown of the branched aldehydes are also found in fresh meat, probably coming from the oxidation of branched fatty acids in animal tissues or from the unreactable fraction of the feed consumed by the animals (acorns). Because of their relatively high threshold value, hydrocarbons probably are not significant contributors to the flavor of the raw ham (Reinbold et al. 1989, Devos et al. 1990).

Aldehyde compounds make up the major class of volatile and the identified heptanal is the most abundant. They may be formed by the breakdown of hydroperoxides derived from unsaturated fatty acids, sugar oxidation or meat proteolysis. Because of their low threshold values and distinctive odor characters they may be the major contributors to the ham's flavor (Hernández and Cheng 1976; Freeland 1985, Drücke et al. 1997). Of the aldehydes, 2-heptenal, 3-methylbutanal, 1-octen-3-ol, pentenal, hexanal and heptanal, the latest seems to be responsible for a floral note and the 1-octen-3-ol produces an unpleasant musty odor (Berdoulat et al. 1991; García et al. 1991; Drücke et al. 1997).

Ketones are represented basically by methyl ketones, which are products of decarbonylation of ketimides or of saturated fatty and β-oxidation. Among the bifunctional ketones, 3-hydroxy-2-butanone might be important as a contributor...
to the buttery notes (Berdagué et al. 1991; García et al. 1991; Durán et al. 1997).

The free carboxylic acids come from the hydrolysis of the triglycerides and phospholipids (Berdagué et al. 1991). A large number of esters have not been properly identified, but they probably arise from the esterification of alcohols and carboxylic acids and are generally associated with fruity flavors (García et al. 1991).

The lactones identified are products of the dehydration and cyclization of the hydroxy-esters of the animal fats. They would be related to buttery, oily, fatty, fruity, and cream-like flavors (Bainés and Mestres 1981).

Sulfur-containing compounds were found in low concentrations. However, among the identified components, the dimethyl tris and tetrathio compounds might influence overall flavor (Durán et al. 1997).

The amount of volatile compounds found in Spanish hams suggests an intense enzyme action during maturation; in particular, lipolysis and lipid oxidation are considered to be the major processes in the volatile flavor production (López-Bote et al. 1996; Veiga et al. 1994). Some of the peaks found in the chromatograms have been identified and associated with the characteristic smell of the product. However, several molecules with a weak chromatographic signal remain unidentified and need more research to determine which are really components in the dry-cured flavor.

Influence of Crossbreed Pigs

Farming, slaughtering techniques, manufacturing procedures, and consumer preferences are important factors in determining the quality of dry-cured hams (Virgili et al. 1998). However, raw material is one of the key factors.

High pH levels, high levels of intramuscular fat, and low salt-to-meat ratios influence texture (Pastor et al. 1985). Animal age effects color, fat content, muscle resistance to drying tension and proteolytic enzyme activity (Serna et al. 1992). Some studies have demonstrated the association between certain quality factors and pig breeds (Cameron et al. 1990; Oliver et al. 1993, 1994). However, chemical analyses have revealed a restricted effect of crossbreeding on the content of volatile compounds and ham flavors (Berdagué et al. 1991). Ninety-two percent of the production in Spain is obtained from confined pork production and the rest from the Iberian breed, extremitas in extensive or semi-intensive conditions (Oliver et al. 1994). The Duroc breed was introduced in Europe to improve quality. Particularly in Spain, this breed has been used to manufacture dry-cured meat products due to its high intramuscular fat level.

Increasing Duroc genetic material in growing pigs produces a higher degree of marbling (less meat/carcass) and intramuscular fat content (chemical measurement) that improves meat quality, particularly tenderness (Edward et al. 1991; Oliver et al. 1994; Virgili et al. 1998b). Furthermore, the Duroc breed seems to be ideal for crossing because of its growth characteristics, the quality of the carcass, and the superior feed conversion ratio. It is also resistant to the PSE-condition and this contributes to the high-quality dry-cured ham manufacturing (Hilasas et al. 1994; Oliver et al. 1993, 1994; Guerrero et al. 1996). The intense flavor of the dry-cured ham of the Duroc line may be associated with the larger amount of marbling and intramuscular fat observed (compare to Large White, Landrace, Pietrain, and Belgian Landrace) and with the volatile compounds formed by the oxidation of its fatty acids (López-Bote et al. 1990; Guerrero et al. 1996).

The increased marbling could also make salt and water diffusion more difficult and require a longer curing time. No differences between genetic types have been found in moisture and pH (Berdagué et al. 1993; Guerrero et al. 1996). Duroc (and Belgian Landrace) cross-breeding improves overall acceptance of the ham with respect to the other breed types (Belgian-Landrace x Landrace or x Large White) which are considered less desirable and producing more defective hams (Oliver et al. 1994).

Main Differences with Other Products

The most important differences between meat products from the northern and southern regions of Europe are found in dry-cured products. In the case of the typical Mediterranean type products, nitrite is used exclusively since such products are submitted to a long period of rearing, nitrite is not usually cured, and smoking is not applied. In the northern European meat products are cured with nitrite and smoking is almost an integral part of the curing process. Hams are smoked after the pasturing stage and subsequently ripened only over 12 months' period. These different methodologies applied for the curing process produce a wide variation in the sensory characteristics of the final product (Flora 1997).

American dry-cured hams also differ usually according to the location of production. During the past some producers utilized peanuts as feed to produce more unsaturated fat, which would encourage more oxidation contributing to part of the desirable flavor. Salt, sometimes sugar, nitrate, sometimes nitrates, sometimes smoking and smoke curing (often pepper) are utilized as cure and flavor adjuncts.

The hams are kept in cure 1 to 1 1/2 days per pound (0.45 kg), allowing to equalize the curing adjuncts, and aged for 3 to 12 months (more intense flavor with longer aging). American hams are usually soaked in water prior to cooking to remove some of the salt. They are usually simmered in water and then baked or sliced and fried in contrast to European hams that are often eaten uncooked.

CONCLUSIONS

The quality of the Mediterranean ham is related to the ripening time and...
REFERENCES


