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Biochemical characteristics of dry-cured lacón

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Abstract

Dry-cured lacón is a salted and ripened meat product made in the north-west of Spain from the fore extremity of the pig following a technological process very similar to those of dry-cured ham. The gross composition, the most relevant physico-chemical parameters, the protein extractability, the nitrogen fractions, as well as some fat characteristics, were determined in 21 units of the end-product. With some minor exceptions, the compositional and physico-chemical parameter values do not differ very much from those observed in cured ham and other meat cured-products made from entire pieces. It can be deduced, from the values of the different nitrogen fractions, that dry-cured lacón, throughout its elaboration, undergoes a very light proteolysis. The values of free fatty acid contents indicate that the lipolysis is also not very intense. However, the peroxide values are higher than those found in dry-cured ham for a similar ripening period.

1. Introduction

Meat is a food which, because of its special characteristics (pH and a_w values, abundance and variety of nutrients) allows for the growth of a multitude of microorganisms which cause its rapid alteration. For this reason, man has from time inmemorial looked for ways to conserve it with the aim of consuming it over more or less long periods.

One of the oldest methods for conserving meat is, without doubt, by curing. Today, curing has become more a method of diversification and adaption to the habits of the consumer than a method of preservation.

Traditional cured meat products, made from whole meat pieces of pork or beef, are abundantly elaborated and consumed in different countries throughout the world. Among these traditional cured meat products is lacón, a product elaborated in the north-west of Spain which has a wide acceptance by consumers.

Its elaboration is begun by cutting the fore extremity of the pig at the shoulder blade–humerus joint and the stages of the process are very similar to those followed in the elaboration of dry-cured ham. The raw pieces, once selected and classified by weight (3.5–6.5 kg), are dry-salted with coarse salt, forming mounds on the floor, alternating between pieces and salt; the period of time the pieces spend in the mound is about 1 day per kg of weight, the temperature of the salting room being between 2 and 5°C and the relative humidity between 80 and 90%. After the salting stage, the pieces are taken from the mound, brushed (sometimes washed) and transferred to a post-salting room where they stay for about a fortnight (minimum 7 days) at a temperature of 2–5°C and a relative humidity of around 85%. Once the post-salting stage has finished, the pieces undergo a drying-ripening process for which they are transferred to a room at 12°C and 70% of relative humidity. They remain in this room for about a month and half (the length of the drying-ripening process is very variable depending on the needs of the market with a minimum of 15 days). The final product, depending on the degree of ripening, can be eaten raw or cooked.

The existing information in scientific literature related to dry-cured lacón is very scarce and refers only to microbiological characteristics (Vilar, García-Fontán, Marra, Tornadijo, & Carballo, 1998; Vilar, Tornadjo, Prieto, & Carballo, 1997).

In order to improve the quality of the final product it is also necessary to know the biochemical phenomena which take place during the elaboration of this product.

The aim of this work, which forms part of a wider study which is being carried out in this laboratory, is to

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study the biochemical characteristics of dry-cured lacón by determining, in the end-product, the gross composition, the main physico-chemical parameters, as well as some parameters which indicate the degree of modification of the protein and lipid fractions during the elaboration process.

2. Materials and methods

2.1. Samples

Twenty-one units of dry-cured lacón, elaborated by 21 well-known pigmeat industries, following the method described in the introduction section, were collected and transported to the laboratory under refrigeration conditions (below 4°C). Once in the laboratory, the pieces were skinned and boned and finally triturated in a high capacity mincer. After carrying out the determinations which could not wait (moisture, water activity and pH), samples were stored in air-tight bottles at −80°C for no longer than 4 weeks.

2.2. Analytical methods

Moisture, fat, protein (Kjeldahl N×6.25), and ash contents were determined following the ISO recommended methods (ISO/R 1442, ISO/R 1433, ISO/R 937, and ISO/R 936, respectively). Nitrate (brucine method), hydroxyproline, and NaCl (Carpentier–Volhard method) contents were determined following the Spanish official standards (Presidencia del Gobierno, 1979).

Total carbohydrates, non-protein nitrogen (NPN), and total volatile basic nitrogen (TVBN) were quantified following the methods cited by Lois, Gutiérrez, Zumalacárregui, and López (1987) in an extract obtained with 0.6 N $HClO_4$ following the procedure described by De Ketelaere, Demeyer, Vanderkerckhove, and Vervaeke (1974). This same extract was used for the determination of the α-aminoacidic nitrogen following the Moore and Stein (1948) method.

The pH was determined in a slurry made by mixing 10 g of sample with 10 ml of distilled water in a Sorvall Omnimixer homogeneizer (Omni International, Waterbury, CT). Measurement was carried out with a pH meter micro pH 2002 (Crison Instruments, S.A., Barcelona, Spain). Water activity (a_w) was measured with a Decagon CX-1 Water Activity System apparatus (Decagon Devices, Pullman, WA). The titratable acidity, nitrosyl-heme pigments, total heme pigments and percentage conversion to cured meat pigments were determined by the methods described by Zaica, Zell, Smith, Palumbo, and Kissinger (1976).

Sarcoplasmic and myofibrilar proteins were extracted and quantified using the methods cited by García, Díez, and Zumalacárregui (1997).

The preparation of the fat extract and the subsequent determination of FFA (acidity index of the fat) were carried out using the method described by Pearson (1968); the FFA was expressed as percentage of oleic acid. The peroxide value (PV) was determined according to Spanish official procedure (Presidencia del Gobierno, 1979).

2.3. Statistical methods

The correlation coefficients between the different biochemical parameters were determined with the aid of the computer program SPSS/PC$^+$ (SPSS Inc., Chicago, IL).

3. Results and discussion

Table 1 shows the data of the gross composition and physico-chemical parameters obtained for the 21 units of dry-cured lacón. The values of the moisture of lacón (average 50.44%) are similar to, or only slightly higher than, those observed at the end of the ripening process of Spanish Serrano ham (Astiasarán et al., 1988; Flores, Bermell, & Nieto, 1985a; Huerta, Hernández, Guamis, & Hernández, 1988; León Crespo, Montero Pérez-Barquero, et al., 1983), Italian hams (Cantoni, Bianchi, D'Aubert, Renon, & Cerutti, 1970; Severini, Di Antonio, Vizzani, Cenci, & Avellini, 1983) and Spanish cecina (García, Zumulacarregui, & Diez, 1995; Gutiérrez, Dominguez, & Zumalacárregui, 1988). This circumstance attracts attention if the short drying-ripening period of lacón (1.5 months) is taken into account as opposed to that of the cited hams (between 6 and 12 months) and of Spanish cecina (5–8 months). This characteristic could be explained by the fact that, in lacón, being a piece of lesser size and thickness, the surface per unit of weight is greater, which favours the dehydration throughout the drying-ripening stage. This circumstance could also provoke a greater loss in water due to the exit of fluids during the salting process.

Lacón has sodium chloride values which are found in the upper extreme of the range of those observed by other authors in other dry-cured meat products made from entire pieces (Astiasarán et al., 1988; Cantoni & Calcinardi, 1967; Cantoni, Bianchi, Renon, & Calcinardi, 1968; Chizzolini, Rosa, & Novelli, 1993; Flores, Bermell, & Nieto, 1985a; García, Zumalacárregui, & Díez, 1995; Giolitti, Cantoni, Bianchi, & Renon, 1971; Gutiérrez et al., 1988; Huerta et al. 1988; León Crespo, Montero Pérez-Barquero et al., 1983; Monin et al., 1997; Silla, Innerarity, & Flores, 1985). These high values can be explained by the greater surface and lesser thickness of the lacón pieces which favour the penetration of salt during the salting process.

The pH values are similar to those found in white pig ham (Buscailhon, Berdagué, Gandemer, Touraille, & Monin, 1994a; Hinrichsen & Pedersen, 1995; Huerta et al., 1988; Silla et al., 1985).

Table 1
Gross composition and physico–chemical parameters of dry–cured lacón ($n = 21$)

	Average	Range	s.d.
Moisture	50.44	41.58–58.14	4.14
Protein ($N \times 6.25$) (% D.M.)	56.4	49.4–70.82	5.53
Fat (% D.M.)	19.73	6.73–31.08	7.53
Ash (% D.M.)	20.66	10.30–25.33	4.31
NaCl (% D.M.)	16.2	6.99–22.8	4.18
Total carbohydrates (% D.M.)	0.58	0.33–1.19	0.23
Hydroxyproline (% D.M.)	0.76	0.45–1.42	0.23
Nitrate (ppm)	41.1	2.40–214	58.1
pH	6.14	5.84–6.45	0.19
Titratable acidity (g lactic acid/100 g)	0.077	0.018–0.126	0.033
a_w	0.872	0.822–0.944	0.030
Nitrosyl–heme pigments (ppm)	34.2	2.61–77.72	24.5
Total heme pigments (ppm)	279	102–903	183
P.C.[a]	13.5	1.93–31.7	9.36

[a] P.C. = Percent conversion to cured meat pigments.
D.M. = Dry matter.

We have not found, in the literature, data on the titratable acidity of raw-cured ham. However, the acidities in dry-cured lacón (average value of 0.077% of lactic acid) are much lower than those found in raw-cured meat products elaborated with entire pieces of beef such as Spanish cecina (Gutiérrez et al., 1988).

The relatively high pH values observed in lacón agree with the low titratable acidity values and they seem to indicate that lacón does not undergo a true lactic fermentation. This finding also seems ratified by the lactic acid bacteria counts observed in lacón (Vilar, Tornadijo et al., 1997) which, at the end of the post-salting and drying-ripening stages, were much lower than those found for salt-tolerant flora (*Micrococcaceae*) and for the total aerobic mesophilic flora. The non-existence of a true lactic fermentation has also been observed in other raw-cured meat products elaborated from entire pieces, in this case from beef, such as Spanish cecina (García Herrero, 1994) or Italian bresaole (Cantoni et al., 1968; Cantoni and Calcinardi, 1967).

The average water activity values in lacón are slightly higher than those found by other authors in white pig ham (Astiasarán et al., 1988; Huerta et al., 1988; Silla et al., 1985), Iberian ham (León Crespo, Beltrán de Heredia, Fernández-Salguero, & Alcalá, 1982), and in Spanish cecina (Gutiérrez et al., 1988). Given that the moisture and NaCl values found in lacón are similar (or even higher in the case of NaCl) to those registered in the previously-mentioned products, the explanation of the slightly higher a_w values could be found in the fact that (this will be discussed later on) lacón has a lower proteolysis than that of hams or cecina. The depressing effect that the nitrogen compounds of low molecular mass, which are generated in the course of protein degradation, have on the water activity, is well-known. Nevertheless, these water activity values (in almost all dry-cured lacón pieces studied below 0.91) together with the high sodium chloride values, make lacón a stable product from a microbiological point of view, despite the fact that the pH values are compatible with the growth of numerous microorganisms.

The percentage of heme pigments transformated to nitrosyl-heme pigments in dry-cured lacón turned out to be really low (average values of 13.5%). These percentage values of conversion are much lower than those found in available literature for other cured meat products. García Herrero (1994) determined a value of 30% in Spanish cecina after 5 months of ripening. Gorospe, Astiasarán, Sánchez-Mange, and Bello (1989) obtained conversion percentages of 50% in raw-cured hams after 3 months of ripening. In fermented sausages higher conversion percentages, of 80–90%, are usually observed (Acton & Dick, 1977; Lois et al., 1987; Zaica, Zell, Palumbo, & Smith, 1978).

According to Zaica, Zell, Smith et al. (1976), the conversion percentage is as high as the pH value is low, since the low pH values favour the dissociation of the nitrates to give NO, which is the compound which reacts to generate the nitrosyl-pigments. The relatively high pH values of lacón could be one of the causes of the low transformation index of the pigments, which seems to be corroborated by the negative correlation coefficient ($r = -0.62$; $P < 0.01$) observed between the pH values and the percent of pigments conversion. However, it is true that the short drying-ripening period of lacón (never more than 1.5 months) could also be another cause of the low conversion percent.

Table 2 shows the protein extractability, the nitrogen fractions and some parameters of the fat in dry-cured lacón. On average, the values of the proteins extracted in lacón were 6.92 g/100 g for the myofibrilar proteins and 6.59 g/100 g for the sarcoplasmic proteins. With no data on extractability of the proteins in fresh lacón pieces being available, it was not possible to quantify the degree of insolubilization undergone by the proteins throughout the elaboration process. However, comparing the extractibility data with those of total protein, also obtained by us, it can be proved that there has been a certain degree of protein insolubilization. The fall in the amount of soluble proteins has been demonstrated throughout ripening of different types of ham by different authors (Ambanelli, Molinari, Trasatti, & Pezzani, 1968; Cantoni & Cattaneo, 1974; Córdoba et al., 1994; De Prado, 1988; Flores, Bermell, Nieto, & Costell, 1984).

The majority of authors think that this protein insolubilization is due to hydrolysis phenomena (proteolysis) and to the denaturalization of the proteins. In the case of lacón, judging from the non-protein nitrogen values obtained, protein hydrolysis is not very important. It therefore seems that the protein insolubilization is more due to denaturalization phenomena. It is very possible that this protein denaturalization is due to the

Table 2
Protein extractability, nitrogen fractions and some fat parameters of dry–cured lacón ($n = 21$)

	Average	Range	s.d.
Myofibrilar proteins (g/100 g)	6.92	4.26–10.6	1.56
Sarcoplasmic proteins (g/100 g)	6.59	3.51–13.2	2.57
Total Nitrogen (TN) (g/100 g)	4.45	3.74–5.91	0.49
Non-protein nitrogen (NPN) (g/100 g)	0.210	0.135–0.405	0.058
(α–aminoacidic nitrogen (NH_2N) (g/100 g)	0.077	0.037–0.127	0.030
Volatile basic nitrogen (VBN) (g/100 g)	0.023	0.010–0.045	0.011
F.F.A. (% oleic acid)	2.33	1.97–2.79	0.17
P.V. (meq O_2/kg of fat)	37.7	14.8–55.5	10.1

sodium chloride used in the salting process, although the synergic action of the salt with other factors such as dehydration can also have some influence. In the case of lacón, the high NaCl values observed could have an effect on the insolubilization of the proteins.

The non-protein nitrogen represented, on average, 210 mg/100 g (i.e. 4.80% of total nitrogen). This value is much lower than observed by other authors in cured ham (Astiasarán et al., 1988; Buscailhon, Monin, Cornet, & Bousset, 1994b; De Prado, 1988; Flores, Bermell, & Nieto, 1985a; Giolitti et al., 1971; Ventanas et al., 1992) or in Spanish cecina (Garcia, Díez, & Zumulacárregui, 1998) even at the end of a very similar ripening time to the elaboration time of lacón (about 2 months). The α-aminoacidic nitrogen values observed in lacón are also lower than those found by Giolitti et al., De Prado and Ventanas et al. in ham or by García, Díez, & Zumulacárregui (1998) in Spanish cecina. The values of total volatile basic nitrogen (23 mg/100 g) are also much lower than those observed in Italian and Iberian hams at the end of the ripening process which oscillate between 50 and 240 mg/100 g (Ambanelli et al., 1968; De Prado; Giolitti et al.).

From the values of the different nitrogen fractions, it is possible to conclude that lacón, throughout the elaboration process, goes through a very slightly pronounced proteolysis, both in extension and in intensity.

The total free fatty acid values (2.33% of oleic acid on average) are very low. From these data it is possible to conclude that the hydrolysis of the lipids in lacón is very weak. However, the peroxide values observed in the fat of lacón (average values of 37.7 meq. O_2/kg of fat) are higher than found by Flores, Nieto, Bermell, and Miralles (1985b) in ham from white pig and by Antequera et al. (1992) in ham from Iberian pig for a ripening period similar to that gone through by lacón.

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