Hindawi
Journal of Food Quality
Volume 2018, Article ID 7690501, 14 pages
https://doi.org/10.1155/2018/7690501

Research Article

Biochemical, Oxidative, and Lipolytic Changes during Vacuum-Packed Storage of Dry-Cured Loin: Effect of Chestnuts Intake by Celta Pigs

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Received 31 October 2017; Revised 5 February 2018; Accepted 26 February 2018; Published 11 April 2018

Academic Editor: Jordi Rovira

The effect of the inclusion of chestnuts in the finishing diet of Celta pig breed on the characteristics of dry-cured loin, a traditional Spanish dry-cured meat product, after the manufacturing process and the vacuum-packed storage was studied. In general, no significant differences between the diets (chestnut, mixed, and concentrate diet) were obtained for physicochemical (moisture, intramuscular fat, and titratable acidity) and lipolytic parameters. Lower pH and higher values for oxidation parameters (peroxide and TBA values) were obtained in loins from pigs fed with chestnuts. However, no differences were found for fatty acids from the different lipid fractions when diets were compared, with the exception of some minor fatty acids. Free fatty acids represented over 2.7% of the fat in the final product. The distinction between diets was procured when a discriminant canonical analysis was performed for fatty acid contents. After vacuum-packed storage, only a slight evolution of the studied parameters was obtained.

1. Introduction

Dry-cured pork loin is a typical Spanish meat product, which represents an important market [1]. During dry-curing process of meat products, lipids degradation occurs, mainly due to lipolytic and oxidative phenomena [2]. Lipolysis leads to the release of free fatty acids (FFA) from both neutral (NL) and polar (PL) lipids. Lipid oxidation reactions produced also changes in the fatty acid composition of the different lipid fractions, giving rise to a number of compounds, which are essential in the development of the typical aroma in these products [3]. Among factors affecting fatty acid composition of pig lipids (genetic factors, rearing system, sex and castration, age at slaughtering, or location in the carcass), feeding appears to be the most important factor [4].

Celta pig, a traditional breed from Galicia (northwest of Spain), was very important until the 1950s but then it was substituted for commercial crossbreeds, being near to disappear in the 80s. High value-added meat products are obtained from Celta pig due to the great fat infiltration in the lean meat [4, 5].

In Galicia, chestnuts (*Castanea sativa* Mill.) have been traditionally used in pig feeding. This fruit is composed of carbohydrates, proteins, lipids, and acceptable content of minerals and vitamins [5]. Also, the content of linoleic acid in its fat is notable [6]. Chestnuts in Spain are insufficiently exploited; this, combined to its adequate composition, makes them suitable for pig feeding.

The novelty of this work lies in the use of *Longissimus dorsi* from Celta pig breed for manufacturing dry-cured loin, as products from this breed were not subjected to many studies so far. Chestnuts can be used on Celta pig feeding in an extensive regime with the consequent reduction of the production cost and obtaining products with a differential quality and added value. Therefore, the aim of this study was to determine the influence of including chestnut in the finishing diet of Celta pig breed on lipolytic and oxidative parameters and fatty acid composition of the manufactured dry-cured loin. For this purpose, three batches of dry-cured loins were manufactured from pigs fed with three different finishing diets (only with concentrate, only with chestnuts, and a mixed diet of chestnuts and concentrate) and chemical composition, physicochemical, lipolytic, and oxidative parameters and fatty acid composition were studied in the final product and during 6 months of vacuum-storage.

2. Material and Methods

2.1. Animals, Diets, and Dry-Cured Loin Manufacture. Thirty-six pigs from Celta breed were reared by the INORDE (Instituto Ourensano de Desarrollo, Ourense, Spain) in a semiextensive system with a density of 12 pigs per hectare. The animals were weaned at the age of 40 days and castrated at 60 days for the males and at 90 days for the females. Pigs were fed with a commercial concentrate until the month 12 and then they were divided into three groups of 12 pigs each. In the first group (chestnut diet), the pigs, after a month of adaptation in which the pigs were fed with a mixed diet of chestnuts and concentrate, received during the rest of the fattening period (3 months) a diet constituted only by chestnuts (5 kg of chestnuts per day and pig). On the second group (mixed diet), the pigs received during the fattening period (last 4 months) a mixed diet of concentrate and chestnuts (1.5 kg of concentrate and 2.5 kg of chestnuts per day and pig). Finally, in the last group (concentrate diet), the pigs were fed the entire fattening period with the commercial concentrate (3 kg of concentrate per day and pig). The chemical composition of the three diets is shown in a previous work using these pigs [5] and it is shown in Table 1.

At 16 months, the pigs were transported to a commercial slaughterhouse (Frigolouro, Porriño, Pontevedra, Spain). After slaughtering, and after 24 hours of refrigeration, the Longissimus dorsi muscles were removed from the carcasses and after removing the surface fat and connective tissue, the muscles were seasoned with a commercial mixture (Doscamix LM30 Salamanca, Doscadesa, Murcia, Spain) containing between other ingredients salt, nitrites, sucrose, and paprika. The dry-cured loin manufacture was carried out in the industry "Cárnicas Pérez Guerra" (Taboadela, Ourense, Spain). For each of the three diets, 18 units of dry-cured loin were manufactured. Loins were kept for 8 days at 4°C and at a relative humidity (RH) of 85–90% to allow the seasoning mixture to penetrate. After that, loins were stuffed into collagen casings and held for 30 days at 4°C at 65–70% RH. Finally, loins were ripened in a natural drying room for 60 additional days where the mean conditions were 8–16°C and at 70–75% RH.

To study the product characteristics, six units of dry-cured loin of each diet group were taken (final product). To study the product stability, after manufacturing, 12 units of dry-cured loin from each batch (diet group) were vacuum-packed and then stored at 20–23°C and 45–55% RH. Samples from each batch were taken after 3 and 6 months of vacuum-packed storage. To prepare samples for analysis, after removing and discarding the outer casing of each loin, the edible part was ground until a homogeneous mass was obtained. After determining the pH and the moisture content, the samples were vacuum-packed and frozen at −80°C for no longer than a month before further analysis.

2.2. Analytical Methods. Dry matter, pH, titratable acidity, acidity value, peroxide value, and TBARS were determined as described by Franco et al. [7]. Fat was extracted according to Folch et al. [8] procedure. Fat extract was weighted and the fat content was expressed as percentage of fat per 100 g of dry matter.

The different lipid fractions (neutral and polar lipids and free fatty acids) were separated using NH_2-aminopropyl columns (500 mg) (SUPELCO, Bellefonte, USA) as described by Kaluzny et al. [9] with some modifications. Two hundred milligrams of the extracted lipids in chloroform was applied to the column. NL were eluted with 3 ml of a mixture of chloroform : 2-propanol (2 : 1), free fatty acids were eluted with 3 ml of 2% of acetic acid in diethyl ether, and finally PL were eluted with 3 ml of methanol. Fatty acids from each lipid fraction and five hundred milligrams of fat (total fatty acids) were transesterified following the method of Shehata et al. [10]. The identification and quantification of the fatty acids methyl esters were carried out by Gas Chromatography using a Thermo Finnigan Trace GC (Thermo Finnigan, Austin, TX, USA) chromatograph, equipped with a Split/Splitless AI 3000 Autoinjector and a flame ionization detector (FID). The separation of the different fatty acids was carried out in an HP-INNOWAX column (30 m; 25 mm ID; 0.25 mm film thickness) (Agilent Technologies, Santa Clara, CA, USA). The temperatures of the detector and injector were 250°C and 230°C, respectively. The gasses used were air (350 mL/min), hydrogen (35 mL/min), and helium (carrier gas) (30 mL/min). Chromatographic conditions were as follows: initial oven temperature of 50°C (held for 1 min) and a ramp at 5°C/min to 248°C (held for 15 min). Identification of fatty acids was performed by comparison of the retention times obtained with a pattern of fatty acid methyl esters (SUPELCO, Bellefonte, USA) and the results were expressed for fatty acids from total NL and PL as percentage of chromatographic total area. Free fatty acids were quantified using tridecanoic acid at 500 mg/L, as internal standard, which was added to samples prior to methylation and the results were expressed as mg/100 g of fat [5].

Means were compared by the least squares difference (LSD) test at a significance level of 0.05, using the software Statistica© 8.0 for Windows (Statsoft Inc., Tulsa, OK, USA). Canonical discriminant analysis (CDA) was applied to different lipid fraction in order to classify the three diets used in Celta pig fed. The selection of variables for CDA was achieved with the extraction of principal components through a factor analysis, selecting the variables with a major discriminant capacity.

3. Results and Discussion

3.1. Biochemical, Lipolytic, and Oxidative Parameters. The evolution of compositional, physicochemical, lipolytic, and oxidative parameters of dry-cured loin, after manufacturing process and after 3 and 6 months of vacuum-packed storage, is shown in Table 2.

Dry matter content of dry-cured loin was similar in the three diet groups. The mean values were about 65%. These contents were similar to those previously found in Iberian

Table 1: General composition and fatty acids of the experimental diets: chestnut, mixed, and concentrate.

	Chestnut[a]	Chestnuts-concentrate[b]	Concentrate[c]
Energy (kcal/100 g)	275.5	343.1	456.6
Composition (g/100 g)			
Dry matter	51.9	66.0	89.5
Crude protein	4.20	8.40	15.3
Ethereal extract	3.30	3.90	4.90
Crude fibre	2.00	3.00	4.60
Starch	32.0	34.9	39.7
Ash	1.30	3.20	6.30
Fatty acids (mg/100 g)			
C12	1.23 ± 0.04	3.18 ± 0.05	6.99 ± 0.06
C14	3.63 ± 0.11	20.0 ± 0.14	52.4 ± 0.19
C14:1*n*-5	0.04 ± 0.01	0.10 ± 0.01	0.21 ± 0.02
C15	2.35 ± 0.02	3.68 ± 0.02	6.12 ± 0.00
C15:1	1.00 ± 0.01	1.10 ± 0.01	1.22 ± 0.03
C16	501 ± 1.25	714 ± 0.92	1097 ± 0.37
C16:1*n*-7	12.0 ± 0.03	32.2 ± 0.12	71.8 ± 0.26
C17	3.20 ± 0.01	7.66 ± 0.09	16.3 ± 0.24
C17:1	1.86 ± 0.02	4.30 ± 0.05	9.03 ± 0.08
C18	32.5 ± 0.31	174 ± 0.22	454 ± 0.08
C18:1*n*-9	911 ± 3.37	1073 ± 2.32	1317 ± 0.57
C18:2*n*-6	1510 ± 0.61	1475 ± 1.65	1272 ± 3.37
C18:3*n*-6	2.50 ± 0.04	2.62 ± 0.06	2.66 ± 0.08
C18:3*n*-3	190 ± 5.58	173 ± 3.58	122 ± 0.24
C20	7.54 ± 0.09	7.33 ± 0.07	6.26 ± 0.04
C20:1*n*-9	12.9 ± 0.24	15.3 ± 0.19	19.0 ± 0.09
C20:2*n*-6	1.59 ± 0.15	3.24 ± 0.22	6.41 ± 0.34
C20:3*n*-6	1.28 ± 0.01	1.52 ± 0.03	1.88 ± 0.06
C20:4*n*-6	0.37 ± 0.10	1.82 ± 0.13	4.69 ± 0.20
C20:3*n*-3	0.53 ± 0.51	1.08 ± 0.44	2.15 ± 0.31
C20:5*n*-3	0.43 ± 0.10	0.99 ± 0.08	2.09 ± 0.05
C22	7.43 ± 0.08	7.63 ± 0.07	7.40 ± 0.07
C22:1*n*-9	2.40 ± 0.25	3.28 ± 0.57	4.82 ± 1.09
C22:2*n*-6	85.6 ± 3.31	188 ± 3.81	385 ± 4.63
C23	1.61 ± 0.07	9.75 ± 0.14	25.9 ± 0.27
C24	4.90 ± 0.22	4.18 ± 0.73	2.29 ± 1.57
C24:1*n*-9	0.32 ± 0.09	0.65 ± 0.19	1.27 ± 0.36
∑SFA	566 ± 1.23	951 ± 0.89	1675 ± 0.33
∑UFA	2734 ± 1.23	2977 ± 0.89	3225 ± 0.33
∑MUFA	941 ± 3.31	1129 ± 2.67	1425 ± 1.60
∑PUFA	1793 ± 2.08	1847 ± 2.03	1800 ± 1.93

∑SFA: sum of saturated fatty acids; ∑UFA: sum of unsaturated fatty acids; ∑MUFA: sum of monounsaturated fatty acids; ∑PUFA: sum of polyunsaturated fatty acids; [a]5 kg of chestnuts/animal and day. [b](1.5 kg of commercial compound feed + 2.5 kg of chestnuts)/animal and day. [c]3 kg of commercial compound feed/animal and day.

dry-cured loin [11–13] and just a little higher than from other breeds [1, 14–16]. These values kept constant after 3 and 6 months of vacuum-packed storage. A similar behaviour was also reported [17, 18] because this method of storage is effective in preventing moisture losses during the storage of the meat products.

In our study, the three diets had similar daily energy, although the chestnut diet provides, per day, higher contents of fat, C18:1*n*-9, C18:2*n*-6, C18:3*n*-3, and carbohydrates (Table 1). However, intramuscular fat content of dry-cured loin was similar in the three diet groups with values about 13.5% (of dry matter). As expected, these values remained

Table 2: Biochemical, lipolytic, and oxidative parameters of dry-cured loin from Celta pig fed with three finishing diets (chestnut, mixed, and concentrate), after manufacturing process and after 3 and 6 months of vacuum-packed storage.

	Chestnuts			Chestnuts-concentrate			Concentrate		
	Final product	Storage time (months) 3	6	Final product	Storage time (months) 3	6	Final product	Storage time (months) 3	6
Dry matter (%)	65.52 ± 1.52	64.56 ± 1.92	64.93 ± 1.15	65.28 ± 2.51	64.97 ± 1.67	64.51 ± 0.77	65.29 ± 2.35	64.78 ± 2.57	65.24 ± 1.94
Intramuscular fat (%)	13.97 ± 1.32	13.64 ± 1.26	13.52 ± 1.17	13.52 ± 2.29	12.90 ± 2.57	12.88 ± 1.91	13.29 ± 1.36	13.39 ± 1.62	12.33 ± 3.32
pH	$5.44 \pm 0.12^{a}_{1}$	$5.47 \pm 0.07^{a}_{1}$	$5.58 \pm 0.15^{b}_{1}$	$5.48 \pm 0.15^{a}_{1}$	$5.57 \pm 0.09^{ab}_{1}$	$5.62 \pm 0.09^{b}_{1}$	$5.66 \pm 0.13_{2}$	$5.69 \pm 0.10_{2}$	$5.73 \pm 0.15_{2}$
Titratable acidity (% lactic acid)	0.99 ± 0.07^{a}	$1.14 \pm 0.08^{b}_{1}$	$1.12 \pm 0.10^{b}_{1}$	0.98 ± 0.17^{a}	$1.11 \pm 0.08^{b}_{1}$	$1.13 \pm 0.11^{b}_{1}$	0.94 ± 0.07	$0.95 \pm 0.07_{2}$	$1.01 \pm 0.15_{2}$
Acidity value (mg KOH/g sample)	23.12 ± 2.17^{a}	36.61 ± 3.13^{b}	$44.10 \pm 5.34^{c}_{12}$	24.01 ± 3.59^{a}	38.10 ± 4.74^{b}	$45.58 \pm 5.68^{c}_{1}$	20.90 ± 2.65^{a}	36.62 ± 3.84^{b}	$41.03 \pm 4.81^{c}_{2}$
Peroxide value (meq O_2/kg fat)	$20.35 \pm 2.44^{a}_{1}$	$13.30 \pm 1.30^{b}_{12}$	15.72 ± 1.50^{c}	$18.63 \pm 3.14^{a}_{2}$	$12.04 \pm 2.49^{b}_{1}$	16.22 ± 2.19^{c}	$16.22 \pm 2.09^{a}_{2}$	$13.83 \pm 1.34^{b}_{2}$	15.55 ± 2.05^{c}
TBA value (mg MDA/kg sample)	$0.30 \pm 0.07^{a}_{1}$	0.12 ± 0.03^{b}	0.10 ± 0.03^{b}	$0.25 \pm 0.07^{a}_{2}$	0.10 ± 0.03^{b}	0.07 ± 0.01^{b}	$0.17 \pm 0.05^{a}_{3}$	0.11 ± 0.03^{b}	0.09 ± 0.04^{b}

$^{a–c}$Different letters within the same row corresponding to the same diet group indicate significant differences ($P < 0.05$); $^{1–3}$different numbers within the same row corresponding to the same sampling point indicate significant differences ($P < 0.05$), when the three finishing diets are compared.

constant during the vacuum-packed storage. The intramuscular fat content of dry-cured loin from Celta pig is closer to those contents determined in dry-cured loin from Iberian pig [11, 12] and quite higher than manufactured from other commercial breeds [19]. Fat is probably the most variable component when dry-cured meat products elaborated from whole pieces are studied. Celta pig is characterized by a highly developed adipogenic metabolism that leads to the deposit of a great amount of fat in its tissues, obtaining higher percentages of back fat compared to other breeds [20].

The pH values (Table 2) of dry-cured loin were significantly affected by the use of chestnut in the finishing diet ($P < 0.05$). With the increase of chestnuts in the diet, a lower pH ($P < 0.05$) was obtained in the dry-cured product (5.44, 5.48, and 5.66 in chestnut, mixed, and concentrated diets, resp.). During vacuum-packed storage, pH values significantly increased ($P < 0.05$) in dry-cured loins from chestnut and mixed diets. After 6 months of storage, lower values ($P < 0.05$) were obtained in loins from chestnut and mixed diet than in concentrate one (5.58, 5.62, and 5.73, resp.). These differences among diets were also observed when the pH of *Longissimus dorsi* muscles of the pigs of the present study were studied [21]. A greater input of carbohydrates (mainly starch) is obtained by chestnut diet (over 1600 g of starch per day) than by mixed or concentrate diet (1395.5 and 1191.0 g of starch per day, resp.). A reason for the pH differences among diets could be related to the fact that the muscle from pigs fed with chestnuts would present a higher content of carbohydrates, which could cause a more prominent pH drop during the muscle rigor-mortis of these pigs, and in consequence, obtaining a lower pH value in fresh meat and in meat products. The pH values observed in the dry-cured loins were slightly lower than observed in the fresh muscles [21]. This pH decrease could have been produced during the first stages of the manufacturing process, as a result of microbial fermentation of the carbohydrates added to the dry-cured loin in its formulation. The pH increase during storage could be attributed to ammonia production as a consequence of proteolytic phenomena, an increase of buffer substances, and a decrease of electrolytes, and to the growth of microorganisms (especially molds and yeasts) capable of consuming lactic acid [22]. The pH values of the present product are in the range obtained in other dry-cured meat products [23, 24].

Dry-cured loins from the three diet groups presented similar values for titratable acidity (Table 2) around 0.97 g of lactic acid/100 of dry matter. During vacuum-packed storage, this parameter significantly increased ($P < 0.05$) in the loins from chestnut and mixed diet to values over 1.12 g of lactic acid/100 of dry matter. However, the increase of this parameter was less intense in loins from concentrate diet, reaching at the end of the storage lower values ($P < 0.05$) of 1.01 g of lactic acid/100 of dry matter than in the other diet groups. The formation of organic acids during the manufacture process causes the increase of this parameter and then, during vacuum-storage, it could be related to the microorganisms that may establish in the product in anaerobe conditions and are involved on the metabolism of these acids [25]. Our values are in the range of those reported in other dry-cured meat products [26, 27].

Regarding lipolytic parameters, the values for acidity index (Table 2), expressed as mg KOH/g of sample, in the dry-cured loins after manufacturing process were around 22 mg KOH/g of sample, finding no effect of chestnut inclusion in the finishing diet. These values progressively increased ($P < 0.05$) during the vacuum-packed storage, reaching after 6 months of storage significantly higher ($P < 0.05$) values in loins from mixed diet than from concentrate diet, while loins from chestnut diet showed intermediate acidity index values, so the differences among samples could not be attributed to the inclusion of chestnuts in the finishing diet. Lipolysis is an enzyme catalyzed process, so the factors that greatly affect the FFA content and lipolytic enzyme activity are the time/temperature cycles of the different stages of the process [2]. The absence of differences among diet groups for lipolysis degree in loin after manufacturing process (final product) is expected because they were manufactured following the same processing conditions and formulation. Our results are lower than those found in dry-cured ham [28, 29] and higher than in dry-cured sausages [18, 30]. These intermediate values are expected since the temperature and time conditions employed in the manufacture of this product are among the conditions used for the manufacture of dry-cured ham (higher temperature and longer time) and dry-cured sausages (lower temperature and shorter time).

The peroxide values (Table 2), expressed as meq O_2/kg of fat, in the final product were significantly higher ($P < 0.05$) in loins from chestnut diet than from mixed and concentrate diets. These values decreased ($P < 0.05$) during the first 3 months of vacuum-packed storage and then increased ($P < 0.05$) until the end of storage to similar values in the three diet groups. Similar peroxide values were found in several types of dry-cured meat products [7]. Nevertheless, the oxidation degree of these products is lower than that obtained in other products manufactured from the whole pieces [31, 32]. This could be due to the higher salt content of these products, which is a well-known prooxidant effect [33], and to the longer time of curing stages. The peroxide values decrease during the first months of vacuum-packed storage is related to the absence of oxygen during these stages, and the subsequent increase could be related to the oxygen permeability of the packaging material throughout the storage time [34, 35].

The TBA values (Table 2), expressed as mg of malonaldehyde (MDA)/kg of sample, of the dry-cured loins, as occurred for peroxide values, were significantly higher ($P < 0.05$) in loins from chestnut diet than from mixed and concentrated diet. During vacuum-packed storage, these values decreased to similar values in the three diet groups. Our results are in the range of previously published values in dry-cured loin [12–15, 36]. The different behaviour of TBA values throughout the storage process with respect to peroxide values could be related to the MDA instability [37] and/or to the reaction of already formed malonaldehyde with sugars or amino acids and amines obtained like a consequence of proteolytic phenomena [38]. The evolution at the end of vacuum-packed storage is quite different for peroxide and TBARS, a fact that was already verified by other authors [34, 38] that show a low reliability of TBARS analysis for the assay of lipid oxidation in a long period of time.

3.2. Fatty Acids. Fatty acid composition of neutral lipids (expressed as %) of the dry-cured loins fat is shown in Table 3. The profile is almost coincident with that of the total lipids (data not shown). In the dry-cured loin (final product), the saturated fatty acids (SFA) represented above 37%, with the palmitic (24%) and the stearic acid (11%) being the most abundant. The percentage in monounsaturated fatty acids (MUFA) was higher than SFA and around a 51%, with oleic acid (48%) being the most important of them. The less abundant fatty acids were the polyunsaturated (PUFA) (around 11%), where the linoleic acid was the main fatty acid (around 8%). When the effect of the finishing diet was studied, no significant differences were found among these major fatty acids. However, loins from chestnut group showed significant higher content ($P < 0.05$) in some minor fatty acids (C8, C11, C14, C14:1, C15, C15:1, C20, and C24:1*n*-9) and lower content ($P < 0.05$) in others (C17, C17:1, C18, C20:2*n*-6, C20:3*n*-3, and C22:1*n*-9). Linoleic acid (18:2*n*-6) is considered the parent of the *n*-6 family because animals can synthetize other *n*-6 fatty acids from it. Nevertheless, these *n*-6 fatty acids can also be directly incorporated through diet. Our results seem to indicate a direct incorporation of C20:2*n*-6, so that this fatty acid presented higher contents in the loins from pigs with a higher intake of this fatty acid [5]. This fatty acid profile of total lipids was very similar to that previously reported in dry-cured loin [12, 39, 40]. In some of these studies, the effect of the different diets was also studied, obtaining a higher content in *n*-3 fatty acids using linseed and olive oils [39]. However, no effect on *n*-3 fatty acids was obtained using pasture and acorn, though a lower content in *n*-6 fatty acids was found [40]. Along the vacuum-packed storage the fatty acid profile remained constant and the minor differences obtained could be related to the variability between samples.

In the neutral lipids (NL), only slight differences are presented, which affects PUFA, showing a lower percentage than in total lipids. This is due to the high proportion of NL in the fat [5]. SFA represented above 36%, with the most abundant being the palmitic (24%) and the stearic acid (11%). MUFA represented over a 53%, with oleic acid (50%) being the most abundant. Finally, PUFA represented a 9% and linoleic acid was the most important of them (7%). This profile coincides with that found by Domínguez et al. [5] in the fat of different intramuscular locations of Celta pig. When the effect of the finishing diet was studied, no significant differences were found for these major fatty acids. However, loins from chestnut group showed significant higher content ($P < 0.05$) in some minor fatty acids (C8, C20:1*n*-9, and C24:1*n*-9) and lower content ($P < 0.05$) in others (C20:2*n*-6). Some of these differences were already found for total fatty acids. The fatty acid composition of NL remained constant during the vacuum-packed storage, with this profile being very similar for the three diet groups. The lack of changes in this profile may be due to PL being the most affected by the lipolysis phenomena [2].

The limited effect of the different diets in this fraction of lipids and a little more pronounced in the PL (as can be seen later) could be because PL have a shorter turnover rate than triglycerides [41] and their fatty acid composition is directly more influenced by the diet. On the other hand, average triacylglycerol life has been estimated to be over 180 days [4], longer than the fattening phase of Celta pigs in this study (90 days). A similar trend was previously found in Iberian pigs [42, 43]. Nevertheless, other authors [6] reported an increment in C18:2*n*-6, C18:3*n*-3, and C20:4*n*-6 in fresh meat when chestnut was included in pig's diet.

Fatty acid composition of polar lipids (expressed as %) of the dry-cured loins fat is shown in Table 4. The fatty acid profile observed in the dry-cured loins after the manufacturing process (final product) was different to that found in total and NL. The main difference is the high content in PUFA, which supposed over 43%, with the most abundant being the linoleic acid (C18:2*n*-6) (33%). Nevertheless, MUFA only represented over 14%, while SFA supposed 43%. The major fatty acids of these two groups were oleic and palmitic acid, respectively. Like in the last lipid fractions studied, no differences were found for major fatty acids when the three diet groups of loins were compared, but they were found in some minor fatty acids, which were higher ($P < 0.05$) (C11, C15, C18:3*n*-6, C18:3*n*-3, C20:3*n*-3, and C22) or lower ($P < 0.05$) (C15:1 and C20:2*n*-6) when chestnut was introduced in the finishing diet. Because C18:2*n*-6 and C18:3*n*-3 are essential fatty acids in animal tissues, their content is directly related to their concentration in the diet. Chestnut diet provides a high quantity of these fatty acids than concentrate diet. In the dry-cured muscles, this higher intake was only evident for C18:3*n*-3. Thus, C18:2*n*-6 intake could be used to synthesise other fatty acids from *n*-6 series, like C18:3*n*-6, also in significantly higher content in loins from chestnut diet, despite being equally provided in the diets. Also, as occurred in total lipids, a direct incorporation of C20:2*n*-6 was obtained in loins from concentrate diet [5].

After vacuum-packed storage, changes in the fatty acids profile of this fraction were observed. After 3 months of storage, PUFA percentage significantly decreases ($P < 0.05$) to values around 38% and then they remained constant to the end of storage. Among these fatty acids, the most affected were the C18:2*n*-6 (descending over 10%), C18:3*n*-6, and C18:3*n*-3. The differences among diet groups were the same than those found in the final product. As mentioned above, PL are considered the main source of free fatty acids [5] and also they are highly susceptible to oxidation.

Fatty acid profile obtained for PL was similar to those reported in other studies in dry-cured loin [16, 44], although contents in PUFA were higher than those in other works [3], which could be related to the higher oxidation indexes obtained in those products.

The content in free fatty acids (FFA) (expressed as mg/100 g of fat) of the dry-cured loins fat is shown in Table 5. The mean content of FFA represented over 2700 mg/100 g of fat and no significant differences were found for this total content when the three diet groups were compared. The major fatty acids, expressed as percentage (data not shown), were around 38% for SFA, 33% for MUFA, and 27% for PUFA, and as in the

TABLE 3: Fatty acid composition of neutral lipids (%) of dry-cured loin from Celta pig fed with three finishing diets (chestnut, mixed, and concentrate), after manufacturing process and after 3 and 6 months of vacuum-packed storage.

	Chestnuts			Chestnuts-concentrate			Concentrate		
	Final product	Storage time (months) 3	Storage time (months) 6	Final product	Storage time (months) 3	Storage time (months) 6	Final product	Storage time (months) 3	Storage time (months) 6
C8	0.02 ± 0.01^{a}	$0.004 \pm 0.002^{b}_{1}$	$0.01 \pm 0.003^{c}_{1}$	0.01 ± 0.003^{ab}	$0.01 \pm 0.01^{a}_{2}$	$0.01 \pm 0.004^{b}_{2}$	0.01 ± 0.003^{a}	$0.02 \pm 0.01^{b}_{3}$	$0.003 \pm 0.001^{a}_{2}$
C10	$0.04 \pm 0.02^{a}_{1}$	$0.05 \pm 0.004^{b}_{1}$	$0.05 \pm 0.01^{b}_{1}$	$0.05 \pm 0.005_{2}$	0.05 ± 0.005	0.05 ± 0.01	$0.04 \pm 0.005_{12}$	0.04 ± 0.003	0.05 ± 0.01
C11	$0.03 \pm 0.02^{a}_{1}$	$0.005 \pm 0.001^{b}_{1}$	0.01 ± 0.01^{c}	$0.02 \pm 0.01_{12}$	$0.02 \pm 0.02_{2}$	0.01 ± 0.005	$0.01 \pm 0.01^{a}_{2}$	$0.04 \pm 0.02^{b}_{3}$	0.005 ± 0.001^{a}
C12	0.04 ± 0.02^{a}	0.05 ± 0.001^{b}	0.05 ± 0.01^{ab}	0.05 ± 0.003	0.05 ± 0.005	0.05 ± 0.003	0.04 ± 0.004	0.05 ± 0.003	0.05 ± 0.004
C14	$1.21 \pm 0.08^{a}_{1}$	1.02 ± 0.05^{b}	0.98 ± 0.10^{b}	$1.09 \pm 0.08^{a}_{2}$	0.95 ± 0.10^{b}	0.93 ± 0.06^{b}	$1.09 \pm 0.08_{2}$	1.01 ± 0.06	1.02 ± 0.06
C14:1	$0.10 \pm 0.09^{a}_{1}$	0.02 ± 0.01^{b}	0.03 ± 0.02^{b}	$0.04 \pm 0.02_{2}$	0.02 ± 0.03	0.01 ± 0.003	$0.02 \pm 0.01_{2}$	0.04 ± 0.03	0.01 ± 0.004
C15	$0.05 \pm 0.05^{a}_{1}$	0.02 ± 0.003^{b}	0.02 ± 0.001^{b}	$0.02 \pm 0.002_{2}$	0.02 ± 0.005	0.02 ± 0.003	$0.02 \pm 0.01_{2}$	0.02 ± 0.005	0.02 ± 0.003
C15:1	$0.002 \pm 0.002_{1}$	0.001 ± 0.001	0.001 ± 0.001	$0.002 \pm 0.001_{12}$	0.002 ± 0.001	0.001 ± 0.001	$0.001 \pm 0.001_{2}$	0.001 ± 0.001	0.001 ± 0.001
C16	$24.43 \pm 0.64^{a}_{1}$	$24.06 \pm 0.46^{a}_{1}$	22.85 ± 1.41^{b}	$23.39 \pm 0.90_{2}$	$22.94 \pm 1.07_{2}$	22.93 ± 0.70	$24.11 \pm 0.61_{12}$	$23.40 \pm 0.56_{12}$	23.65 ± 0.67
C16:1	2.18 ± 0.93^{a}	2.40 ± 0.10^{ab}	2.87 ± 0.50^{b}	2.31 ± 0.29	2.35 ± 0.27	2.48 ± 0.26	2.22 ± 0.27	2.48 ± 0.48	2.66 ± 0.43
C17	$0.09 \pm 0.05^{a}_{1}$	0.14 ± 0.01^{b}	0.13 ± 0.02^{ab}	$0.13 \pm 0.06_{12}$	0.16 ± 0.05	0.15 ± 0.03	$0.14 \pm 0.04_{2}$	0.13 ± 0.04	0.14 ± 0.02
C17:1	$0.11 \pm 0.05^{a}_{1}$	0.15 ± 0.01^{ab}	0.16 ± 0.03^{b}	$0.17 \pm 0.03_{2}$	0.17 ± 0.05	0.17 ± 0.04	$0.15 \pm 0.04_{12}$	0.14 ± 0.03	0.15 ± 0.02
C18	$11.09 \pm 1.04^{a}_{1}$	$12.30 \pm 0.21^{b}_{1}$	$10.33 \pm 1.32^{a}_{1}$	$11.87 \pm 0.80_{12}$	$11.55 \pm 0.45_{12}$	$11.61 \pm 0.50_{2}$	$12.21 \pm 1.22_{2}$	$11.19 \pm 1.20_{2}$	$11.55 \pm 1.07_{2}$
C18:1*n*-9	48.79 ± 1.75^{a}	49.42 ± 0.86^{ab}	$51.29 \pm 1.56^{b}_{1}$	$48.75 \pm 1.17_{1}$	49.26 ± 1.21	$48.82 \pm 1.63_{2}$	$47.89 \pm 2.80_{2}$	48.93 ± 2.21	$47.80 \pm 1.64_{2}$
C18:2*n*-6	7.97 ± 1.27	7.78 ± 0.77	7.89 ± 1.38	8.30 ± 0.92	9.33 ± 1.54	9.37 ± 1.13	8.68 ± 1.80	9.19 ± 1.86	9.22 ± 1.24
C18:3*n*-6	0.03 ± 0.002	0.05 ± 0.003	$0.05 \pm 0.004_{1}$	0.03 ± 0.003	0.06 ± 0.01	$0.06 \pm 0.01_{2}$	0.03 ± 0.01	0.05 ± 0.02	$0.05 \pm 0.004_{12}$
C18:3*n*-3	0.32 ± 0.05^{a}	0.36 ± 0.03^{b}	0.35 ± 0.05^{b}	0.34 ± 0.02^{a}	0.39 ± 0.07^{b}	0.37 ± 0.05^{b}	0.31 ± 0.07^{a}	0.34 ± 0.08^{b}	0.33 ± 0.05^{b}
C20	$0.07 \pm 0.05_{1}$	0.07 ± 0.01	0.10 ± 0.02	$0.03 \pm 0.003^{a}_{12}$	0.07 ± 0.03^{ab}	0.07 ± 0.04^{b}	$0.03 \pm 0.003^{a}_{2}$	0.08 ± 0.02^{b}	0.08 ± 0.04^{b}
C20:1*n*-9	0.05 ± 0.01^{a}	0.02 ± 0.01^{b}	0.03 ± 0.01^{b}	0.05 ± 0.01^{a}	0.03 ± 0.01^{b}	0.03 ± 0.01^{b}	0.05 ± 0.01^{a}	0.03 ± 0.01^{b}	0.02 ± 0.003^{b}
C20:2*n*-6	$0.24 \pm 0.03_{1}$	0.27 ± 0.02	$0.22 \pm 0.10_{1}$	$0.30 \pm 0.02_{12}$	0.32 ± 0.05	$0.33 \pm 0.03_{2}$	$0.34 \pm 0.09_{2}$	0.32 ± 0.06	$0.33 \pm 0.07_{2}$
C20:3*n*-6	0.11 ± 0.02^{a}	$0.10 \pm 0.02^{b}_{1}$	0.10 ± 0.02^{b}	0.10 ± 0.03^{a}	$0.14 \pm 0.05^{b}_{2}$	0.13 ± 0.02^{b}	0.10 ± 0.03^{a}	$0.11 \pm 0.03^{b}_{12}$	0.13 ± 0.04^{b}
C20:4*n*-6	0.95 ± 0.21	0.82 ± 0.20	0.99 ± 0.28	0.94 ± 0.43	1.24 ± 0.40	1.27 ± 0.33	0.91 ± 0.32	1.25 ± 0.53	1.35 ± 0.59
C20:3*n*-3	$0.03 \pm 0.02^{a}_{1}$	0.01 ± 0.002^{b}	0.01 ± 0.003^{b}	$0.06 \pm 0.004^{a}_{2}$	0.01 ± 0.001^{b}	0.01 ± 0.004^{b}	$0.06 \pm 0.02^{a}_{2}$	0.01 ± 0.002^{b}	0.01 ± 0.003^{b}
C20:5*n*-3	0.02 ± 0.01^{a}	$0.03 \pm 0.01^{b}_{12}$	0.03 ± 0.005^{b}	0.01 ± 0.005^{a}	$0.04 \pm 0.01^{b}_{1}$	0.04 ± 0.01^{b}	0.01 ± 0.001^{a}	$0.03 \pm 0.01^{b}_{2}$	0.03 ± 0.01^{b}
C22	0.03 ± 0.01^{a}	0.01 ± 0.002^{b}	0.01 ± 0.001^{b}	0.03 ± 0.01^{a}	0.01 ± 0.002^{b}	0.01 ± 0.002^{b}	0.03 ± 0.01^{a}	0.01 ± 0.003^{b}	0.01 ± 0.003^{b}
C22:1*n*-9	$0.02 \pm 0.02_{1}$	0.01 ± 0.002	0.01 ± 0.002	$0.05 \pm 0.02^{a}_{2}$	0.01 ± 0.005^{b}	0.01 ± 0.001^{b}	$0.03 \pm 0.01^{a}_{1}$	0.01 ± 0.01^{b}	0.01 ± 0.002^{b}
C22:2*n*-6	1.44 ± 0.31^{a}	0.58 ± 0.09^{b}	1.08 ± 0.50^{ab}	1.37 ± 0.47^{a}	0.52 ± 0.16^{b}	0.70 ± 0.35^{b}	1.09 ± 0.17	0.73 ± 0.28	0.89 ± 1.13
C23	0.15 ± 0.03^{a}	0.07 ± 0.01^{b}	0.16 ± 0.06^{a}	0.12 ± 0.05	0.07 ± 0.02	0.09 ± 0.04	0.10 ± 0.02^{ab}	0.09 ± 0.04^{a}	0.17 ± 0.16^{b}
C24	0.29 ± 0.12	0.14 ± 0.11	0.13 ± 0.11	0.27 ± 0.22	0.14 ± 0.07	0.20 ± 0.12	0.23 ± 0.09	0.19 ± 0.13	0.19 ± 0.21
C24:1*n*-9	$0.11 \pm 0.05^{a}_{1}$	0.05 ± 0.04^{b}	0.06 ± 0.04^{b}	$0.11 \pm 0.07_{1}$	0.07 ± 0.03	0.08 ± 0.04	$0.05 \pm 0.02_{2}$	0.07 ± 0.04	0.06 ± 0.03
∑SFA	37.53 ± 0.94^{a}	$37.94 \pm 0.34^{a}_{1}$	$34.82 \pm 2.03^{b}_{1}$	37.07 ± 1.38	$36.04 \pm 1.41_{2}$	$36.13 \pm 1.12_{12}$	38.05 ± 1.74^{a}	$36.28 \pm 1.48^{b}_{2}$	$36.93 \pm 1.07^{ab}_{2}$
∑UFA	62.48 ± 0.92^{a}	$62.06 \pm 0.34^{a}_{1}$	$65.18 \pm 2.03^{b}_{1}$	62.92 ± 1.37	$63.96 \pm 1.41_{2}$	$63.87 \pm 1.12_{12}$	61.95 ± 1.74^{a}	$63.72 \pm 1.48^{b}_{2}$	$63.07 \pm 1.07^{ab}_{2}$
∑MUFA	51.37 ± 1.94^{a}	52.07 ± 0.86^{a}	$54.45 \pm 1.79^{b}_{1}$	51.46 ± 0.94	51.91 ± 1.18	$51.60 \pm 1.63_{2}$	50.42 ± 2.95	51.70 ± 2.19	$50.72 \pm 1.52_{2}$
∑PUFA	11.12 ± 1.58	10.00 ± 0.97	10.73 ± 2.09	11.46 ± 1.57	12.05 ± 2.10	12.28 ± 1.61	11.53 ± 2.22	12.03 ± 2.46	12.35 ± 2.40

∑SFA: sum of saturated fatty acids; ∑UFA: sum of unsaturated fatty acids; ∑MUFA: sum of monounsaturated fatty acids; ∑PUFA: sum of polyunsaturated fatty acids. [a–c]Different letters within the same row corresponding to the same diet group indicate significant differences ($P < 0.05$). [1–3]Different numbers within the same row corresponding to the same sampling point indicate significant differences ($P < 0.05$), when the three finishing diets are compared.

TABLE 4: Fatty acid composition of polar lipids (%) of dry-cured loin from Celta pig feed with three finishing diets (chestnut, mixed, and concentrate), after manufacturing process and after 3 and 6 months of vacuum-packed storage.

	Chestnuts			Chestnuts-concentrate			Concentrate		
	Final product	Storage time (months) 3	6	Final product	Storage time (months) 3	6	Final product	Storage time (months) 3	6
C8	0.01 ± 0.003^{a}	0.01 ± 0.003^{a}	0.02 ± 0.003$^{b}_{12}$	0.004 ± 0.004^{a}	0.01 ± 0.003^{b}	0.02 ± 0.01$^{c}_{1}$	0.004 ± 0.002^{a}	0.01 ± 0.004^{b}	0.01 ± 0.01$^{b}_{2}$
C10	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.001 ± 0.001	N.D.	N.D.
C11	0.02 ± 0.01^{ab}	0.01 ± 0.01^{a}	0.03 ± 0.02$^{b}_{1}$	0.02 ± 0.01	0.02 ± 0.01	0.01 ± 0.01$_{2}$	0.01 ± 0.01^{a}	0.02 ± 0.02^{a}	0.03 ± 0.02$^{b}_{1}$
C12	0.02 ± 0.01^{a}	0.06 ± 0.05^{ab}	0.09 ± 0.08^{b}	0.01 ± 0.01^{a}	0.08 ± 0.06^{b}	0.06 ± 0.04^{ab}	0.02 ± 0.02^{a}	0.04 ± 0.02^{a}	0.10 ± 0.06^{b}
C14	5.22 ± 2.04^{a}	4.42 ± 0.57^{a}	5.53 ± 2.70$^{a}_{12}$	4.17 ± 2.16^{a}	5.03 ± 1.41^{ab}	6.46 ± 1.51$^{b}_{1}$	5.28 ± 1.09	4.35 ± 2.22	3.67 ± 0.68$_{2}$
C14:1	0.04 ± 0.05	0.02 ± 0.01$_{1}$	0.06 ± 0.08	0.01 ± 0.01^{a}	0.14 ± 0.18$^{b}_{2}$	0.08 ± 0.03^{ab}	0.02 ± 0.01^{a}	0.20 ± 0.15$^{b}_{2}$	0.13 ± 0.07^{b}
C15	0.14 ± 0.06^{a}	0.03 ± 0.01^{b}	0.05 ± 0.04$^{b}_{12}$	0.11 ± 0.06^{a}	0.05 ± 0.01^{b}	0.10 ± 0.05$^{ab}_{1}$	0.09 ± 0.06^{a}	0.04 ± 0.01^{ab}	0.04 ± 0.01$^{b}_{2}$
C15:1	0.09 ± 0.07	0.08 ± 0.01$_{1}$	0.08 ± 0.06$_{12}$	0.10 ± 0.06^{a}	0.15 ± 0.04$^{b}_{2}$	0.10 ± 0.03$^{a}_{1}$	0.10 ± 0.03^{a}	0.06 ± 0.04$^{ab}_{1}$	0.05 ± 0.02$^{b}_{2}$
C16	25.51 ± 1.37^{a}	25.85 ± 3.68^{a}	25.69 ± 1.84$^{a}_{12}$	27.74 ± 1.72	27.07 ± 2.51	27.78 ± 0.93$_{1}$	27.31 ± 1.62	27.32 ± 2.40	27.12 ± 1.67$_{2}$
C16:1	1.36 ± 0.55^{a}	0.57 ± 0.20^{b}	0.54 ± 0.08^{b}	1.49 ± 0.80^{a}	0.52 ± 0.12^{b}	0.35 ± 0.07^{b}	1.69 ± 0.47^{a}	0.73 ± 0.37^{b}	0.57 ± 0.33^{b}
C17	3.24 ± 1.21	3.29 ± 1.55	3.88 ± 1.43$_{1}$	3.19 ± 2.14^{a}	2.73 ± 1.31^{a}	2.09 ± 1.56$^{b}_{2}$	2.50 ± 0.83	2.95 ± 1.19	3.53 ± 1.08$_{1}$
C17:1	1.62 ± 0.61	1.71 ± 0.74	1.87 ± 1.21	1.50 ± 1.06^{ab}	1.36 ± 0.88^{a}	2.41 ± 0.58^{b}	1.30 ± 0.42	1.71 ± 0.75	1.70 ± 0.60
C18	6.90 ± 0.36^{a}	7.35 ± 1.38^{ab}	8.72 ± 2.74$^{b}_{1}$	7.65 ± 0.81^{a}	8.30 ± 1.12^{a}	8.25 ± 1.75$^{a}_{12}$	6.80 ± 0.89	7.86 ± 1.32	6.89 ± 1.12$_{2}$
C18:1n-9	11.35 ± 2.39^{a}	14.85 ± 2.37$^{b}_{1}$	13.92 ± 1.21^{b}	10.90 ± 1.39^{a}	12.09 ± 1.42$^{b}_{2}$	12.65 ± 0.77^{b}	10.67 ± 1.91^{a}	13.86 ± 4.03$^{b}_{12}$	12.83 ± 2.92^{ab}
C18:2n-6	34.36 ± 2.50^{a}	25.84 ± 2.19^{b}	24.42 ± 2.94^{b}	32.23 ± 1.74^{a}	26.83 ± 2.92^{b}	24.83 ± 2.13^{b}	31.92 ± 4.15^{a}	26.03 ± 4.23^{b}	24.55 ± 3.80^{b}
C18:3n-6	0.13 ± 0.02$^{a}_{1}$	0.12 ± 0.02$^{a}_{1}$	0.09 ± 0.02$^{b}_{12}$	0.11 ± 0.02$^{a}_{2}$	0.13 ± 0.02$^{a}_{1}$	0.10 ± 0.01$^{b}_{1}$	0.09 ± 0.01$_{2}$	0.09 ± 0.01$_{2}$	0.08 ± 0.02$_{2}$
C18:3n-3	0.37 ± 0.08$^{a}_{1}$	0.36 ± 0.04$^{a}_{1}$	0.31 ± 0.02$^{b}_{1}$	0.32 ± 0.03$^{a}_{12}$	0.28 ± 0.05$^{b}_{2}$	0.17 ± 0.06$^{a}_{2}$	0.26 ± 0.05$_{2}$	0.25 ± 0.04$_{2}$	0.22 ± 0.03$_{2}$
C20	0.03 ± 0.01^{a}	0.08 ± 0.02$^{b}_{1}$	0.05 ± 0.01$^{c}_{12}$	0.03 ± 0.01^{a}	0.06 ± 0.03$^{b}_{2}$	0.07 ± 0.02$^{b}_{1}$	0.02 ± 0.01^{a}	0.04 ± 0.01$^{ab}_{2}$	0.04 ± 0.01$^{b}_{2}$
C20:1n-9	0.18 ± 0.04^{a}	0.28 ± 0.04$^{b}_{1}$	0.28 ± 0.06$^{b}_{1}$	0.22 ± 0.05^{a}	0.37 ± 0.04$^{b}_{2}$	0.41 ± 0.02$^{b}_{2}$	0.22 ± 0.06^{a}	0.28 ± 0.03$^{b}_{1}$	0.30 ± 0.07$^{b}_{1}$
C20:2n-6	0.43 ± 0.04$^{a}_{1}$	0.57 ± 0.05$^{b}_{1}$	0.68 ± 0.04$^{b}_{1}$	0.57 ± 0.07$^{a}_{2}$	0.79 ± 0.07$^{b}_{2}$	0.94 ± 0.04$^{c}_{2}$	0.61 ± 0.05$^{a}_{2}$	0.71 ± 0.16$^{b}_{2}$	0.77 ± 0.25$^{b}_{1}$
C20:3n-6	0.98 ± 0.13	1.03 ± 0.17	1.06 ± 0.13$_{12}$	0.93 ± 0.11^{a}	1.03 ± 0.07^{a}	1.26 ± 0.07$^{b}_{1}$	0.88 ± 0.07	0.86 ± 0.23	0.88 ± 0.34$_{2}$
C20:4n-6	6.77 ± 1.71^{a}	8.49 ± 3.36^{a}	9.39 ± 2.20^{b}	7.27 ± 2.97^{a}	9.48 ± 1.31^{ab}	9.06 ± 1.63^{b}	8.16 ± 2.78	9.48 ± 1.80	8.80 ± 3.34
C20:3n-3	0.06 ± 0.03	0.08 ± 0.01	0.06 ± 0.03$_{1}$	0.07 ± 0.01^{a}	0.09 ± 0.01^{ab}	0.11 ± 0.01$^{b}_{2}$	0.04 ± 0.03^{a}	0.08 ± 0.01^{b}	0.09 ± 0.03$^{b}_{2}$
C20:5n-3	0.01 ± 0.01^{a}	0.01 ± 0.004^{a}	0.05 ± 0.03$^{b}_{1}$	0.01 ± 0.002^{a}	0.03 ± 0.002^{a}	0.07 ± 0.01$^{b}_{1}$	0.01 ± 0.005^{a}	0.02 ± 0.02^{a}	0.11 ± 0.05$^{b}_{2}$
C22	0.48 ± 0.04$^{a}_{1}$	0.63 ± 0.15$^{b}_{1}$	0.64 ± 0.08$^{b}_{1}$	0.46 ± 0.12$^{a}_{1}$	0.54 ± 0.06$^{ab}_{1}$	0.59 ± 0.07$^{b}_{1}$	0.35 ± 0.03$_{2}$	0.40 ± 0.05$_{2}$	0.40 ± 0.07$_{2}$
C22:1n-9	0.02 ± 0.005^{a}	0.04 ± 0.01^{a}	0.10 ± 0.02$^{b}_{1}$	0.02 ± 0.005^{a}	0.04 ± 0.004^{a}	0.24 ± 0.15$^{b}_{2}$	0.02 ± 0.01	0.05 ± 0.05	0.05 ± 0.004$_{1}$
C22:2n-6	0.33 ± 0.27^{a}	0.77 ± 0.19$^{b}_{12}$	0.90 ± 0.33$^{b}_{12}$	0.46 ± 0.23^{a}	0.52 ± 0.38$^{a}_{1}$	0.64 ± 0.12$^{a}_{1}$	0.64 ± 0.41^{a}	1.13 ± 0.54$^{b}_{2}$	1.32 ± 0.55$^{b}_{2}$
C23	0.03 ± 0.01^{a}	0.04 ± 0.01^{a}	0.09 ± 0.07$^{a}_{1}$	0.03 ± 0.02^{a}	0.07 ± 0.005^{a}	0.28 ± 0.22$^{b}_{2}$	0.04 ± 0.01	0.04 ± 0.02	0.10 ± 0.06$_{1}$
C24	0.24 ± 0.30^{a}	2.80 ± 0.73^{b}	1.14 ± 1.31$^{ab}_{1}$	0.21 ± 0.25^{a}	1.82 ± 0.69^{a}	0.68 ± 0.22$^{a}_{1}$	0.77 ± 0.89^{a}	1.18 ± 1.31^{a}	4.61 ± 3.75$^{b}_{2}$
C24:1n-9	0.09 ± 0.13^{a}	0.60 ± 0.19$^{b}_{1}$	0.25 ± 0.25$^{a}_{1}$	0.18 ± 0.19^{a}	0.37 ± 0.14$^{a}_{12}$	0.19 ± 0.06$^{a}_{1}$	0.15 ± 0.16^{a}	0.20 ± 0.16$^{a}_{2}$	0.99 ± 0.75$^{b}_{2}$
∑SFA	41.82 ± 1.89^{a}	44.58 ± 3.29^{ab}	45.93 ± 4.15^{b}	43.62 ± 2.33	45.77 ± 4.01	46.40 ± 0.49	43.19 ± 2.02	44.26 ± 2.66	46.56 ± 3.54
∑UFA	58.18 ± 1.89^{a}	55.42 ± 3.29^{ab}	54.07 ± 4.15^{b}	56.38 ± 2.33	54.23 ± 4.01	53.60 ± 0.49	56.81 ± 2.02	55.74 ± 2.66	53.44 ± 3.54
∑MUFA	14.75 ± 2.14^{a}	18.16 ± 1.77$^{b}_{1}$	17.10 ± 0.80^{a}	14.42 ± 1.37	15.05 ± 1.20$_{2}$	16.43 ± 0.89$_{1}$	14.18 ± 1.88^{a}	17.09 ± 4.38$^{b}_{12}$	16.61 ± 3.21$^{ab}_{2}$
∑PUFA	43.43 ± 2.74^{a}	37.27 ± 5.03^{b}	36.97 ± 4.57^{ab}	41.97 ± 3.19^{a}	39.18 ± 3.88^{ab}	37.17 ± 0.86^{b}	42.63 ± 3.57^{a}	38.65 ± 4.01^{ab}	36.83 ± 6.17^{b}

∑SFA: sum of saturated fatty acids; ∑UFA: sum of unsaturated fatty acids; ∑MUFA: sum of monounsaturated fatty acids; ∑PUFA: sum of polyunsaturated fatty acids. $^{a–c}$Different letters within the same row corresponding to the same diet group indicate significant differences ($P < 0.05$). $^{1–3}$Different numbers within the same row corresponding to the same sampling point indicate significant differences ($P < 0.05$), when the three finishing diets are compared.

Table 5: Free fatty acids content (mg/100 g of fat) of dry-cured loin from Celta pig fed with three finishing diets (chestnut, mixed, and concentrate), after manufacturing process and after 3 and 6 months of vacuum-packed storage.

	Chestnuts			Chestnuts-concentrate			Concentrate		
	Final product	Storage time (months) 3	6	Final product	Storage time (months) 3	6	Final product	Storage time (months) 3	6
C8	0.08 ± 0.03^{a}	$0.44 \pm 0.28^{b}_{1}$	0.18 ± 0.23^{a}	0.11 ± 0.07	$0.07 \pm 0.03_{2}$	0.21 ± 0.19	0.15 ± 0.18	$0.05 \pm 0.01_{2}$	0.09 ± 0.02
C10	0.78 ± 0.17^{a}	2.66 ± 0.20^{b}	$4.00 \pm 0.80^{c}_{1}$	0.88 ± 0.10^{a}	2.21 ± 0.21^{b}	$4.32 \pm 0.56^{c}_{1}$	0.78 ± 0.17^{a}	2.38 ± 0.47^{b}	$3.08 \pm 0.47^{c}_{2}$
C11	$0.05 \pm 0.04^{a}_{1}$	0.18 ± 0.05^{b}	0.27 ± 0.04^{c}	$0.07 \pm 0.03^{a}_{1}$	0.15 ± 0.05^{a}	0.30 ± 0.04^{b}	$0.19 \pm 0.19_{2}$	0.15 ± 0.04	0.22 ± 0.02
C12	$1.43 \pm 0.51^{a}_{1}$	$2.34 \pm 0.25^{b}_{1}$	$3.59 \pm 0.77^{c}_{1}$	$1.38 \pm 0.31^{a}_{2}$	$2.08 \pm 0.39^{b}_{2}$	$2.95 \pm 0.25^{c}_{12}$	$1.07 \pm 0.15^{a}_{2}$	$2.01 \pm 0.17^{b}_{3}$	$2.83 \pm 0.57^{c}_{2}$
C14	19.85 ± 5.01^{a}	$46.33 \pm 5.04^{b}_{1}$	$65.74 \pm 8.14^{c}_{1}$	19.11 ± 3.05^{a}	$37.74 \pm 5.52^{b}_{2}$	$54.93 \pm 7.46^{c}_{2}$	17.54 ± 3.88^{a}	$45.45 \pm 9.93^{b}_{1}$	$55.85 \pm 7.28^{c}_{2}$
C14:1	0.24 ± 0.07^{a}	$0.45 \pm 0.03^{b}_{1}$	$0.71 \pm 0.05^{c}_{1}$	0.24 ± 0.05^{a}	$0.37 \pm 0.07^{b}_{2}$	$0.58 \pm 0.12^{c}_{2}$	0.22 ± 0.04^{a}	$0.46 \pm 0.06^{b}_{1}$	$0.60 \pm 0.05^{c}_{2}$
C15	$1.38 \pm 0.05^{a}_{12}$	1.99 ± 0.13^{b}	2.04 ± 0.21^{b}	$1.65 \pm 0.46^{a}_{1}$	2.06 ± 0.35^{b}	2.06 ± 0.36^{b}	$1.23 \pm 0.29^{a}_{2}$	1.77 ± 0.45^{b}	1.96 ± 0.30^{b}
C15:1	$0.02 \pm 0.01^{ab}_{1}$	$0.01 \pm 0.01^{a}_{1}$	$0.03 \pm 0.02^{b}_{12}$	$0.05 \pm 0.03^{a}_{2}$	$0.03 \pm 0.02^{b}_{12}$	$0.02 \pm 0.01^{b}_{1}$	$0.01 \pm 0.01^{a}_{1}$	$0.03 \pm 0.01^{b}_{2}$	$0.04 \pm 0.004^{b}_{2}$
C16	680.86 ± 114.75^{a}	1118.17 ± 136.99^{b}	$1449.04 \pm 254.88^{c}_{1}$	783.47 ± 189.31^{a}	1019.24 ± 157.95^{b}	$1262.90 \pm 88.46^{c}_{2}$	637.12 ± 119.71^{a}	938.43 ± 73.09^{b}	$1177.97 \pm 180.22^{c}_{2}$
C16:1	42.05 ± 6.42^{a}	62.73 ± 9.30^{b}	$95.11 \pm 11.13^{c}_{1}$	40.53 ± 5.26^{a}	53.05 ± 8.77^{b}	$76.93 \pm 20.79^{c}_{2}$	36.25 ± 7.71^{a}	53.56 ± 3.39^{b}	$69.95 \pm 12.11^{c}_{2}$
C17	$8.57 \pm 0.78^{a}_{12}$	$14.66 \pm 2.85^{b}_{1}$	15.23 ± 1.13^{b}	$10.32 \pm 2.32^{a}_{1}$	$14.99 \pm 4.40^{b}_{1}$	15.21 ± 2.56^{b}	$7.20 \pm 1.71^{a}_{2}$	$10.64 \pm 1.08^{b}_{2}$	12.83 ± 1.92^{b}
C17:1	3.78 ± 0.40^{a}	6.31 ± 1.46^{b}	$6.82 \pm 0.76^{b}_{1}$	5.25 ± 0.92^{a}	5.71 ± 1.27^{a}	$8.70 \pm 3.34^{b}_{2}$	4.34 ± 0.87	4.65 ± 0.45	$4.60 \pm 2.17_{3}$
C18	257.30 ± 40.29^{a}	480.31 ± 10.81^{b}	$651.41 \pm 113.57^{c}_{1}$	280.81 ± 57.27^{a}	482.94 ± 44.34^{b}	$585.87 \pm 46.80^{c}_{12}$	266.44 ± 43.73^{a}	418.36 ± 47.45^{b}	$539.71 \pm 72.84^{c}_{2}$
C18:1*n*-9	842.50 ± 112.84^{a}	1180.02 ± 139.06^{b}	$1574.24 \pm 88.62^{c}_{1}$	910.03 ± 94.12^{a}	1057.36 ± 88.18^{a}	$1304.07 \pm 193.82^{b}_{2}$	828.82 ± 183.70^{a}	1109.08 ± 82.26^{b}	$1213.99 \pm 256.72^{b}_{2}$
C18:2*n*-6	$557.27 \pm 28.20^{a}_{12}$	446.58 ± 27.16^{b}	471.71 ± 36.01^{b}	$626.10 \pm 103.47^{a}_{1}$	522.66 ± 68.00^{b}	522.30 ± 48.00^{b}	$524.67 \pm 128.77_{2}$	465.49 ± 72.48	525.69 ± 59.27
C18:3*n*-6	3.41 ± 0.40	$2.98 \pm 0.42_{12}$	3.00 ± 0.16	3.60 ± 0.77	$3.37 \pm 0.78_{1}$	3.35 ± 0.38	3.07 ± 0.69	$2.60 \pm 0.39_{2}$	3.09 ± 0.42

Table 5: Continued.

	Chestnuts			Chestnuts-concentrate			Concentrate		
	Final product	Storage time (months) 3	6	Final product	Storage time (months) 3	6	Final product	Storage time (months) 3	6
C18:3n-3	$17.77 \pm 2.60^{a}_{1}$	$14.04 \pm 0.53^{b}_{12}$	$16.93 \pm 1.47^{a}_{1}$	$17.00 \pm 2.36_{1}$	$15.10 \pm 2.94_{1}$	$14.69 \pm 2.38_{12}$	$12.68 \pm 3.39_{2}$	$11.76 \pm 0.85_{2}$	$13.52 \pm 2.35_{2}$
C20	2.24 ± 0.51^{a}	3.61 ± 0.44^{b}	4.67 ± 0.88^{c}	2.50 ± 0.48^{a}	3.31 ± 0.52^{b}	4.11 ± 0.37^{c}	2.06 ± 0.45^{a}	3.33 ± 0.18^{b}	4.18 ± 0.72^{c}
C20:1n-9	12.76 ± 1.43^{a}	19.22 ± 2.50^{b}	24.89 ± 2.58^{c}	14.36 ± 2.60^{a}	17.40 ± 0.81^{a}	23.21 ± 5.33^{b}	14.89 ± 3.35^{a}	19.31 ± 2.28^{b}	22.61 ± 3.18^{b}
C20:2n-6	$6.37 \pm 1.06^{a}_{1}$	9.26 ± 0.71^{b}	$10.82 \pm 0.77^{b}_{1}$	$8.36 \pm 1.11^{a}_{2}$	10.55 ± 1.59^{b}	$13.48 \pm 2.47^{c}_{2}$	$9.02 \pm 1.71^{a}_{2}$	10.83 ± 1.24^{b}	$13.48 \pm 1.31^{c}_{2}$
C20:3n-6	10.04 ± 2.93^{a}	7.47 ± 0.92^{b}	6.20 ± 0.58^{b}	11.10 ± 1.91^{a}	8.36 ± 2.13^{b}	8.54 ± 1.48^{b}	11.29 ± 3.53^{a}	6.96 ± 2.16^{b}	7.73 ± 1.23^{b}
C20:4n-6	119.52 ± 45.79	139.76 ± 44.09	$153.46 \pm 24.72_{1}$	91.85 ± 22.48	126.45 ± 34.77	$124.02 \pm 38.98_{2}$	85.76 ± 15.61^{a}	119.59 ± 11.76^{ab}	$145.95 \pm 49.86^{b}_{2}$
C20:3n-3	$1.61 \pm 0.49_{1}$	1.68 ± 0.20	$1.72 \pm 0.31_{1}$	$2.24 \pm 0.42_{12}$	1.98 ± 0.46	$2.11 \pm 0.38_{2}$	$2.28 \pm 0.46^{a}_{2}$	0.65 ± 0.82^{b}	$0.49 \pm 0.35^{b}_{2}$
C20:5n-3	$0.59 \pm 0.16^{a}_{12}$	$0.43 \pm 0.36^{ab}_{1}$	$0.97 \pm 0.39^{b}_{1}$	$0.99 \pm 0.39_{1}$	$0.96 \pm 0.69_{2}$	$2.10 \pm 0.22^{b}_{2}$	$0.18 \pm 0.25^{a}_{2}$	$0.77 \pm 0.48^{b}_{12}$	$2.03 \pm 0.54^{c}_{2}$
C22	$4.02 \pm 0.95^{a}_{1}$	$4.05 \pm 0.50^{a}_{1}$	2.96 ± 0.31^{b}	$4.25 \pm 0.94_{1}$	$3.31 \pm 0.62_{12}$	3.59 ± 0.11	$2.07 \pm 1.77_{2}$	$2.60 \pm 0.91_{2}$	2.87 ± 0.34
C22:1n-9	0.65 ± 0.10	$0.77 \pm 0.43_{1}$	$0.80 \pm 0.37_{1}$	0.74 ± 0.19^{ab}	$0.96 \pm 0.39^{a}_{12}$	$0.41 \pm 0.17^{b}_{2}$	0.61 ± 0.30^{a}	$1.15 \pm 0.25^{b}_{2}$	$0.80 \pm 0.25^{a}_{1}$
C22:2n-6	74.29 ± 7.39^{a}	$122.36 \pm 15.63^{b}_{1}$	179.02 ± 26.91^{c}	64.75 ± 13.45^{a}	$201.88 \pm 95.53^{b}_{2}$	141.02 ± 25.56^{c}	63.81 ± 19.62^{a}	$150.02 \pm 26.25^{b}_{1}$	160.56 ± 24.46^{c}
C23	4.80 ± 0.49^{a}	$8.42 \pm 2.11^{a}_{1}$	$15.36 \pm 3.42^{b}_{1}$	4.38 ± 0.54^{a}	$13.77 \pm 6.82^{b}_{2}$	$9.95 \pm 3.15^{c}_{2}$	4.84 ± 2.34^{a}	$9.85 \pm 2.71^{b}_{1}$	$10.98 \pm 2.31^{c}_{2}$
C24	31.56 ± 5.85^{a}	81.80 ± 28.92^{b}	$54.12 \pm 16.73^{ab}_{1}$	52.83 ± 30.72^{a}	73.75 ± 56.84^{a}	$136.08 \pm 26.69^{b}_{2}$	53.05 ± 46.99^{a}	80.29 ± 31.15^{ab}	$106.75 \pm 34.38^{b}_{2}$
C24:1n-9	$19.67 \pm 5.52_{12}$	24.87 ± 6.55	$21.91 \pm 10.78_{1}$	$29.14 \pm 7.53^{a}_{1}$	25.60 ± 15.60^{a}	$49.21 \pm 17.33^{b}_{2}$	$12.36 \pm 8.45^{a}_{2}$	28.40 ± 9.85^{b}	$46.21 \pm 11.21^{c}_{2}$
∑FFA	2725.48 ± 236.95^{a}	3803.91 ± 291.97^{b}	$4836.99 \pm 480.95^{c}_{1}$	2988.07 ± 450.03^{a}	3707.42 ± 464.09^{b}	$4377.22 \pm 373.63^{c}_{12}$	2604.01 ± 434.95^{a}	3500.63 ± 279.32^{b}	$4150.65 \pm 499.72^{c}_{2}$
∑SFA	1012.93 ± 142.95^{a}	1764.96 ± 145.52^{b}	$2268.63 \pm 359.49^{c}_{1}$	1161.77 ± 273.38^{a}	1655.63 ± 242.04^{b}	$2082.48 \pm 126.77^{c}_{12}$	993.74 ± 161.35^{a}	1515.31 ± 115.42^{b}	$1919.30 \pm 249.30^{c}_{2}$
∑UFA	1712.55 ± 151.29^{a}	2038.95 ± 172.79^{b}	$2568.37 \pm 140.48^{c}_{1}$	1826.30 ± 184.73^{a}	2051.79 ± 249.55^{a}	$2294.74 \pm 248.30^{b}_{12}$	1610.26 ± 337.28^{a}	1985.32 ± 184.13^{b}	$2231.35 \pm 295.67^{b}_{2}$
∑MUFA	921.67 ± 112.07^{a}	1294.38 ± 144.86^{b}	$1724.51 \pm 93.60^{c}_{1}$	1000.33 ± 100.30^{a}	1160.48 ± 112.14^{a}	$1463.13 \pm 214.66^{b}_{2}$	897.51 ± 192.32^{a}	1216.65 ± 88.47^{b}	$1358.81 \pm 264.36^{b}_{2}$
∑PUFA	790.88 ± 58.58	$744.56 \pm 63.42_{1}$	843.86 ± 57.84	825.97 ± 118.07	$891.31 \pm 163.94_{2}$	831.62 ± 61.94	712.75 ± 154.86^{a}	$768.67 \pm 95.93^{ab}_{12}$	872.53 ± 85.27^{b}

∑FFA: sum of free fatty acids; ∑SFA: sum of saturated fatty acids; ∑UFA: sum of unsaturated fatty acids; ∑MUFA: sum of monounsaturated fatty acids; ∑PUFA: sum of polyunsaturated fatty acids. [a–c]Different letters within the same row corresponding to the same diet group indicate significant differences ($P < 0.05$). [1–3]Different numbers within the same row corresponding to the same sampling point indicate significant differences ($P < 0.05$), when the three finishing diets are compared.

Table 6: Results of canonical discriminant analysis: loadings of correlation matrix between predictor variables (standardized canonical coefficients) and discriminant functions (roots 1 and 2).

Fatty acids	Total fatty acids				Neutral lipids				Polar lipids				Free fatty acids			
	Final product		After storage		Final product		After storage		Final product		After storage		Final product		After storage	
	Root 1	*Root 2*	*Root 1*	*Root 2*	*Root 1*	*Root 2*	*Root 1*	*Root 2*	*Root 1*	*Root 2*	*Root 1*	*Root 2*	*Root 1*	*Root 2*	*Root 1*	*Root 2*
C8									1.960	−0.279						
C10					2.085	−1.058										
C11	−1.073	1.052	2.455	0.523												
C12															4.286	1.750
C14					−1.649	0.943			−8.483	1.054						
C14:1													−0.011	0.089		
C15			1.812	0.364							0.388	0.123				
C15:1					0.907	0.585					−0.071	−0.505				
C16			−1.087	0.243											−2.547	−3.738
C16:1									7.730	−1.666					4.319	1.446
C17									−2.701	0.835	1.593	−0.449				
C17:1	−1.929	1.384														
C18					0.848	−0.333										
C18:1*n*-9									0.748	−0.905			0.600	−0.496	1.890	−0.604
C18:2*n*-6							−3.246	5.010	0.748	−0.905			0.630	1.656		
C18:3*n*-6															−2.581	1.599
C18:3*n*-3	2.597	−0.059					1.963	−3.369					−1.294	0.210		
C20					0.749	−0.972										
C20:1*n*-9					0.784	−0.028									−7.534	0.257
C20:2*n*-6	−1.725	−0.414	−1.236	0.148							2.069	1.321				
C20:3*n*-6					−0.953	−0.001	−1.424	−0.730	−0.254	0.538	−1.390	−1.441			1.658	0.348
C20:4*n*-6	0.058	−0.379	−2.083	0.644			0.744	−4.360			−1.727	0.092				
C20:3*n*-3											0.457	−0.036	0.542	−0.104		
C20:5*n*-3	0.898	−0.685					1.258	3.166								
C22					0.423	0.409			1.041	−1.872					−0.961	−2.000
C22:1*n*-9			1.414	0.476									−0.344	0.170		
C22:2*n*-6			1.129	0.527									−0.216	−1.346		
C23	1.185	−0.388														
C24													−0.016	−0.162		
C24:1*n*-9			−1.274	−1.585			1.273	0.046								
Statistics																
Canonical *R*	0.936	0.544	0.951	0.522	0.911	0.817	0.940	0.656	0.895	0.756	0.942	0.788	0.810	0.665	0.968	0.904
Eigenvalue	7.06	0.42	9.53	0.38	4.88	2.01	7.59	0.76	4.02	1.33	7.86	1.64	1.91	0.79	14.96	4.50
Cumulative proportion	0.944	1.000	0.962	1.000	0.708	1.000	0.909	1.000	0.751	1.000	0.827	1.000	0.707	1.000	0.769	1.000
Probability	0.010	0.649	0.015	0.818	0.007	0.080	0.001	0.217	0.009	0.118	0.001	0.070	0.268	0.458	0.000	0.007

last fractions studied, the most representatives in each groups were palmitic and stearic, oleic, and linoleic acid, respectively. In the final product, significant differences ($P < 0.05$) were found in some minor fatty acids, with higher (C12, C18:3*n*-3, and C22:1*n*-9) and lower (C20:2*n*-6 and C20:3*n*-3) content in loins from chestnut diet. The values and the profile obtained in the present study for FFA are similar to those previously reported in the scientific literature for dry-cured loin [3, 16]. The similarity of the profile with the beforehand studied about PL, especially with regard to high PUFA percentage, confirms that FFA comes mainly from polar fraction but also is perceived as an influence of NL.

After vacuum-packed storage, as occurred for acidity index, FFA content significantly increased ($P < 0.05$) to reach after six months of storage higher values in loins from chestnut diet than in concentrate diets. The FFA profile was also modified during storage, decreasing PUFA to 19% and increasing SFA to 46%. This alteration leads us to think that a change in the acting microbial enzymes could have happened. Some authors attributed the higher lipolysis during the vacuum-storage to the action of lactic acid bacteria [45] in addition to endogenous lipases and phospholipases.

3.3. Discrimination of the Different Finishing Diets. With the objective of discrimination between diets, multivariate statistical techniques were applied. The variables used for the analysis were the percentage of the fatty acids for total PL and NL and the content in free fatty acids. In the final product and after storage, a factorial analysis was previously performed to obtain the variables which contributed the most to the classification. From these variables, a canonical discriminant analysis was carried out and the coefficients (correlation discriminant functions) obtained are presented in Table 6. When canonical discriminant analysis was performed for their selected fatty acids, the percentage of classification was of the 100% for the final product and the product after storage in all the lipids fractions, except for the total lipids in the product after storage, with a classification of the 94.4%, in NL in the final product with a classification of the 94.4% and in FFA in the final product with a classification of the 88.9%.

The functions with the highest signification ($P < 0.001$) were root 1 for NL and PL and FFA after being vacuum-packed. A larger coefficient corresponds to a greater contribution of the respective variable to the discrimination between groups. The fatty acids with the highest discriminating power (Table 6) were in the final product C18:3*n*-3 acid for total lipids, C10 acid for NL, C14 acid for PL, and C18:2*n*-6 acid for FFA. In the product after storage, the fatty acids with the highest discriminating power were C11 acid for total lipids, C18:2*n*-6 acid for NL, C20:2*n*-6 acid for PL, and C20:1*n*-9 acid for free fatty acids.

Within the fatty provided in a large quantity by the chestnut diet, C18:2*n*-6 could be introduced in the classification of the diet groups in NL in the final product and in PL in the product after storage. However, C18:3*n*-3 could be also used in the classification of the diets for the total lipids and FFA in the final product and in NL in the product after storage. C18:1*n*-9 could be introduced in the discrimination roots in the final product for PL and FFA and for FFA in the product after storage. Within the fatty acids provided in a small quantity by the chestnut diet, C20:2*n*-6 could be used in the discriminant roots for total lipids in the final product and in the product after storage and for PL in the product after storage. Finally, C20:4*n*-6 could be used for the discrimination of the diets for total lipids in the final product and in the product after storage and for NL and PL in the product after storage. The fatty acids that could be introduced in a greater number of roots were the C20:3*n*-6 and C20:4*n*-6.

These results are in accordance with a previous work, where "chorizo," a traditional dry-cured Spanish sausage, was manufactured with the meat of these Celta pigs [46]. In this study, also the fatty acids C18:2*n*-6, C18:3*n*-3, C18:1*n*-9, C20:2*n*-6, and C20:4*n*-6 could be used in the classification of the diets in the different lipid fractions.

4. Conclusions

A study of the main characteristics of dry-cured loin from Celta pig was performed, including the description of the fatty acid profile of the different lipid fractions. Also, the vacuum storability of the product was checked. Chestnuts inclusion in the finishing diet of Celta pig resulted in a lower pH value and in higher values of oxidation parameters of the dry-cured loin. However, fatty acid profile of the different lipid fractions was generally not affected by finishing diet, although, when a discriminant canonical analysis was performed, the discernment between the three finishing diets was procured. According to these results, including chestnuts on Celta pig feeding in an extensive regime would result in a remarkable impact on the main characteristics of the dry-cured products. Nevertheless, further researches (volatile compounds and sensory analysis) should be carried out in order to determine if the higher fat oxidation in loins from chestnut diet could be decisive in the acceptation of this dry-cured product.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Acknowledgments

This work was financially supported by the Spanish Ministry of Science and Innovation (Grant AGL2008-05274-C02-01/ALI). Authors also wish to thank Instituto Ourensano de Desarrollo (INORDE) for its valuable collaboration with pig rearing and to Meat Technology Center of Galicia (Ourense, Spain) for the collaboration in the sausage manufacture.

References

[1] M. Aliño, R. Grau, F. Toldrá, E. Blesa, M. J. Pagán, and J. M. Barat, "Influence of sodium replacement on physicochemical properties of dry-cured loin," *Meat Science*, vol. 83, no. 3, pp. 423–430, 2009.

[2] G. Gandemer, "Lipids in muscles and adipose tissues, changes during processing and sensory properties of meat products," *Meat Science*, vol. 62, no. 3, pp. 309–321, 2002.

[3] E. Muriel, A. I. Andres, M. J. Petron, T. Antequera, and J. Ruiz, "Lipolytic and oxidative changes in Iberian dry-cured loin," *Meat Science*, vol. 75, no. 2, pp. 325–333, 2007.

[4] I. Franco, M. Cristina Escamilla, J. García, M. C. García Fontán, and J. Carballo, "Fatty acid profile of the fat from Celta pig breed fattened using a traditional feed: Effect of the location in the carcass," *Journal of Food Composition and Analysis*, vol. 19, no. 8, pp. 792–799, 2006.

[5] R. Domínguez, S. Martínez, M. Gómez, J. Carballo, and I. Franco, "Fatty acids, retinol and cholesterol composition in various fatty tissues of Celta pig breed: Effect of the use of chestnuts in the finishing diet," *Journal of Food Composition and Analysis*, vol. 37, pp. 104–111, 2015.

[6] C. Coutron-Gambotti, G. Gandemer, and F. Casabianca, "Effects of substituting a concentrated diet for chestnuts on the lipid traits of muscle and adipose tissues in Corsican and Corsican × Large White pigs reared in a sylvo-pastoral system in Corsica," *Meat Science*, vol. 50, no. 2, pp. 163–174, 1998.

[7] I. Franco, B. Prieto, J. M. Cruz, M. López, and J. Carballo, "Study of the biochemical changes during the processing of Androlla, a Spanish dry-cured pork sausage," *Food Chemistry*, vol. 78, no. 3, pp. 339–345, 2002.

[8] J. Folch, M. Lees, and G. H. Sloane Stanley, "A simple method for the isolation and purification of total lipides from animal tissues," *The Journal of Biological Chemistry*, vol. 226, no. 1, pp. 497–509, 1957.

[9] M. A. Kaluzny, L. A. Duncan, M. V. Merritt, and D. E. Epps, "Rapid separation of lipid classes in high yield and purity using bonded phase columns," *Journal of Lipid Research*, vol. 26, no. 1, pp. 135–140, 1985.

[10] A. Shehata, J. deMan, and J. Alexander, "A Simple and Rapid Method for the Preparation of Methyl Esters of Fats in Milligram Amounts for Gas Chromatography," *Canadian Institute of Food Technology Journal*, vol. 3, no. 3, pp. 85–89, 1970.

[11] E. Muriel, J. Ruiz, D. Martin, M. J. Petron, and T. Antequera, "Physico-chemical and sensory characteristics of dry-cured loin from different Iberian pig lines," *Food Science and Technology International*, vol. 10, no. 2, pp. 117–123, 2004.

[12] M. R. Ramírez and R. Cava, "Effect of Iberian × Duroc genotype on dry-cured loin quality," *Meat Science*, vol. 76, no. 2, pp. 333–341, 2007.

[13] E. Soto, L. Hoz, J. A. Ordóñez et al., "Impact of feeding and rearing systems of Iberian pigs on volatile profile and sensory characteristics of dry-cured loin," *Meat Science*, vol. 79, no. 4, pp. 666–676, 2008.

[14] M. Campus, M. Flores, A. Martínez, and F. Toldrá, "Effect of high pressure treatment on colour, microbial and chemical characteristics of dry cured loin," *Meat Science*, vol. 80, no. 4, pp. 1174–1181, 2008.

[15] P. Hernández, J. L. Navarro, and F. Toldrá, "Lipolytic and oxidative changes in two Spanish pork loin products: Dry-cured loin and pickled-cured loin," *Meat Science*, vol. 51, no. 2, pp. 123–128, 1999.

[16] D. Martin, T. Antequera, E. Muriel, T. Pérez-Palacios, and J. Ruiz, "Effect of dietary conjugated linoleic acid in combination with monounsaturated fatty acids on the meat composition and quality traits of dry-cured loin," *Meat Science*, vol. 80, no. 4, pp. 1309–1319, 2008.

[17] Ö. Coşkuner, A. H. Ertaş, and A. Soyer, "The effect of processing method and storage time on constituents of turkish sausages (Sucuk)," *Journal of Food Processing and Preservation*, vol. 34, no. 1, pp. 125–135, 2010.

[18] C. Summo, F. Caponio, and A. Pasqualone, "Effect of vacuum-packaging storage on the quality level of ripened sausages," *Meat Science*, vol. 74, no. 2, pp. 249–254, 2006.

[19] J. Ruiz-Ramírez, X. Serra, J. Arnau, and P. Gou, "Profiles of water content, water activity and texture in crusted dry-cured loin and in non-crusted dry-cured loin," *Meat Science*, vol. 69, no. 3, pp. 519–525, 2005.

[20] L. Sánchez, J. A. González-Carril, M. Otero, L. Sánchez, and J. A. González-Carril, "Caracterización etnológica del cerdo Celta," *Archivos de Zootecnia*, vol. 49, no. 185-186, pp. 175–177, 2000.

[21] S. Temperan, J. M. Lorenzo, B. D. Castiñeiras, I. Franco, and J. Carballo, "Carcass and meat quality traits of celta heavy pigs. Effect of the inclusion of chestnuts in the finishing diet," *Spanish Journal of Agricultural Research*, vol. 12, no. 3, pp. 694–707, 2014.

[22] S. Fonseca, A. Cachaldora, M. Gómez, I. Franco, and J. Carballo, "Monitoring the bacterial population dynamics during the ripening of Galician chorizo, a traditional dry fermented Spanish sausage," *Food Microbiology*, vol. 33, no. 1, pp. 77–84, 2013.

[23] M. Elías and A. V. Carrascosa, "Characterisation of the Paio do Alentejo, a traditional Portuguese Iberian sausage, in respect to its safety," *Food Control*, vol. 21, no. 1, pp. 97–102, 2010.

[24] P. M. Ikonić, L. S. Petrović, T. A. Tasić, N. R. Džinić, M. R. Jokanović, and V. M. Tomović, "Physicochemical, biochemical and sensory properties for the characterisation of petrovská klobása (Traditional fermented sausage)," *Acta Periodica Technologica*, vol. 41, pp. 19–31, 2010.

[25] J. Samelis, A. Kakouri, and J. Rementzis, "The spoilage microflora of cured, cooked turkey breasts prepared commercially with or without smoking," *International Journal of Food Microbiology*, vol. 56, no. 2-3, pp. 133–143, 2000.

[26] J. Fernández-López, E. Sendra, E. Sayas-Barberá, C. Navarro, and J. A. Pérez-Álvarez, "Physico-chemical and microbiological profiles of 'salchichón' (Spanish dry-fermented sausage) enriched with orange fiber," *Meat Science*, vol. 80, no. 2, pp. 410–417, 2008.

[27] J. M. Lorenzo, B. Prieto, J. Carballo, and I. Franco, "Compositional and degradative changes during the manufacture of dry-cured 'lacón'," *Journal of the Science of Food and Agriculture*, vol. 83, no. 6, pp. 593–601, 2003.

[28] C. S. Vestergaard, C. Schivazappa, and R. Virgili, "Lipolysis in dry-cured ham maturation," *Meat Science*, vol. 55, no. 1, pp. 1–5, 2000.

[29] I. Cilla, L. Martínez, J. A. Beltrán, and P. Roncalés, "Factors affecting acceptability of dry-cured ham throughout extended maturation under 'bodega' conditions," *Meat Science*, vol. 69, no. 4, pp. 789–795, 2005.

[30] M. J. Beriain, J. Chasco, and G. Lizaso, "Relationship between biochemical and sensory quality characteristics of different commercial brands of salchichon," *Food Control*, vol. 11, no. 3, pp. 231–237, 2000.

[31] L. Martín, M. L. Timón, M. J. Petrón, J. Ventanas, and T. Antequera, "Evolution of volatile aldehydes in Iberian ham matured under different processing conditions," *Meat Science*, vol. 54, no. 4, pp. 333–337, 2000.

[32] R. Garrido, M. Gómez, I. Franco, and J. Carballo, "Lipolytic and oxidative changes during the manufacture of dry-cured lacón. Effect of the time of salting," *Grasas y Aceites*, vol. 60, no. 3, pp. 255–261, 2009.

[33] F. Shahidi, "Assessment of lipid oxidation and off-flavor development in meat and meat products," in *Flavor of Meat and Meat Products*, F. Shahidi, Ed., pp. 247–266, Springer, New York, NY, USA, 1994.

[34] B. Rubio, B. Martínez, M. D. García-Cachán, J. Rovira, and I. Jaime, "Effect of the packaging method and the storage time on lipid oxidation and colour stability on dry fermented sausage salchichón manufactured with raw material with a high level of mono and polyunsaturated fatty acids," *Meat Science*, vol. 80, no. 4, pp. 1182–1187, 2008.

[35] E. Zanardi, V. Dorigoni, A. Badiani, and R. Chizzolini, "Lipid and colour stability of Milano-type sausages: Effect of packing conditions," *Meat Science*, vol. 61, no. 1, pp. 7–14, 2002.

[36] R. Cava, L. Ladero, S. González, A. Carrasco, and M. R. Ramírez, "Effect of pressure and holding time on colour, protein and lipid oxidation of sliced dry-cured Iberian ham and loin during refrigerated storage," *Innovative Food Science and Emerging Technologies*, vol. 10, no. 1, pp. 76–81, 2009.

[37] M. J. Melgar, J. M. Sánchez-Monge, and J. Bello, "A study of the changes in the chemical properties of fat during ripening of dry spanish sausage," *Journal of Food Composition and Analysis*, vol. 3, no. 1, pp. 73–80, 1990.

[38] D. R. Janero, "Malondialdehyde and thiobarbituric acid-reactivity as diagnostic indices of lipid peroxidation and peroxidative tissue injury," *Free Radical Biology & Medicine*, vol. 9, no. 6, pp. 515–540, 1990.

[39] L. Hoz, I. Cambero, C. Santos, B. Herranz, and J. A. Ordóñez, "Fatty acids and sensory characteristics of Spanish dry-cured loin enriched in acid α-linolenic and α-tocopherol," *Food Chemistry*, vol. 101, no. 4, pp. 1701–1706, 2007.

[40] E. Soto, L. de La Hoz, J. A. Ordóñez et al., "The feeding and rearing systems of iberian pigs affect the lipid composition and texture profile of dry-cured loin," *Journal of Animal and Feed Sciences*, vol. 18, no. 1, pp. 78–89, 2009.

[41] M. K. Hellerstein, R. A. Neese, and J.-M. Schwarz, "Model for measuring absolute rates of hepatic de novo lipogenesis and reesterification of free fatty acids," *American Journal of Physiology-Endocrinology and Metabolism*, vol. 265, no. 5, pp. E814–E820, 1993.

[42] A. I. Andrés, R. Cava, A. I. Mayoral, J. F. Tejeda, D. Morcuende, and J. Ruiz, "Oxidative stability and fatty acid composition of pig muscles as affected by rearing system, crossbreeding and metabolic type of muscle fibre," *Meat Science*, vol. 59, no. 1, pp. 39–47, 2001.

[43] A. Daza, A. I. Rey, J. Ruiz, and C. J. Lopez-Bote, "Effects of feeding in free-range conditions or in confinement with different dietary MUFA/PUFA ratios and α-tocopheryl acetate, on antioxidants accumulation and oxidative stability in iberian pigs," *Meat Science*, vol. 69, no. 1, pp. 151–163, 2005.

[44] S. Ventanas, M. Estevez, J. F. Tejeda, and J. Ruiz, "Protein and lipid oxidation in Longissimus dorsi and dry cured loin from Iberian pigs as affected by crossbreeding and diet," *Meat Science*, vol. 72, no. 4, pp. 647–655, 2006.

[45] C. Zambonelli, F. Papa, P. Romano, G. Suzzi, and L. Grazia, *Microbiologia dei Salumi*, Edagricole, Bologna, 1992.

[46] M. Gómez, S. Fonseca, A. Cachaldora, J. Carballo, and I. Franco, "Effect of chestnuts intake by Celta pigs on lipolytic, oxidative and fatty acid profile changes during ripening and vacuum-packed storage of Galician 'chorizo'," *Journal of Food Composition and Analysis*, vol. 56, pp. 73–83, 2017.