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RESEARCH ARTICLE

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Carcass and meat quality traits of Celta heavy pigs. Effect of the inclusion of chestnuts in the finishing diet

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Abstract

Carcass and meat quality traits were studied in 36 Celta pigs (a breed native from NW of Spain) reared for 16 months in an extensive regime and slaughtered at a live weight of around 170 kg. The effect of partially or totally replacing commercial compound feed with chestnuts in the finishing diet was also investigated. Celta heavy pigs were characterised by high killing out, subcutaneous fat thickness, and ham length values, and by low ham perimeter, and *Longissimus lumborum* muscle area values. Meat showed high myoglobin contents and a* values, and very high hardness. By increasing the proportion of chestnuts in the finishing diet the quantity of back fat increased and the pH of the meat decreased. However, neither these effects, nor any of those on the other traits studied were statistically significant. The absence of significant effects may be due to the fact that pigs fed with chestnuts were not subjected to feed restrictions.

Additional key words: animal feeding; autochthonous resources; carcass traits; Celta pig breed; native breeds.

Introduction

Celta is the most important autochthonous pig in the north of Spain (Carril *et al.*, 2001). Their breeding and exploitation are well organized, and an association of breeders and a herd book exist for this breed (DOG, 2000). Due to its good adaptation to the environmental conditions in the autochthonous forests in northern Spain, its rearing in a completely extensive regime, making good use of naturally available food resources, is possible. This breed is also greatly appreciated by consumers for the high quality of the raw-cured meat products (Franco & Lorenzo, 2013).

Modern intensive swine production uses improved breeds with a high percentage of lean meat in the carcass. However, the complex conditions of handling and feeding lead to an appreciable decrease of the quality of the meat (Hansson & Lundström, 1989; Daszkiewicz *et al.*, 2004). At present, in developed countries meat consumption satisfies a desire rather than covers a necessity, and consumers show preferences for different "brands" of meat that guarantee quality. There is therefore a great opportunity for the meat from native breeds, which is known to have particular characteristics and high quality. However, production must be rationalized and production costs minimized to maintain reasonable prices of both fresh meat and meat products (mainly raw-cured meat products).

In the northwest of Spain, chestnuts are traditionally considered as valuable fodder for livestock. The composition of chestnut (Mataix *et al.*, 2003) makes it a suitable food for maintaining and fattening adult animals, in which establishment of a correct balance bet-

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Abbreviations used: CL (cooking loss); IMF (intramuscular fat); MUFA (monounsaturated fatty acids); NSPs (non-starch polysaccharides); PUFA (polyunsaturated fatty acids); SFA (saturated fatty acids); UFA (unsaturated fatty acids).

Table 1. Chemical composition[1] (expressed as g/100 g) of chestnuts and commercial compound feed used in the diets, and daily individual intake of each compound (g) in each feed (A, B or C) group

	Chestnut	Compound feed	A	B	C
Dry matter	51.9	89.5	2685	2640	2595
Crude protein	4.2	15.3	459	334.5	210
Ether extract	1.3	4.9	147	106	65
Crude fiber	2.0	4.6	138	119	100
Starch	32.0	39.7	1191	1395.5	1600
Ash	1.1	6.4	192	123.5	55
Ca	0.04	0.61	18.3	10.15	2
P	0.05	0.27	8.1	5.3	2.5
Lys	0.21	0.70	21	15.75	10.5
Met	0.08	0.20	6	5	4

[1] Data are the mean values of four determinations. A = commercial compound feed diet (3 kg commercial compound feed pig^{-1} d^{-1}); B = mixed diet (1.5 kg commercial compound feed + 2.5 kg chestnuts pig^{-1} d^{-1}); C = chestnuts diet (5 kg chestnuts pig^{-1} d^{-1}).

ween protein and energy in the diet is not as critical as in young growing animals. Chestnuts could be used to feed autochthonous pigs, as another way of valorization of this vegetal resource thus maintaining reasonable production costs and increasing the quality of the meat and meat products.

Despite the fact that works have been carried out recently studying pigs of 130-140 kg live weight (Franco & Lorenzo, 2013), at present, carcass and meat characteristics of heavy pigs from Celta breed remain scarcely described. Moreover, given the effect of diet on the characteristics of the carcass and meat, a rigorous study is required to determine the effects of the inclusion of chestnut in the diet of Celta pigs on the quality traits of the carcass and meat.

Very few studies have addressed the effect of the inclusion of chestnuts in the finishing diets of the pigs. Previous studies have involved the Corsican and Cinta Senese breeds and have above all dealt with the effects on lipid traits in muscle and adipose tissues (Coutron-Gambotti *et al.*, 1998; Pugliese *et al.*, 2007, 2013). The effects on the carcass and overall meat quality traits still remain scarcely known.

The aim of the present study, which forms part of a wider project investigating the performance of the Celta pig breed in different rearing systems and conditions, was to study the carcass and meat quality traits of heavy pigs and also to investigate the effect on carcass traits and meat quality parameters of replacing commercial compound feed with chestnuts in the finishing diet.

Materials and methods

Pigs and diets

A total of 36 Celta pigs (20 males and 16 females) were used in this study. Piglets, which were vaccinated and deparasitised following standard protocols, were suckled until 40 days. Males and females were castrated at the age of two and three months, respectively. All pigs were reared and fattened until the age of 16 months in an extensive regime, with a livestock density of 12 animals per hectare. After weaning, the pigs were fed a commercial compound feed. At the age of 12 months, pigs were randomly divided into three different groups each comprising 12 animals: group A (6 males and 6 females) was fed commercial compound feed (3 kg $animal^{-1}$ d^{-1}) for the 4 months prior to slaughter; group B (7 males and 5 females) was fed a mixed diet (commercial compound feed/chestnuts; 1.5 kg commercial compound + 2.5 kg chestnuts $animal^{-1}$ d^{-1}) for the remaining four months; and group C (7 males and 5 females) was fed a mixed diet (commercial compound feed/chestnuts) for a month (until the age of 13 months), and then a diet of only chestnuts (5 kg $animal^{-1}$ d^{-1}) in the three months prior to slaughter. The chemical composition (g/100 g) of chestnuts and commercial compound feed used in the diets, and the daily individual intake of each compound (g) in each feed group are shown in Table 1; the fatty acid composition of the fat of

Table 2. Fatty acid composition[1] (g/100 g total fatty acids) of the fat of chestnuts and commercial compound feed used in this study

Fatty acid	Chestnuts	Compound feed
C12:0	0.04	0.14
C14:0	0.11	1.07
C15:0	0.07	0.12
C15:1	0.03	0.02
C16:0	15.19	22.40
C16:1	0.36	1.46
C17:0	0.10	0.33
C17:1	0.06	0.18
C18:0	0.98	9.27
C18:1 c *n9*	27.60	26.88
C18:2 *n6*	45.76	25.97
C18:3 *n6*	0.08	0.05
C18:3 *n3*	5.76	2.50
C20:0	0.23	0.13
C20:1 *n9*	0.39	0.39
C20:2 *n6*	0.05	0.13
C20:3 *n6*	0.04	0.04
C20:4 *n6*	0.01	0.10
C20:3 *n3*	0.02	0.04
C20:5 *n3*	0.01	0.04
C22:0	0.23	0.15
C22:1 *n9*	0.07	0.10
C22:2 *n6*	2.60	7.86
C23:0	0.05	0.53
C24:0	0.15	0.05
C24:1 *n9*	0.01	0.03
SFA	17.14	34.19
UFA	82.86	65.81
MUFA	28.53	29.07
PUFA	54.33	36.74

[1] Data are the mean values of four determinations. SFA: sum of saturated fatty acids; UFA: sum of unsaturated fatty acids; MUFA: sum of monounsaturated fatty acids; PUFA: sum of polyunsaturated fatty acids.

commercial compound feed and chestnuts is shown in Table 2. During the last four months (finishing period), groups A, B and C were kept in different pieces of land, and there was not any other vegetation which pigs have possibly consumed.

Handling and slaughtering

Pigs were transported to a commercial slaughterhouse (Frigolouro, Porriño, Pontevedra, Spain) located 80 km from the experimental land, and were kept for 12 h with full access to water but not to food. Pigs were electrically stunned, exanguinated, scalded, skinned, eviscerated and chilled according to standard commercial procedures.

Carcass measurements

Two hours before slaughter pigs were weighed (kg). Twenty four hours after slaughter, carcasses were weighed, and carcass length (from the mid point of the cranial side of the first rib to the cranial side of the pubic symphysis), ham length (from the cranial side of the pubic symphysis to the tarso-metatarsal articulation) and ham perimeter (at the widest area in the piece) were measured with a metric tape measure.

Back fat thickness (mm) was measured in the mid-dorsal line at the level of the mid point of the *Gluteus medius* muscle. The *Longissmus lumborum* area (cm^2) was assessed between the last lumbar and the first sacral vertebrae.

Jointing and weighing the different joints

Jointing was also carried out 24 h after slaughter. Head was first removed, by cutting between the occipital bone and atlas, and weighed; the jowls (right and left) were also removed and weighed. The following cuts were later obtained from each side, and weighed: back fat (dorsal + dorsolateral subcutaneous fat), belly, loin, shoulder, and ham. Loin comprises the muscles of the neck end, dorsum, loin and rump, along with the corresponding vertebrae and dorsal part of the ribs. The shoulder joint consists of the muscles of the shoulder, arm and forearm with the corresponding bones and feet. Ham is composed of the pelvic-trochanteric, thigh, buttock and leg muscles with corresponding bones and feet. Data taken for each carcass were the mean of the right and left cut.

The carcass weight distribution was calculated as the weight of individual joints (right + left) (g) per 100 g of carcass.

Meat quality assessment

Longissimus dorsi and *Semimembranosus* muscles were obtained from the left side in each carcass, and analysed on the same day as jointing.

Moisture, protein and fat contents were assessed following international standards ISO R-1442, ISO R-937 and

ISO R-1443, respectively (BOE, 1979). The pH values were assessed following the Spanish official method (BOE, 1979), with a pH meter (micro pH 2002, Crison Instruments S.A., Barcelona, Spain). A portable colorimeter CE-XTH (Gretagmacbeth LLC, New Windsor, NY, USA) was used to measure meat colour in the CIELAB space (Lightness, L*; redness, a*; yellowness, b*) (CIE, 1978). Chroma values were calculated as described by Estévez *et al.* (2003). The myoglobin content was determined following the method described by Hornsey (1956); hematin and haem iron contents were calculated as described by Estévez *et al.* (2003).

Textural properties (shear force) were measured following the AMSA (1995) guidelines. Vacuum packaged steaks from the muscles were cooked by placing in a water bath with automatic temperature control (JP Selecta Model Tectron Bio, Spain) until reaching an internal temperature of 80°C, controlled by thermocouples type K (Comark, PK23M, UK) connected to a data logger (Comark Dilligence EVG, N3014, UK). Samples were then cooled to room temperature by placing the vacuum package bags in a circulating water bath at 18°C for 30 min. Samples used for the Warner-Bratzler shear test were obtained by cutting pieces of approx. 1 × 1 × 2.5 cm. A texture analyser TA.XT2 (Stable Micro Systems Ltd., Surrey, UK) was used, and all samples were cut perpendicular to the muscle fibre direction at a crosshead speed of 3.3 mm s^{-1}. The maximum shear force was expressed in Newton (N). The average value for each sample was recorded between six and eight times.

Cooking loss (CL) was measured by cooking a portion of the corresponding muscle as described in the texture analysis, and by calculating the difference in weight between the cooked and raw samples (Honikel, 1997).

The intramuscular fat (IMF) was extracted following the procedure described by Folch *et al.* (1957). Fat extracts were methylated and fatty acid profiles were determined using the procedure described by Franco *et al.* (2006). Fatty acid methyl esters were analysed by gas chromatography using a Thermo Finnigan Trace GC (Thermo Finnigan, Austin, TX, USA). The separation of the different fatty acids was carried out in an Innowax column: 30 m, 0.25 mm ID, 0.25 µm film thickness (Agilent Technologies, Palo Alto, CA, USA). The temperature of the detector was 250°C and that of the injector 230°C. Chromatographic conditions used in the determination of the fatty acids were: initial oven temperature: 50°C for 1 min; ramp1: 5°C min^{-1} to 248°C; ramp2: 248°C for 6 min. The gasses used were air, 350 mL min^{-1}; hydrogen, 35 mL min^{-1}; and helium (carrier gas), 30 mL min^{-1}. All the samples and standards (Sigma Chemical Co., Saint Louis, MO, USA) were injected at least in duplicate. Repeatability tests were performed injecting a standard and a sample consecutively six times a day. Reproducibility tests were also carried out, injecting the standard and the sample twice a day for 3 days under the same experimental conditions. Significant differences ($p < 0.05$) were not found between the results obtained in either of the tests. Results are expressed as percentages of the total fatty acid composition.

Statistical analysis

Analyses of variance (ANOVA) were performed to detect any differences between the different finishing diets or between muscles ($p < 0.05$). Means were compared by the least squares difference (LSD) test, with the Statistica© 5.1 computer program for Windows (Statsoft Inc, 1996, Tulsa, OK, USA). Statistical correlations between parameters were determined by multiple regression ($p < 0.05$, $p < 0.01$ and $p < 0.001$), using the Statistica© 5.1 computer program.

Results

Carcass traits

Live weight for the pigs fed with the commercial compound feed diet (n = 12) was 166.27 ± 14.36 kg; carcass weight was 144.35 ± 18.21 kg; killing out, 86.58 ± 4.56%; and the joint weights (kg) were: head, 12.79 ± 1.62; jowl, 1.78 ± 0.33; back fat, 6.40 ± 1.27; belly, 3.28 ± 0.63; loin, 10.08 ± 0.90; shoulder, 10.39 ± 1.18; ham, 15.46 ± 1.65. The use of chestnuts in the finishing diet did not modify significantly these values. However, although differences were not statistically significant, increasing proportions of chestnuts in the finishing diet appeared to increase the quantity of back fat.

Carcass measurements for the pigs fed with the commercial compound feed diet (n = 12) were: carcass length, 96.27 ± 4.47 cm; compacity index of the carcass, 1.49 ± 0.13; ham length, 46.31 ± 2.13 cm; ham perimeter, 77.22 ± 3.58 cm; compacity index of the ham, 1.66 ± 0.05; subcutaneous fat thickness, 38.0 ± 7.9 mm;

Table 3. Correlation coefficients between weights and carcass measurements in the Celta pigs used in this study (n=36)

	Live weight	Carcass weight	Killing out	Head weight	Jowl weight	Back fat weight	Belly weight	Loin weight	Shoulder weight	Ham weight	Carcass length	CI of the carcass	Ham lenght	Ham perimeter	Back fat thickness	Area of the Ll muscle
Live weight	1	0.92***	0.41*	0.67***	0.50*	0.57**	0.60**	0.80***	0.77***	0.85***	0.69***	0.86***	0.74***	0.71***	0.12	0.03
Carcass weight		1	0.74***	0.76***	0.53**	0.60**	0.72***	0.83***	0.87***	0.96***	0.75***	0.94***	0.71***	0.74***	0.25	0.04
Killing out			1	0.62**	0.38	0.39	0.59**	0.54**	0.71***	0.75***	0.55**	0.70***	0.39	0.53**	0.34	0.04
Head weight				1	0.70***	0.25	0.60**	0.58**	0.87***	0.82***	0.78***	0.62**	0.61**	0.58**	0.01	0.11
Jowl weight					1	0.48*	0.52**	0.37	0.51*	0.58**	0.32	0.55**	0.38	0.67***	0.29	0.20
Back fat weight						1	0.49*	0.33	0.32	0.47*	0.11	0.73***	0.27	0.60**	0.57**	–0.13
Belly weight							1	0.64**	0.60**	0.69***	0.53**	0.65**	0.32	0.52**	0.36	0.28
Loin weight								1	0.69***	0.83***	0.69***	0.74***	0.65**	0.68***	0.07	0.34
Shoulder weight									1	0.89***	0.84***	0.72***	0.70***	0.64**	0.15	0.03
Ham weight										1	0.77***	0.88***	0.75***	0.77***	0.28	0.05
Carcass length											1	0.49*	0.78***	0.46*	–0.13	0.06
CI carcass												1	0.56**	0.77***	0.38	0.02
Ham lenght													1	0.51*	–0.04	–0.06
Ham perimeter														1	0.44*	0.10
Back fat thickness															1	–0.11
Area of the Ll muscle																1

CI: compacity index. Ll: *Longisimus lumborum;* * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

area of the *Longissimus lumborum* muscle, 32.96 ± 3.89 cm^2. The inclusion of chestnuts in the finishing diet did not have any significant effect on these values. Positive and in most cases significant correlations were observed for all the joint weights and measurements assessed in the carcasses (Table 3), except for back fat thickness, which was only significantly and positively correlated with the back fat weight (r = 0.57; $p < 0.01$) and with the ham perimeter (r = 0.44; $p < 0.05$), and for the area of the *Longissimus lumborum* muscle, which was not significantly correlated with any of the other parameters assessed (weights or measurements).

The joint weight distribution (g/100 g of the carcass) in the pigs fed with the commercial compound feed diet (n = 12) were: head, 8.97 ± 0.96; jowl, 2.56 ± 0.36; back fat, 8.87 ± 1.27; belly, 4.54 ± 0.60; loin, 14.04 ± 0.84; shoulder, 14.43 ± 0.93; ham, 21.48 ± 0.91. The use of chestnuts in the finishing diet did not modify significantly these percentages. As occurred for the back fat weight, the increase in the amount of chestnuts in the diet appeared to increase the proportion (%) of the back fat, although differences were not significant again.

Meat quality traits

The physical and chemical parameters in the *Longissimus dorsi* and *Semimembranosus* muscles in the pigs fed with the three different finishing diets are shown in Table 4.

In the present study, the IMF content varied slightly within the same muscle for each specific finishing diet. Although the average values were similar in both muscles and for all three diets and no significant differences were observed, the values were slightly higher in the pigs fed only chestnuts than in those fed the other two diets. The protein contents of the muscles did not differ in relation to the finishing diets or between muscles with respect to the same finishing diet.

The average pH value of both muscles was approximately 5.6 at 24 h *post-mortem*. The increased amount of chestnuts in the diet led to a slight decrease in the pH values, which was most apparent in the *Semimembranosus* muscle. However, there were no significant differences ($p > 0.05$) between the groups fed the different finishing diets within each muscle, or between muscles within each group.

The myoglobin content was slightly higher in the *Semimembranosus* (average values around 2.2 mg/100 g) than in the *Longissimus dorsi* muscles (average values around 1.7 mg/100 g), although the differences were not significant; there were no significant differences in the myoglobin content between the groups of pigs fed each diet.

The redness (a*) values in the present study were similar for the three finishing diets and in both muscles, and were in an interval between 11 and 12.5. The

Table 4. Physical and chemical parameters of the muscles of the Celta pigs fed with the three different finishing diets[1] (average ± standard deviation)

	Longissimus dorsi			*Semimembranosus*			Significance level	
	A (n = 12)	B (n = 12)	C (n = 12)	A (n = 12)	B (n = 12)	C (n = 12)	Diet	Muscle
Moisture (%)	72.91 ± 0.76	73.37 ± 0.51	72.64 ± 1.48	73.21 ± 1.13	74.25 ± 2.45	73.04 ± 1.76	ns	ns
Protein (%)	22.83 ± 1.27	22.61 ± 0.86	22.28 ± 1.15	22.08 ± 1.21	22.14 ± 0.78	21.49 ± 1.15	ns	ns
Fat (%)	2.33 ± 1.18	1.91 ± 0.84	2.59 ± 1.72	2.22 ± 1.32	1.82 ± 0.86	2.76 ± 1.95	ns	ns
pH	5.60 ± 0.12	5.60 ± 0.17	5.52 ± 0.10	5.66 ± 0.18	5.62 ± 0.11	5.59 ± 0.11	ns	ns
Myoglobin (mg/100 g)	1.75 ± 0.17	1.72 ± 0.18	1.64 ± 0.18	2.10 ± 0.57	2.30 ± 0.46	2.15 ± 0.49	ns	ns
Hematin (ppm)	20.00 ± 3.83^{a}	20.31 ± 3.74^{a}	17.70 ± 4.97^{a}	32.91 ± 5.95^{b}	33.93 ± 3.92^{b}	31.76 ± 4.25^{b}	ns	*
Haem iron (ppm)	5.98 ± 0.60^{a}	5.90 ± 0.61^{a}	5.60 ± 0.62^{a}	7.21 ± 1.96^{b}	7.86 ± 1.58^{b}	7.38 ± 1.68^{b}	ns	*
Lightness (L*)	49.70 ± 4.11^{a}	49.46 ± 4.45^{a}	50.72 ± 5.00^{a}	43.83 ± 3.21^{b}	45.86 ± 4.70^{b}	45.95 ± 4.11^{b}	ns	*
Redness (a*)	11.13 ± 1.56	11.00 ± 1.94	10.99 ± 1.45	11.59 ± 1.10	12.49 ± 1.68	12.27 ± 2.04	ns	ns
Yellowness (b*)	4.12 ± 1.22^{a}	4.07 ± 0.99^{a}	3.48 ± 0.95^{a}	7.61 ± 1.78^{b}	8.43 ± 1.47^{b}	7.62 ± 1.65^{b}	ns	*
Chroma	11.89 ± 1.38^{a}	11.75 ± 2.06^{a}	11.57 ± 1.42^{a}	13.93 ± 1.57^{b}	15.10 ± 1.99^{b}	14.48 ± 2.40^{b}	ns	*
Cooking loss (%)	17.03 ± 3.28	17.21 ± 2.60	16.91 ± 2.48	16.87 ± 4.73	17.68 ± 3.36	18.60 ± 3.80	ns	ns
Shear force (N)	100.41 ± 23.89^{a}	104.79 ± 10.75^{a}	108.53 ± 26.65^{a}	135.28 ± 22.60^{b}	122.66 ± 20.54^{b}	127.92 ± 36.12^{b}	ns	*

[1] A = commercial compound feed diet (3 kg commercial compound feed pig^{-1} d^{-1}); B = mixed diet (1.5 kg commercial compound feed + 2.5 kg chestnuts pig^{-1} d^{-1}); C = chestnuts diet (5 kg chestnuts pig^{-1} d^{-1}). $^{a\text{-}b}$ Means within the same row (corresponding to the same trait) not followed by a common letter, differ significantly ($p < 0.05$). * Significant differences ($p < 0.05$) when compared the values of the two muscles (*Longissimus dorsi* and *Semimembranosus*). ns: not significant.

lightness (L*) and yellowness (b*) values, for the same muscle, did not differ significantly between feeding groups. However, in each feeding group there were significant differences ($p < 0.05$) between the *Longissimus dorsi* and *Semimembranosus* muscles, being the L* values higher in the *Longissimus dorsi* muscles, and the b* values higher in the *Semimembranosus* muscles.

The cooking loss values in the present study were in all cases around 17%, and there were no significant differences in the values of this parameter associated to the finishing diet or to the type of muscle.

The shear force values (hardness) we determined were always higher than 100 N, and were not significantly affected by the finishing diet. Within each feeding group however, the *Semimembranosus* muscles showed significant higher average values ($p < 0.05$) than the *Longissimus dorsi* muscles.

The fatty acid profile of the IMF in the *Longissimus dorsi* and *Semimembranosus* muscles in the pigs fed with the three different finishing diets is shown in Table 5. The fat of *Longissimus dorsi* muscle showed significantly lower contents of saturated fatty acids (SFA) ($p < 0.01$) and polyunsaturated fatty acids (PUFA) ($p < 0.01$), and significantly higher contents of monounsaturated fatty acids (MUFA) ($p < 0.001$) than of the *Semimembranosus* muscle.

Despite the differences in fatty acid composition between fat of chestnuts and compound feed (Table 2), with very higher percentages of PUFA (due above all to the higher percentages in C18:2 *n6* and C18:3 *n3*) in chestnuts, the inclusion of chestnuts in the finishing diet did not produce noticeable significant differences in the fatty acid profile of the muscles. Results seems to indicate that the use of chestnuts in the finishing diet decreases the SFA contents (above all C16 content) and increases the MUFA contents (above all the C18:1 c*n9* contents); however, these differences were not statistically significant. Significant differences ($p < 0.01$) among diets were observed in the C20:2 *n6* acid percentage.

Discussion

Carcass traits

Killing out values (around 85%) were higher than those reported in other studies carried out on improved breeds and their crosses (Blasco *et al.*, 1994; García-Macías *et al.*, 1996; Correa *et al.*, 2006; Flores-Rondón *et al.*, 2009) and also higher than those reported for Celta pigs slaughtered at an age of 12 months (Franco & Lorenzo, 2013). This was probably due to the high live weights of the pigs in the present study, as killing out values are widely reported to increase with the live

Table 5. Fatty acid profile (% of total fatty acids) of the intramuscular fat of the muscles of the Celta pigs fed with the three different finishing diets[1] (average ± standard deviation)

	Longissimus dorsi			*Semimembranosus*			Significance level	
	A (n = 12)	B (n = 12)	C (n = 12)	A (n = 12)	B (n = 12)	C (n = 12)	Diet	Muscle
C10:0	0.04±0.01	0.05±0.02	0.05±0.02	0.05±0.01	0.04±0.01	0.05±0.02	ns	ns
C12:0	0.05±0.01	0.06±0.01	0.06±0.01	0.05±0.00	0.05±0.01	0.05±0.01	ns	ns
C14:0	1.37±0.09^{a}	1.28±0.14^{a}	1.37±0.06^{a}	1.14±0.07^{2b}	1.06±0.12^{1b}	1.09±0.08^{12b}	*	***
C14:1	0.09±0.08^{a}	0.09±0.06^{a}	0.14±0.07^{a}	0.02±0.01^{b}	0.01±0.00^{b}	0.02±0.00^{b}	ns	***
C15:0	0.04±0.02^{1}	0.05±0.03^{1}	0.08±0.05^{2a}	0.04±0.01	0.05±0.02	0.04±0.02^{b}	*	ns
C16:0	24.00±0.52^{a}	23.60±0.77^{a}	23.54±0.95^{a}	23.30±0.66^{b}	22.81±0.96^{b}	22.77±0.70^{b}	ns	***
C16:1	2.75±0.41^{a}	2.62±0.40^{a}	2.82±0.33^{a}	3.32±0.40^{b}	3.24±0.32^{b}	3.43±0.47^{b}	ns	***
C17:0	0.18±0.03	0.22±0.06	0.18±0.04	0.18±0.03	0.20±0.05	0.19±0.05	ns	ns
C17:1	0.17±0.04^{2a}	0.22±0.04^{1}	0.20±0.02^{12}	0.22±0.02^{b}	0.24±0.04	0.23±0.04	*	***
C18:0	12.63±0.95^{12a}	13.34±1.39^{2a}	11.89±1.12^{1a}	15.16±2.60^{b}	15.38±3.09^{b}	15.89±2.96^{b}	ns	***
C18:1 c *n9*	43.68±1.45	44.00±1.29	44.96±1.83	42.68±3.30	42.49±4.54	43.78±2.78	ns	ns
C18:2 *n6*	8.60±0.78	8.31±1.16	8.08±1.19	9.02±1.68	9.38±2.79	8.10±1.85	ns	ns
C18:3 *n6*	0.01±0.00^{a}	0.02±0.01^{a}	0.02±0.01^{b}	0.03±0.01^{b}	0.04±0.02^{b}	0.04±0.01^{b}	ns	***
C18:3 *n3*	0.42±0.05^{a}	0.48±0.10^{a}	0.43±0.06^{a}	0.31±0.04^{b}	0.35±0.06^{b}	0.35±0.06^{b}	ns	***
C20:0	0.19±0.03	0.18±0.03	0.18±0.02	0.21±0.01	0.18±0.04	0.19±0.03	ns	ns
C20:1 *n9*	0.89±0.14^{a}	0.89±0.11	0.82±0.13^{a}	1.03±0.14^{b}	0.98±0.16	0.98±0.14^{b}	ns	***
C20:2 *n6*	0.42±0.08^{2}	0.37±0.08^{12}	0.34±0.05^{1}	0.42±0.08^{2}	0.41±0.07^{2}	0.35±0.05^{1}	**	ns
C20:3 *n6*	0.08±0.02^{a}	0.08±0.03^{a}	0.10±0.03^{a}	0.14±0.05^{b}	0.17±0.07^{b}	0.14±0.05^{b}	ns	***
C20:4 *n6*	0.72±0.23^{a}	0.59±0.23^{a}	0.80±0.26^{a}	1.66±0.94^{b}	1.87±1.11^{b}	1.43±0.70^{b}	ns	***
C20:3 *n3*	0.07±0.02	0.07±0.01	0.07±0.01	0.06±0.02	0.07±0.01	0.06±0.01	ns	ns
C22:0	0.02±0.01^{2a}	0.02±0.01^{2a}	0.03±0.01^{1}	0.03±0.02^{b}	0.06±0.03^{b}	0.05±0.03	ns	***
C22:2 *n6*	0.25±0.20^{a}	0.29±0.22^{a}	0.25±0.15^{a}	0.72±0.32^{b}	0.71±0.20^{b}	0.58±0.24^{b}	ns	***
C24:0	0.09±0.02^{a}	0.10±0.03^{a}	0.10±0.03^{a}	0.15±0.07^{b}	0.19±0.10^{b}	0.17±0.08^{b}	ns	***
C24:1 *n9*	0.03±0.01	0.03±0.02	0.05±0.02	0.03±0.03	0.04±0.05	0.04±0.04	ns	ns
SFA	38.61±1.05^{a}	38.90±1.58	37.50±1.61^{a}	40.32±2.54^{b}	40.01±4.05	40.49±2.68^{b}	ns	**
UFA	61.39±1.05^{12a}	61.10±1.58^{2}	62.50±1.61^{1a}	59.68±2.54^{b}	59.99±4.05	59.51±2.68^{b}	ns	**
MUFA	50.81±1.58^{a}	50.91±1.90^{a}	52.41±2.20^{a}	47.31±3.40^{b}	47.01±4.75^{b}	48.48±2.98^{b}	ns	***
PUFA	10.58±1.09	10.19±1.34^{a}	10.09±1.54	12.36±2.90	12.99±4.11^{b}	11.04±2.57	ns	**
P/S	0.27±0.03	0.26±0.04^{a}	0.27±0.04	0.31±0.08	0.33±0.12^{a}	0.28±0.07	ns	*

[1] A = commercial compound feed diet (3 kg commercial compound feed pig^{-1} d^{-1}); B = mixed diet (1.5 kg commercial compound feed + 2.5 kg chestnuts pig^{-1} d^{-1}); C = chestnuts diet (5 kg chestnuts pig^{-1} d^{-1}). SFA: sum of saturated fatty acids; UFA: sum of unsaturated fatty acids; MUFA: sum of monounsaturated fatty acids; PUFA: sum of polyunsaturated fatty acids; P/S: the ratio of total PUFA to total SFA. [1-2] Means within the same row and muscle not followed by a common number were influenced by diet ($p < 0.05$). [a-b] Means within the same row and diet not followed by the same letter was influenced by location (muscle) ($p < 0.05$). Significant differences: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; ns: not significant.

weight (García-Macías *et al.*, 1996; Weatherup *et al.*, 1998; Correa *et al.*, 2006).

Although differences were not statistically significant, increasing proportions of chestnuts in the finishing diet appeared to increase the quantity of back fat, possibly as a result of the increased intake of starch. The lipogenic effect of the carbohydrates in the diet is largely known.

High values of carcass length were observed, in accordance with the high live weights of the pigs used in this study. However, values were lower than those reported in literature for heavy pigs of Landrace and Large White breeds (Lukic *et al.*, 2010; Watanabe *et al.*, 2010).

The subcutaneous fat thickness was notably higher than that reported in previous studies (Blasco *et al.*, 1994; Ellis *et al.*, 1996; García-Macías *et al.*, 1996; Weatherup *et al.*, 1998; Flores-Rondón *et al.*, 2009; Watanabe *et al.*, 2010). The main reason for this finding is probably the high slaughtering weight, as the thickness of back fat is known to increase with live weight (García-Macías *et al.*, 1996; Weatherup *et al.*, 1998); the back fat thickness is estimated to be 1.5-2.5 mm for each 10 kg live weight (Weatherup *et al.*,

1998). Castration also increases the thickness of back fat (Ellis *et al.*, 1996). Finally, there is probably also a genetic influence; back fat is thicker in rustic unimproved than in improved breeds (Gispert *et al.*, 1997). The strong adipogenic ability of unimproved breeds is widely known (Labroue *et al.*, 2000; Franci *et al.*, 2003).

Values of ham length were higher, and those of ham perimeter lower, than those reported for Landrace × Large White heavy pigs (Lukic *et al.*, 2010). This shows a particular characteristic of the Celta pig, already described (Franco & Lorenzo, 2013), and other unimproved breeds, *i.e.* long legs adapted to walking, as a consequence of outdoor exploitation in extensive systems.

The values of the area of the *Longissimus lumborum* muscle were lower than those reported for improved breeds of pigs slaughtered at much lower live weights than the Celta pigs used in the present study (Ellis *et al.*, 1996; García-Macías *et al.*, 1996; Flores-Rondón *et al.*, 2009). The values in the present study were also much lower than those reported for Landrace × Large White heavy pigs (mean values of 64 cm^2) (Lukic *et al.*, 2010). This finding reaffirms the condition of unimproved breed of the Celta pigs.

Positive and in most cases significant correlations were observed for all the joint weights and measurements assessed. This was an expected finding, because for the same genetic background and carcass conformation, the weight of the different joints and the different measurements increase as the carcass weight increases. Positive correlations between live weight and carcass weight, carcass length and killing out (dressing yield) values have previously been reported (García-Macías *et al.*, 1996; Candek-Potokar *et al.*, 1998; Latorre *et al.*, 2003; Correa *et al.*, 2006).

The distribution of the weights of the different joints basically coincides with the information previously reported (Franco & Lorenzo, 2013) and again indicates the rustic and unimproved condition of the Celta pig breed. The large contribution of the head to the carcass weight (around 8.5%) is outstanding and confirms previous findings (Sánchez *et al.*, 2000); the values of this ratio reported for other pig breeds vary at around 5% (García-Macías *et al.*, 1996; Franci *et al.*, 2003). Values for ham contribution to the total weight were lower than those reported for improved breeds (Blasco *et al.*, 1994; García-Macías *et al.*, 1996; Flores-Rondón *et al.*, 2009; Watanabe *et al.*, 2010); the same applies to the contribution of shoulder to the total weight (Flores-Rondón *et al.*, 2009). The ratio ham/shoulder (around 1.5) indicates that Celta breed has very different characteristics from the desirable "four ham" type of pig.

The contributions from back fat, shoulder, ham and loin are similar to those reported for Celta pig slaughtered at 12 months (Franco & Lorenzo, 2013) and for Corsican pig (Franci *et al.*, 2003), another unimproved breed.

Reported findings in literature on the effect of the inclusion of different vegetable feeds at different levels in the finishing diets of heavy swine on the carcass conformation are contradictory. While Fraga *et al.* (2008) did not report any reduction in the carcass yield in response to the inclusion of 19% of rice hull in the diet of swine slaughtered at a live weight of 130 kg, Scipione *et al.* (1991) reported a significant reduction in carcass yield in pigs fed with sugar beet pulp silage and slaughtered at 144 kg. Paiva-Martins *et al.* (2009) reported that the use of 5 or 10% of olive leaves in the diet decreased the carcass weight and yield, the back fat thickness and the area of the *Longissimus* muscle. More recently, Watanabe *et al.* (2010) observed negative linear responses on final live weight, carcass yield and ham weight values as the inclusion of citrus pulp level in the diet was increased from 0% to 30% in pigs slaughtered at a live weight of 130 kg. The present results are consistent with those of Coutron-Gambotti *et al.* (1998), who studied the effects of substituting a concentrated diet with chestnuts in Corsican pig and did not observe any effect on the live weight, carcass weight, carcass yield or thickness of subcutaneous adipose tissue.

Negative effects reported by some authors may be due to the high intake of non-starch polysaccharides (NSPs). Pluske *et al.* (1998) reported a negative correlation between the intake of NSPs and the carcass yield. In the present study, the increased proportion of chestnuts in the finishing diet caused an increase in the daily individual intake of starch, but a decrease in the intake of crude fibre (see Table 1). This, together with an absence of qualitative or quantitative feed restrictions, may explain the absence of any effect on the live weight, carcass weight, killing out, joint weight and other measures carried out in the present study. The chestnut diet provides less protein (210 g pig^{-1} d^{-1}) than the mixed diet (334.5 g pig^{-1} d^{-1}) and the compound feed diet (459 g pig^{-1} d^{-1}) (Table 1), although it appears that 210 g pig^{-1} d^{-1} is a sufficient intake to cover the nitrogen requirements of the pigs, as pre-

viously observed by Coutron-Gambotti *et al.* (1998) with a diet providing 225 g of protein pig^{-1} d^{-1} to the Corsican pig. This is possible because the pigs deposited only small amounts of muscle tissue during the fattening period (Secondi *et al.*, 1996).

Meat quality traits

The moisture contents of both muscles (around 73% for all the finishing diets) are within the range of values described by other authors (72-74%) for improved pig breeds or hybrids of meat aptitude (Gentry *et al.*, 2002; Hamilton *et al.*, 2003; Latorre *et al.*, 2003; Correa *et al.*, 2006).

The IMF content is perhaps the most commonly studied parameter of the proximate composition and is considered to have the greatest effect on the quality of the pig meat. A high content of IMF is a positive element for genetic improvement strategies because of its positive influence on the sensorial quality: flavour, tenderness, juiciness and general acceptance (Ellis *et al.*, 1996; Fernandez *et al.,* 1999). The average values in the present study (between 1.82 and 2.76%) agree with data previously reported for this breed (Franco & Lorenzo, 2013) and they are within the wide range described for different muscles in other breeds (Sellier, 1988; Oliver *et al.*, 1993). However, these values are much lower than those described for other rustic unimproved Spanish breeds such as Chato Murciano (6.39%) (Peinado *et al.*, 2004) and Iberian pig (7%) (Mayoral *et al.*, 1999).

The average values of protein content, around 22%, are within the range described by other authors for other breeds (Correa *et al.*, 2006; Juárez *et al.*, 2009).

The pH values in the present study are within the range previously reported for muscles from pigs of different genotypes, with different regimes of physical exercise, nutrition levels, types of stunning, etc. (Channon *et al.*, 2000; Gentry *et al.*, 2002; Hamilton *et al.*, 2003; Latorre *et al.*, 2003; Franci *et al.*, 2005; Correa *et al.*, 2006), and transported to the slaughterhouse and slaughtered under appropriate conditions, minimizing stress, as occurred with the pigs used in this study.

The values of the myoglobin content in the present study were generally higher than those reported in the literature for improved breeds (Estévez *et al.*, 2003; Latorre *et al.*, 2003) and also for Iberian pig (Estévez *et al.*, 2003), although other studies carried out in Iberian pig reported values of around 4 mg/100 g of muscle. Age and physical activity increase the myoglobin content in muscles (Tikk, 2007); the age (16 months) and the rearing system (extensive) of the pigs used in the present study would therefore explain the relatively high myoglobin contents.

The average values reported in the literature for the parameters of the colour L*, a* and b* in meat from pigs of different breeds were in the ranges 44-58, 5-10 and 4-9, respectively (Hamilton *et al.*, 2003; Latorre *et al.*, 2003; Olsson *et al.*, 2003; Millet *et al.*, 2005; Correa *et al.*, 2006; Renaudeau & Mourot, 2007; Ruusunen *et al.*, 2007). Regarding rustic unimproved breeds, reported values were 47, 10 and 6 for Chato Murciano (Peinado *et al.,* 2004), 30-38, 10-14, 5-12 for Iberian (Juárez *et al.*, 2009), and 47-52, 8 and 9-11 for Celta (Franco & Lorenzo, 2013) pigs.

The redness (a*) values in the present study were slightly higher than the values previously reported for both improved and unimproved breeds. The a* value is related to the concentration of pigments and to the pH value. The high a* values can be explained by the high Fe contents in the muscles of the Celta pigs, in comparison with the values reported for other breeds. Pigs in the present study were raised outdoors, and high values of a* and a redder meat were therefore expected.

The lightness (L*) and yellowness (b*) values observed in the present study are within the range of values previously reported. The L* value is positively related to the moisture and fat contents (Pedauyé *et al.*, 1994) and is also affected by the pH of the meat (high pH values result in darker meat with lower L* values).

In general, the rustic unimproved traditional breeds (Chato Murciano, Iberian, etc.), like the Celta pigs in the present and in previous (Franco & Lorenzo, 2013) studies, appear to have darker (lower L* values), redder (higher a* values) and more yellowish (higher b* values) meat, when compared with the improved breeds (Landrace, Large White, Yorkshire, Pietrain) and their crosses. In addition to the genetic component, these differences are also associated with older ages and heavier weights at slaughtering, with higher iron contents, and with higher contents of IMF in the traditional breeds.

The cooking loss values in the present study (in all cases around 17%) were similar to those reported by other authors (Pugliese *et al.*, 2004; Juárez *et al.*, 2009) in pigs of several breeds and origins. The effect of the

genotype, rearing system and diet on the water holding capacity has been widely investigated (Olsson *et al.*, 2003; Millet *et al.*, 2005; Renaudeau & Mourot, 2007; Ruusunen *et al.*, 2007).

The shear force values reported in previous studies, usually between 40 and 80 N (Hamilton *et al.*, 2003; Olsson *et al.*, 2003; Swigert *et al.*, 2004), are much lower than those found for the Celta pigs in the present study. The factors resulting in harder meat of the Celta pigs than in improved breeds of pigs are probably the older age at slaughtering and the greater physical activity during rearing.

As indicated in the section of results, the use of the chestnuts in the finishing diet did not significantly affect the meat quality parameters assessed in the present study. Previous studies on the effect of the diet on meat quality are certainly abundant, although, as occurred in the present study, limited effects have been reported by different authors in all cases, and the colour parameters are the parameters most affected.

Pugliese *et al.* (2013) reported an increase of the L*, a* and b* values in the *Longissimus lumborum* muscle in pigs fattened with chestnuts during 1 or 3 months in comparison with pigs fattened without chestnuts. Authors attributed this effect to the tannin content of the chestnuts. However, in previous works (Pugliese *et al.*, 2007) no effect was observed of the feeding with chestnuts in the colour parameters of the muscles.

Watanabe *et al.* (2010) reported that the use of citrus pulp in the diet modified the colour parameters, and observed a linear reduction in the L*, a* and b* values as the dietary levels of citrus pulp increased from 10 to 30%. Fraga *et al.* (2008) also reported a reduction in the a* and b* values as a result of the inclusion of rice hull in diets; these authors indicated that this effect is probably due to a reduction in dietary pigments due to the low level of corn in the diet.

Besides the composition of the diet, a reduction in the amount of food provided could also modify the meat colour parameters. Candek-Potokar *et al.* (1999) reported that a 30% reduction in feed affected the muscular configuration of the loin in pigs slaughtered at 130 kg LW, with a higher relative area occupied by slow contracting red muscular fibres. In the present study, the amount of food was not reduced in the pigs fed with chestnuts, and the possibility of modification of the colour parameters by this factor does not exist.

The main difference in the diets used in the present study is the protein content (see Table 1). Previous findings show that the protein level in the diet does not have a marked effect on the meat quality, and that the most affected traits are, again, the colour parameters. Some authors found that low protein diets increased L*, a* and b* values (Goerl *et al.*, 1995; Teye *et al.*, 2006). However, low protein diets did not affect the colour in other studies (Cisneros *et al.*, 1996; Ruusunen *et al.*, 2007). It appears that the effects of low protein diets on the colour are due to effects on the IMF content which, as already mentioned, were not evident in the present study.

The increase in the proportion of chestnuts in the diet led to an increase in the starch intake (see Table 1). Intake of carbohydrates increases the muscle glycogen stores and it is well known that the glycogen content in the muscles affects both the rate and the extent of the decrease in pH *post mortem* (Henckel *et al.*, 2000). In the present study, as already mentioned, the increased amount of chestnuts in the diet led to a slight, although not significant decrease in the final pH values, which was more apparent in the *Semimembranosus* muscle. However, the differences were so small that the effects of these differences on the cooking loss and colour parameters were not perceptible.

The fatty acid profile observed in the two muscles agrees with that reported in previous works in Celta pig (Franco *et al.*, 2006; Lorenzo *et al.*, 2012) and was also similar to those observed in other unimproved breeds such as Iberian (Pérez-Palacios *et al.*, 2009) and Chato Murciano (Galián *et al.*, 2008) breeds.

The differences in SFA, PUFA and MUFA contents between *Longissimus dorsi* and *Semimembranosus* muscles seem to be related with the different type of metabolism in the two muscles. *Longissimus dorsi* is a predominantly glycolytic muscle while *Semimembranosus* has a metabolism predominantly oxidative. Several authors (Leseigneur-Meynier & Gandemer, 1991; Hernández *et al.*, 1998) reported that the PUFA content increases with the oxidative activity of the muscle.

Although this effect was not significant ($p > 0.05$), in the present study the inclusion of chestnuts in the finishing diet seems to decrease the SFA content in the *Longissimus dorsi* muscle (38.61%, 38.90% and 37.50% for commercial compound, mixed, and chestnuts diets, respectively); however, this effect was not observed in the *Semimembranosus* muscle (40.32%, 40.01% and 40.49% for commercial compound, mixed, and chestnuts diets, respectively). Our results are in contrast with those previously observed by Bermúdez *et al.* (2102) who, when analyzed the *Biceps femoris* muscle of the dry-cured hams manufactured from the same

pigs used in this study, reported significant differences ($p < 0.001$) in SFA content associated to the use of chestnuts in the finishing diet (40.33%, 35.57% and 35.63% for commercial compound, mixed, and chestnuts diets, respectively). These authors correlated ($r = 0.86$; $p < 0.01$) the differences in SFA content in the *Biceps femoris* muscle from the three diets with differences in C16 content. Also in our case, the increase of chestnuts in the diet seems to decrease the C16 content in the two muscles (24%, 23.60% and 23.54% for commercial compound, mixed, and chestnuts diets, respectively, in the *Longissimus dorsi*, and 23.30%, 22.81% and 22.77% for commercial compound, mixed, and chestnuts diets, respectively, in the *Semimembranosus* muscle), although these differences were not significant.

Regarding the effect on the MUFA content, the increase of chestnut in the finishing diet seems to increase these fatty acids in muscles (50.81%, 50.91% and 52.41% for commercial compound, mixed and chestnuts diets, respectively, in the *Longissimus dorsi*, and 47.31%, 47.01% and 48.48% for commercial compound, mixed, and chestnuts diets, respectively, in the *Semimembranosus* muscle), although differences were not significant ($p > 0.05$). Also for the MUFA contents, our result were not totally in agreement with those reported by Bermúdez *et al.* (2012) who observed significant differences ($p < 0.001$) associated to the diets in the *Biceps femoris* muscle of the dry-cured ham (43.85%, 50.70% and 49.79% for commercial compound, mixed, and chestnuts diets, respectively). These authors correlated the MUFA contents in *Biceps femoris* muscle with the C18:1 c*n9* contents in diets. In our case the increase of chestnuts in the diet caused an increase in C18:1 c*n9* contents in the two muscles (43.68%, 44% and 44.96% for commercial compound, mixed and chestnuts diets, respectively, in the *Longissimus dorsi*, and 42.68%, 42.49% and 43.78% for commercial compound, mixed, and chestnuts diets, respectively, in the *Semimembranosus* muscle), although one more time these differences were not significant.

From our results and from those reported by Bermúdez *et al.* (2012) for the *Biceps femoris* muscle from dry-cured ham, it seems that the effect of the inclusion of chestnuts in the finishing diet on the fatty acid content is dependent on the type of muscle considered, although the drying-ripening process of the ham, and its particular action over each fatty acid type, could modulate this effect.

The contents in C18:2 *n6* and C18:3 *n3* in the porcine tissues are directly related to the contents of these two fatty acids in the diet, because they cannot be synthesised in the tissues. Therefore, higher contents in C18:2 *n6* and C18:3 *n3* acids in the muscular fat would be expected as the proportion of chestnuts increases in the diet.

Significant differences ($p < 0.01$) among diets were observed in the C20:2 *n6* acid percentage. The C18:2 *n6* acid is the precursor of the synthesis of the other *n6* PUFA, although these can be also incorporated from the diet. Our results seem indicate a higher direct deposition from the diet of the C20:2 *n6* acid, being the content of this fatty acid higher in the muscles of the pigs feed with commercial compound feed which contains higher levels of this fatty acid (Table 2).

Our results are not in line with previous findings in literature. Coutron-Gambotti *et al.* (1998) reported higher contents in PUFA in the *Biceps femoris* muscle in pigs fed with chestnuts, despite the fact that in their study chestnuts showed similar or even lower PUFA contents than the concentrated diet used in pig feeding. These authors explained the higher PUFA contents in muscles of pigs fed with chestnuts on the basis of differences in the mechanisms of the *de novo* synthesis of fatty acids from carbohydrates or of the desaturation and elongation of both endogenous and dietary fatty acids.

In conclusion, carcass measures and distribution of the weights of the different joints indicate the rustic and unimproved nature of the Celta pig breed. Also, meat of the Celta pigs slaughtered at high live weights shows high myoglobin contents and a* values, and very high hardness. The partial or total replacement of the commercial compound feed with chestnuts in the finishing diet of Celta pigs slaughtered at high live weights had no significant effect on the carcass traits (live weight, carcass weight, killing out, carcass measures, joint weights, and joint weight distribution) or on the meat quality (proximate composition, pH, colour, cooking loss, and shear force). This replacement seems to decrease the SFA content and to increase the MUFA content in the pig muscles, although this effect was not statistically significant in the present study.

The present study provides scientific basis for the use of chestnuts in the finishing diet of the Celta pigs. However, more studies will be needed in the future in order to investigate the effect of the use of chestnuts in the diet on the quality of the dry-cured meat products.

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