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POSTER

Influence of sex on meat quality of Celta pig breed

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SUMMARY

The aim of this work was to study the effect of sex on the chemical composition, color parameters and textural analysis of meat of Celta pig breed. For this purpose, 27 pigs (16 castrated barrows and 11 gilts) were used. Animals were fed *ad libitum* with a commercial concentrate suited to their nutritional needs and they were slaughtered when they reached a live weight of 102.49±8.23 and 100.72±9.74 kg (P>0.05) for barrows and gilts, respectively. The muscle *longissimus dorsi* (LD) was extracted from each carcass, between the fourth and the tenth rib. For the investigation of the effect of sex on the different parameters of quality studied, an analysis of variance (ANOVA) was performed for all variables, using the SPSS 21.0 software package for Windows. Color parameters were not significantly affected by gender, although meat from barrows was darker. On the other hand, the pH values did not display significant (P>0.05) differences between sexes with a mean value of 5.94. Regarding chemical composition, the highest moisture and protein contents were observed in barrow samples, whereas the highest intramuscular fat percentages were found in gilts samples. There were no significant differences in cooking loss between sexes with mean values of 15.7%. Finally, no significant differences (P>0.05) between genders on textural parameters measured by WB and TPA test were found.

Influencia del sexo sobre la calidad de la carne de cerdo de la raza Celta

Palabras clave adicionales
Raza autóctona en peligro de extinción.
Composición química.
Parámetros de textura.
Efecto del sexo.

RESUMEN

El objetivo de este trabajo fue estudiar el efecto del sexo sobre la composición química, parámetros de color y análisis de textura de la carne en cerdos de la raza Celta. Para ello se utilizaron 27 cerdos (16 machos castrados y 11 hembras). Los animales fueron alimentados ad libitum con un pienso comercial adecuado a sus necesidades nutricionales y se sacrificaron cuando alcanzaron un peso vivo de 102,49±8,23 y 100,72±9,74 kg (P>0.05) en machos y hembras, respectivamente. En cada canal se tomaron muestras del músculo longissimus dorsi (LD) entre las vértebras 4ª y 10ª. Para estudiar el efecto del sexo sobre los distintos parámetros analizados se realizó un análisis de varianza (ANOVA) usando el programa SPSS versión 21.0. Los parámetros de color no se vieron afectados de un modo significativo por el sexo, aunque la carne procedente de los machos fue más oscura que la de las hembras. Por otro lado, los valores de pH no mostraron diferencias significativas (P>0,05) entre sexos, con valores medios de 5,94. Con respecto a la composición química, los machos presentaron los mayores contenidos de humedad y proteína, mientras que las hembras mostraron los mayores porcentajes de grasa intramuscular. No hubo diferencias significativas en las pérdidas por cocción entre sexos, con valores medios de 15,7%. Finalmente, no se encontraron diferencias significativas entre géneros (P>0,05) en los parámetros de textura medidos por los test WB y TPA.

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INTRODUCTION

The use of local breeds as an alternative pig production system has important advantages since these breeds are well adapted to the environment and they help to maintain biodiversity and sustainable agricultural production, especially in depressed areas. Celta pig is the unique autochthonous pig breed of Galicia (NW Spain). It is included in the Official Catalogue of Pig Breeds of Spain as being in danger of extinction (Franco et al. 2014, p. 195). The traditional livestock production system of the Celta pig is closed to an extensive or semi-free system than to an intensive system, but nowadays it is commonly farmed intensively.

The Celta pig breed is highly appreciated by consumers for its succulent meat that derives from the profuse infiltration of fat into the lean meat (Franco et al. 2014, p. 195), and production of these pigs mainly focuses on the manufacture of dry-cured meat products such as ham (Bermúdez et al. 2014, p. 263), "lacón" (Lorenzo et al. 2014, p. 211), dry-cured loin (Pateiro et al. 2015, p.4808) and sausages (Gómez & Lorenzo 2013, p. 658). Pig meat production is commonly evaluated according to growth curve performance, carcass composition and meat quality. It is crucial to provide well characterized, high quality, labelled meats to consumers. Factors that affect pig meat composition and quality include genotype, sex, diet, production system, and slaughtering weight and age (Pugliese et al. 2004, p. 523; Pugliese et al. 2005, p. 459). Scarce information about the effect of gender on meat quality of Celta pig breed have been reported until now (Franco & Lorenzo 2013, p. 727), making necessary to study more deeply for the correct characterization of the breed and its products. Under such a scenario, the aim of this study was to assess the influence of sex on chemical composition (moisture, intramuscular fat (IMF), protein and ash content), color parameters and textural properties of meat from Celta pig breed.

MATERIAL AND METHODS

Twenty-seven pigs (16 castrated barrows and 11 gilts) from the Celta breed were used. Animals were fed *ad libitum* with a commercial concentrate suited to their nutritional needs and they were slaughtered when they reached a live weight of 102.49±8.23 and 100.72±9.74 kg (P>0.05) for barrows and gilts, respectively. At 48 h *post-mortem* a portion of the loin, M. *longissimus dorsi* (LD), between the fourth and tenth rib, was taken for meat quality assessment. The LD piece was cut into three steaks of 2.5 cm thickness. The first two steaks were used to assess pH, color parameters and proximate composition, whereas the third steak was used to determine the water-holding capacity and texture parameters. The pH was measured using a digital pH-meter (Thermo Orion 710 A+, Cambridgeshire, UK) equipped with a penetration probe. A portable colorimeter (Konica Minolta CM-600d, Osaka, Japan) was used to estimate the color in the CIELAB space: lightness, (L*); redness, (a*); yellowness, (b*). The color of each steak was measured three times. Calibration of the instrument was always performed before measurements using a white ceramic tile. Moisture, fat, protein (Kjeldahl N × 6.25) and ash were quantified according to Franco et al. (2014, p. 195). To evaluate cooking loss (CL), one 2.5 cm thick steak was packed individually under vacuum (97%) (Tecnotrip model EV-15-1-D) and cooked in a water bath (Selecta Tectron Bio, Barcelona, Spain) at 75 °C for 45 min. Samples were cooled at room temperature and CL was determined. Seven meat pieces of 1 × 1 × 2.5 cm (height × width x length) were removed parallel to the muscle fibre direction and were completely cut using a Warner–Braztler (WB) shear blade with a triangular slot cutting edge (1 mm thick) using a texture analyzer (TA.XTplus, Stable Micro Systems, Vienna Court, UK). Texture profile analysis (TPA) was carried out by compression to 60% with a compression probe of 19.85 cm^2 surface contact. Force–time curves were recorded at a crosshead speed of 3.33 mm/s and recording speed was also 3.33 mm/s. In order to evaluate the effect of sex on each one of the parameters studied, an analysis of variance (ANOVA) using the IBM SPSS Statistics 21.0 program (IBM Corporation, Somers, NY, USA) was performed. All statistical tests of LSM were performed with a confidence interval of 95% (P<0.05).

RESULTS

The effect of sex on chemical composition and color parameters of LD muscle from Celta pig breed is shown in **Table I**. The pH values were not significantly (P>0.05) affected by gender, although higher pH values were observed in barrows (5.96 *vs*. 5.91, for barrows and gilts, respectively). Regarding chemical composition, the highest moisture and protein contents were observed in barrow samples, whereas the highest intramuscular fat percentages were found in gilt samples (2.13 *vs*. 3.56%, P<0.05, for barrows and gilts, respectively). On the other hand, color parameters were not significantly affected by gender, although meat from

Table I. Effect of sex on pH, color parameters and chemical composition of *longissimus dorsi* muscle from Celta pig breed. Values are means ± standard deviations (Efecto del sexo sobre el pH, parámetros de color y composición química del músculo *longissimus dorsi* de la raza porcina celta. Los valores son medias ± desviaciones estándar).

	Barrows (n=16)	Gilts (n=11)	SEM	SIG
pH	5.96 ± 0.16	5.91 ± 0.32	0.05	n.s.
Color parameters				
Luminosity (L*)	49.26 ± 2.62	50.72 ± 3.54	0.59	n.s.
Redness (a*)	2.10 ± 1.28	2.71 ± 1.36	0.26	n.s.
Yellowness (b*)	11.17 ± 0.98	11.22 ± 2.07	0.29	n.s.
Chemical composition (%)				
Moisture	73.33 ± 0.99	72.27 ± 1.93	0.29	n.s.
Intramuscular fat	2.13 ± 0.70	3.56 ± 2.33	0.33	*
Protein	23.82 ± 0.91	23.08 ± 0.63	0.17	*
Ashes	1.12 ± 0.09	1.16 ± 0.07	0.02	n.s.

SEM: standard error of the mean. SIG: Significance: *** (P<0.001), ** (P<0.01), *P<0.05), n.s. (not significant).

Table II. Effect of sex on cooking loss and textural parameters of *longissimus dorsi* muscle from Celta pig breed. Values are means ± standard deviations (Efecto del sexo sobre la pérdida de cocción y los parámetros texturales del músculo *longissimus dorsi* de la raza porcina celta. Los valores son medias ± desviaciones estándar).

	Barrows (n=16)	Gilts (n=11)	SEM	SIG
WHC (%)				
Cooking loss	16.02 ± 3.25	15.16 ± 4.22	0.70	n.s.
WB test				
Shear force (N/cm^2)	17.03 ± 3.55	18.45 ± 5.71	0.87	n.s.
Firmness (N/s)	4.69 ± 0.90	5.00 ± 1.67	0.24	n.s.
Total work (N ·mm)	96.74 ± 28.63	103.75 ± 37.26	6.14	n.s.
TPA test				
Hardness (N)	58.78 ± 13.64	55.56 ± 16.07	2.79	n.s.
Springiness (mm)	0.53 ± 0.05	0.52 ± 0.04	0.01	n.s.
Cohesiveness	0.51 ± 0.05	0.50 ± 0.03	0.01	n.s.
Gumminess (N)	30.07 ± 8.32	27.90 ± 8.30	1.58	n.s.
Chewiness (N ·mm)	15.96 ± 5.17	14.49 ± 4.56	0.94	n.s.

SEM: standard error of the mean. SIG: Significance: *** (P<0.001), ** (P<0.01), * (P<0.05), n.s. (not significant)

barrows was darker **(Table I)**. **Table II** shows the effect of sex on cooking loss, WB shear force and TPA analysis of LD from Celta pig breed. There were no significant differences in cooking loss between sexes with mean values of 15.7%. Finally, no significant effect of gender (P>0.05) on the textural parameters measured by WB test and TPA test was found.

DISCUSSION

The mean pH value (5.94) is considered within the normal range for pigs which do not produce PSE meat. Values in the same range were reported by other authors (Franco, & Lorenzo 2013, p. 727; Pugliese et al. 2004, p. 523; Pugliese et al. 2005, p. 459) in autochthonous pig breeds. On the other hand, our outcomes obtained from chemical composition are in disagreement with those reported by other authors (Pugliese et al. 2004, p. 523; Franco & Lorenzo 2013, p. 727; Franci et al. 2005, p. 545) who did not find any significant differences on IMF between sexes. Overall, the values of IMF content in this study (2.13-3.56%) are comparable with those recorded in other local breeds: 3.19% in Cinta Senese (Franci et al. 2005, p. 545), 2.28% in Celta (Temperán et al. 2014, p. 694), 3.81 in Nero Siciliano (Pugliese et al. 2004, p. 523) and 3.34% in Iberian (Estevez et al. 2003, p. 499) pigs. Although color parameters were not significantly affected by gender, gilts produced lighter and more yellow meat, probably due to its higher intramuscular fat content. This result is in agreement with data reported by Pugliese et al. (2004, p. 523) who noticed that sex did not significantly affect any color parameters in Nero Siciliano pig breed. The CL has a great importance in the properties of meat, because it affects consumer acceptance. Our finding is in agreement with data reported by Franci et al. (2005, p.545) who did not observe significant differences on CL between sexes. However, Franco and Lorenzo (2013, p. 727) found significantly (P<0.01) higher CL values in meat from gilts than from barrows. Finally, WB test was not affected by sex, which agrees with the results reported by Pugliese et al. (2004, p. 523). On the other hand, we found lower hardness values in gilts, which may be due to the different amount of collagen or marbling degree (Huff-Lonergan et al. 2000, pp. 1-4; Maiorano et al. 2013, p. 346; Stoller et al. 2003, p.1513). Contrary, Franco and Lorenzo (2013, p. 727) noticed significantly (P<0.01) higher hardness values in meat from gilts than from barrows. From the results, we can conclude that sex did not have great influence on meat quality of Celta pig breed.

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BIBLIOGRAPHY

Bermúdez, R, Franco, D, Carballo, J, Sentandreu, MA, & Lorenzo, JM 2014, `Influence of muscle type on the evolution of free amino acids and sarcoplasmic and myofibrillar proteins through the manufacturing process of Celta dry-cured ham´, *Food Research International,* vol. 56, pp. 226-235.

Estévez, M, Morcuende, D, & López, RC, 2003, `Physico-chemical characteristics of M. *Longissimus dorsi* from three lines of free-range reared Iberian pigs slaughtered at 90 kg live-weight and commercial pigs: a comparative study´, *Meat Science,* vol. 64, pp. 499-506.

Franci, O, Bozzi, R, Pugliese, C, Acciaioli, A, Campodoni, G, & Gandini, G 2005, `Performance of Cinta Senese pigs and their crosses with Large White. 1 Muscle and subcutaneous fat characteristics´, *Meat Science,* vol. 69, pp. 545-550.

Franco, D, Vázquez, JA, & Lorenzo, JM 2014, `Growth performance, carcass and meat quality of the Celta pig crossbred with Duroc and Landrace genotypes´, *Meat Science,* vol. 96, pp.195-202.

Franco, D, & Lorenzo, JM, 2013, `Effect of gender (barrows vs. females) on carcass traits and meat quality of Celta pig reared outdoors´, *Journal of the Science of Food and Agriculture,* vol. 93, pp. 727-734.

Gómez, M, & Lorenzo, JM 2013, `Effect of fat level on physicochemical, volatile compounds and sensory characteristics of dry-ripened "chorizo" from Celta pig breed´, *Meat Science,* vol. 95, pp. 658-666.

Huff-Lonergan, E, Lonergan, SM, & Vaske L 2000, `pH relationships to quality attributes: tenderness, *American Meat Science Association's Reciprocal Meat Conference Proceedings*, vol. 53, pp. 1-4.

Maiorano, G, Kapelański, W, Bocian, M, Pizzuto, R, & Kapelańska, J 2013, `Influence of rearing system, diet and gender on performance, carcass traits and meat quality of Polish Landrace pigs´, *Animal*, vol. 7:2, pp. 341-347.

Lorenzo, JM, Franco, D, & Carballo, J 2014, `Effect of the inclusion of chestnut in the finishing diet on volatile compounds during the manufacture of dry-cured "Lacón" from Celta pig breed´, *Meat Science,* vol. 96, pp. 211-223.

Pateiro, M, Franco, D, Carril, JA, & Lorenzo, JM 2015, `Changes on physico-chemical properties, lipid oxidation and volatile compounds during the manufacture of Celta dry-cured loin´, *Journal of Food Science and Technology,* vol. 52, pp. 4808-4818.

Pugliese, C, Bozzi, R, Campodoni, G, Acciaioli, A, Franci, O, & Gandini, G 2005, `Performance of Cinta Senese pigs reared outdoors and indoors. 1. Meat and subcutaneous fat characteristics´, *Meat Science,* vol. 69, pp. 459-464.

Pugliese, C, Calagna, G, Chiofalo, V, Moretti, VM, Margiotta, S, Franci, O, & Gandini, G 2004, `Comparison of the performances of Nero Siciliano pigs reared indoors and outdoors: 2. Joints composition, meat and fat traits´, *Meat Science,* vol. 68, pp. 523-528.

Stoller, GM, Zerby, H.N, Moeller, SJ, Baas, TJ, Johnson, C, & Watkins, LE 2003, `The effect of feeding ractopamine (Paylean) on muscle quality and sensory characteristics in three diverse genetic lines of swine´, *Journal of Animal Science*, vol. 81, pp. 1508-1516.

Temperán, S, Lorenzo, JM, Castiñeiras, BD, Franco, I, & Carballo, J, 2014, `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, pp. 694-707.