INFLUENCE OF GENOTYPE ON PHYSICO-CHEMICAL PARAMETERS OF CELTA PIGS FROM AN EXTENSIVE PRODUCTION SYSTEM

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Abstract – The influence of line (Santiaguesa *vs.* Carballina *vs.* Barcina) on colour, water holding capacity (WHC) and textural parameters of Celta pigs (*longissimus dorsi* -LD- and subcutaneous fat) was studied. For this work, a total of 42 animals were used. Genotype affected colour parameters of LD and dorsal fat. Meat from Santiaguesa genotype was paler than meat from Carballina and Barcina pigs (P<0.05), whereas meat from Barcina and Santiaguesa lines was redder (P<0.05) than meat from Carballina genotype. As for b* value, meat from Santiaguesa line pigs had more yellow index than meat from Carballina pigs (P<0.05) while Barcina genotype pigs were intermediate (P<0.05). Dorsal fat redness and yellowness were significantly different (P<0.05) in Barcina lines (2.45 vs. 1.57 and 6.97 vs. 6.05 for a* and b*, respectively), whereas no differences in the colour traits of ventral fat were detected among lines. On the other hand, all types of measurement of WHC were significantly influenced by genotype, whereas only hardness was different among lines. Finally, genotype factor had no significant effect (P>0.05) on parameters measured by Warner-Bratzler test (shear force, firmness and total work of cut), whereas textural profile analysis only showed significant differences for hardness, with pork from Santiaguesa line being the hardest (P<0.05).

Key Words – Barcina line, Carballina line, Santiaguesa line.

I. INTRODUCTION

The Celta pig breed was the most important in Galicia (NW Spain) until the beginning of the 20th century, but since that time it's being suffering a continuous decrease caused by the introduction of improved breeds and their crosses. Celta pig breed has benefited from a breeders association since 1999 (ASOPORCEL), so in recent years its number has been growing with about 780 sows in 2011 [1]. This breed is characterized by a great rusticity that allows a perfect ability to adapt to the habitat conditions of the autochthonous forests. The farming system used to raise Celta pig is typical of the outdoor pig production, farmed on wood pastures, chestnuts and acorns. Within the Celta pig breed can be distinguish three varieties or lines of similar morphotype but with differences in skin pigmentation: Barcina, Carballina and Santiaguesa. Thus, the aim of this study was to assess the influence of genotype on physico-chemical properties of Celta pigs from an extensive production system

II. MATERIALS AND METHODS

A. Experimental design and animal management

For this study, 42 pigs from the Celta breed (Barcina line: 20, Carballina line: 16 and Santiaguesa line: 16) were used. All specimens, registered in the Record of Births of Stud-Book, were obtained from ASOPORCEL (Lugo). Pigs were reared in a single group in an extensive system. They were fed *ad libitum* with commercial concentrate suited to the nutritive needs of the animals (17 % protein, 2.4 % fat and 3.25 kcal of metabolized energy). The day before slaughter, the animals were transported to the abattoir trying to minimize the stress of the animals. Pigs were slaughtered in an accredited abattoir using carbon dioxide to stun the animals (Matadero Municipal de Sarria, Lugo, Spain).

B. Analytical methods

After 48 hours *post-mortem* a portion of the loin (*longissimus dorsi*, LD) and subcutaneous fat

from two locations (dorsal and ventral) were taken for colour, water holding capacity and textural traits. A CM-600d portable colorimeter (Konica Minolta Sensing, Osaka, Japan) was used to measure meat and fat colour in the CIELAB space (lightness: L*, redness: a* and yellowness: b*) [2]. The water holding capacity (WHC) was measured by four different methods: cooking loss (CL), drip loss (DL), thawing loss (TL) and pressing loss (PL), according to Honikel (1997) [3]. TL was calculated by determining the difference in weight between the samples before and after being frozen. CL was calculated by measuring the difference in weight between the cooked and raw thawed sample; samples were cooked placing vacuum package bags in a water bath with automatic temperature control (80 ºC) until reached an internal temperature of 70 ºC, controlled by thermocouples. Cooked samples were cooled at room temperature before weigh them. To determine PL, a sample of intact meat of 5 g was placed onto two disk of filter paper and a mass of 2.35 kg was applied for 5 min. To determine DL, a sample of intact meat (80-100 g) was placed on the top of a net inside a closed container which was placed in a chamber at 4 ºC for 48 h. Meat tenderness was measured by two textural tests in a TA. XT.plus texture analyzer (Stable Micro Systems, Surrey, United Kingdom): Warner-Bratzler (WB) and textural profile analysis (TPA). For both tests, cooked and cooled samples from CL determination were used. The samples for WB shear test were obtained by cutting pieces of approximately 1 x 1 x 2.5 cm (height x width x length) of cross section, parallel to the muscle fiber direction. They were completely cut through using a WB shear blade with a triangular slot cutting edge (1 mm of thickness) at a crosshead speed of 3.33 mm/s, determining three parameters: (i) the maximum shear force, represented by the highest peak of the force-time curve thus representing the maximum resistance of the sample to the cut; (ii) the shear firmness, represented by the slope from the beginning of the cut up to the highest point of the force-time curve; and (iii) the total work required to cut the sample, represented by the area under the curve obtained. Samples for TPA were obtained by cutting cubes of 1 x 1 x 1 cm approximately perpendicular to the muscle fiber direction and then compressing to 80 % with a compression probe of 19.85 cm^2 of surface contact at a crosshead speed of 3.33 mm/s. Between the first and second compression, there was an interval of 2 s. In this test the following variables were obtained: hardness, cohesiveness, springiness, gumminess and chewiness.

C. Statistical analysis

Results were statistically analyzed using the SPSS package (SPSS 18.0, Chicago, USA). One-way analysis of variance (ANOVA) and a posterior Duncan´s test with a 0.05 level of significance were performed.

III. RESULTS AND DISCUSSION

Colour, water holding capacity and textural parameters (WB test and TPA test) of *longissimus dorsi* and fat (dorsal and ventral locations) from Celta pigs genotypes (Barcina, Carballina and Santiaguesa line) are shown in Table 1.

Genotype affected colour parameters of LD and dorsal fat. Meat from Santiaguesa genotype had more lightness than meat from Carballina and Barcina pigs ($P<0.05$), whereas meat from Barcina and Santiaguesa lines was redder ($P<0.05$) than meat from Carballina genotype. Finally, meat from Santiaguesa line pigs had more yellow index than meat from Carballina pigs ($P<0.05$) while Barcina genotype pigs were intermediate ($P<0.05$). Dorsal fat colour redness and yellowness were significantly different ($P<0.05$) in Barcina lines (2.45 vs. 1.57 and 6.97 vs. 6.05 for a* and b*, respectively), whereas no differences in the colour traits of ventral fat were detected among lines. The average values found in the bibliography for colour parameters (L*, a* and b*) in pork meat from different breeds are in a wide range (44-58, 5-10 and 4-9, for L* a* and b*, respectively) [4]. In the present study, values for luminosity were inside the described range previously mentioned, whereas redness and yellowness values were slightly higher in all genotypes. In the subcutaneous colour fat, our values of L* were higher than reported by [5-6] in Chato Murciano pigs breed. Obviously, these

differences in results may be explained by the breed, slaughter age, colorimeter used and other factors like time post-mortem since measurement was made.

All types of measurement of WHC were significantly influenced by genotype. The WHC measured by CL and PL ($P<0.001$) and by TL and DL ($P<0.01$) was significant affected by genotype effect. Santiaguesa line presented the highest loss in water. DL in all pigs studied was relatively low, since the lowest values were described in Barcina group. The values of CL in this study (21.7 %,) were lower than those recorded in other local breeds: 28.45 % in Cinta Senese [7] and 24.25 % in Nero Siciliano [8].

Regarding meat texture, genotype factor had no significant effect ($P>0.05$) on parameters measured by WB test (shear force, firmness and total work of cut), whereas TPA showed only significant different for hardness. Hardness is the most important parameter of this test was significantly higher ($P<0.05$) in meat from Santiaguesa line. Overall, the values of maximum shear force in this study (3.42 kg) were lower than those recorded in other native breeds: 9.27 kg in Nero Siciliano pig [8] and 12.8.kg in Cinta Senese pig [7].

Table 1 Meat and fat colour characteristics (L*, a* and b*) and WHC and textural parameters of LD from the three Celta pig lines

	Barcina (n=20)	**Carballina (n=16)**	**Santiaguesa (n=16)**	**SEM**	**SIG**
Colour parameters					
Longissimus dorsi					
Luminosity (L*)	46.34[a]	47.08[a]	52.95[b]	0.68	***
Redness (a*)	13.26[a]	9.61[b]	12.25[a]	0.32	***
Yellowness (b*)	10.61[a]	9.30[b]	12.31[c]	0.29	***
Dorsal fat					
Luminosity (L*)	80.67	80.42	80.47	0.17	ns
Redness (a*)	2.45[a]	1.36[b]	1.78[b]	0.13	**
Yellowness (b*)	6.97[a]	6.13[b]	5.98[b]	0.13	**
Ventral fat					
Luminosity (L*)	83.53	83.37	83.16	0.25	ns
Redness (a*)	1.90	1.33	1.69	0.15	ns
Yellowness (b*)	7.05	7.21	6.78	0.25	ns
Water holding capacity					
Cooking loss (%)	20.50[a]	20.32[a]	24.51[b]	0.43	***
Drip loss (%)	1.80[a]	1.88[a]	2.46[b]	0.09	**
Thawing loss (%)	7.03[ab]	5.86[a]	8.00[b]	0.26	**
Pressing loss (%)	25.29[a]	22.13[b]	26.81[a]	0.47	***
Textural parameters					
WB test					
Shear force (kg/cm^2)	3.11	3.57	3.59	0.12	ns
Total work (kg x mm)	15.35	18.24	15.85	0.73	ns
Firmness (kg/s)	0.80	0.90	0.94	0.02	ns
TPA test					
Hardness (kg)	7.97[a]	9.00[ab]	9.47[b]	0.26	*
Springiness (mm)	0.53	0.54	0.52	0.001	ns
Cohesiveness	0.54	0.55	0.54	0.004	ns
Gumminess (kg)	4.39	4.96	5.18	0.16	ns
Chewiness (kg x mm)	2.36	2.78	2.74	0.10	ns

[a-c] Mean values in the same row with different letter presented significant differences.
Significance levels: *** ($P<0.001$), ** ($P<0.01$), * ($P<0.05$), ns (not significant, $P>0.05$).
SEM: standard error of mean.

IV. CONCLUSIONS

Results from this research showed that genotype affected colour parameters of LD and dorsal fat. Meat from Santiaguesa genotype had more lightness than meat from Carballina and Barcina pigs, whereas meat from Barcina and Santiaguesa lines was redder than meat from Carballina genotype. On the other hand, all types of measurement of WHC were significantly influenced by genotype. Finally, genotype did not affect on parameters measured by WB test (shear force, firmness and total work of cut), whereas TPA showed only significant different for hardness.

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