Effect of slaughter weight, breed and genotype on loin and ham composition and quality.

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INTRODUCTION

Pig meat industry allows to satisfy the consumer demand but raw material varies according to genetic background , sex and live weight of slaughter animals. According to several studies halothane gene could play an important role on meat quality and carcass composition but his effect could be different across breeds and slaughter weights. At present time, carrier and non gene carrier animals from the base populations of cross breeding schemes can be detected with DNA blood analyses and heterozygous or negative homozygous animals could be detected by the breeding companies. The aim of this contribution is to evaluate the effect of this gene on the carcass main joints composition and quality at several slaughter weights taking into account the breeds involved.

MATERIAL AND METHODS

A total of 104 boars from Large White (LW) and Landrace (LR) breeds provided by 18 nucleus herds belonging to ANPS (*Asociación Nacional de Porcino Selecto*) were studied. The halothane genotype (homozygous Hal^{++} and Hal^{--} and the heterozygous Hal^{+-}) was determined using the molecular analysis of the cDNA of blood samples. Data from 41 Hal^{--} and 11 Hal^{+-} Large White, and 35 Hal^{--} and 17 Hal^{+-} Landrace were analyzed.

The animals were slaughtered at two slaughter weights (90 and 110 kg) after a standardized pre-slaughter treatment. Hot carcass weight (kg) was obtained during the 1st hour *post mortem* and used to calculate the killing-out proportion (g/kg). Measurements with the Fat'o'Meater has been taken to estimate carcass lean content (Gispert and Diestre, 1994). Carcass conformation was made by the visual assessment of the shape of the carcass from 1 = very good to 4 = very poor conformation.

After removal of flare fat, kidneys and diaphragm, the left side of each carcass was divided into 12 joints according to the New EU Reference Dissection Method (Walstra and Merkus, 1995). The ham and the loin were dissected into fat (subcutaneous fat with skin and intermuscular fat), lean and bone and weighted separately. Carcass joint distribution was calculated as weight of individual joint (g) / hot carcass weight (kg). The distribution of the joint composition (lean, fat and bone) was calculated as weight of the individual component of joint (g) / weight of the component of all the dissected joints (kg).

The economic yield of each carcass was calculated by adding the product of the weight of each joint by its commercial price (ptas/kg) divided by its carcass weight. The prices were obtained in local cutting rooms.

Muscle pH (Scharlau pHmeter, HI-9025) and electrical conductivity (PQM, Giralda), was measured at *M. longissimus thoracis* (LT) -at last rib level- and *M. semimembranosus* (SM) at 45 min and 24 h *post mortem*. Muscle color were recorded subjectively at 24 h *post mortem* on the surface of the muscle LT (scoring from 1 -pale- to 6 -dark-). Intramuscular fat was determined in a sample of 200 g of muscle LT, previously removed of connective tissue, taken at the last rib level using the Near Infrared Transmittance system (Infratec 1265 Meat Analyzer).

The statistical analysis were performed using the GLM program of the SAS statistical package (SAS, 1988). The fixed effects of breed , slaughter weight, and halothane genotype were studied. Deviation of individual weight from the mean weight of 90 kg or 110 kg, was included as a covariate.

RESULTS AND DISCUSSION

A significant effect of breed was found for estimated lean contents. Halothane genotype had a significant effect on killing-out proportion, carcass conformation and estimated carcass lean content. In single carriers of the halothane gene (Hal^{+-}) killing-out proportion increased (0.8 %) and conformation visual score was improved. Also the heterozygous animals produced leaner carcasses. Slaughter weight (from 90 to 110 Kg) had a positive significant effect on killing-out proportion, but carcass lean content was not affected. Our results generally agree with Gibson **et al.** (1996) and Larzul **et al.** (1997) who observed increases of 0.5 and 1.3 % in killing-out proportion of carriers and heavy carcasses.

A significant difference between breeds were observed on ham and loin proportions. The carcasses of LR breed had a higher proportion of loin and lower proportion of ham than LW breed. Moreover, a significant breed effect on joint composition of the main cuts was found on lean and fat contents of the ham and loin. LW breed had a higher lean and lower fat contents respect LR .

The effect of the halothane gene on carcass weight distribution and joint composition was less significative than breed effect. The halothane genotype affected significatively the proportion of ham. Non carrier pigs had a lower proportion of ham than single carrier pigs. Furthermore, the hams from non carriers carcasses had more bone than carriers. Recently, Leach **et al.** (1996) and Gibson **et al.** (1996) found a higher proportion of ham in heterozygous pigs. This increase in ham proportion and changes in visual conformation could indicate a redistribution of lean meat, that finally leads in a higher economic yield of carrier pigs in the Spanish market. We did not find differences in weight distribution and composition of the joints between slaughter weights.

The halothane genotype had a significant effect on pH45 and ultimate electrical conductivity (QMu) in both muscles, LT and SM. Furthermore, the halothane gene affected the subjective color of the loin. These results indicates a negative effect of the halothane gene on meat quality. Jensen and Barton-Gade (1985) and García-Macías **et al.** (1996) have found similar results, indicating that the single carrier genotype (+-) was more prone to produce PSE meat than the non carrier genotype. Overall, slaughter weight had only a small effect on meat quality like the results of Larzul **et al.** (1997). Pigs of the two breeds had also similar meat quality.

Breed and halothane genotype had a significative effect on intramuscular fat content in the loin muscle. This relationship between intramuscular fat an halothane genotype was also noted by Leach **et al.** (1996), who found less visible marbling in carrier pigs. However, García-Macías **et al.** (1996) and Candek-Potokar **et al.** (1996) reported no significant differences between breeds and halothane genotype in intramuscular fat content. The chemical composition of the loin remain constant with increasing slaughter weight from 90 to 110 kg.

A significant breed x slaughter weight interaction was found for killing-out proportion, and ultimate pH measured either in SM or LT muscles. With increasing slaughter weight from 90 to 110 kg the LW pigs increased significatively their killing-out, whereas no changes were observed in LR pigs. In LR breed, ultimate pH of LT and SM muscles decreased with increasing slaughter weight, while no differences were observed in pHu of LW muscles studied. A interaction breed x halothane has been found for carcass conformation, weight distribution of the ham and subjective color variables. This interaction agree with the results from O'Brien (1995), who demonstrate that the expresion of the halothane gene could be affected by the phenotype. However, Gibson **et al.** (1996) found that the effect of the halothane gene appeared to be the same across breed, but the detrimental effect of the gen on meat quality may be worse for Hampshire and Yorkshire than for Landrace. Ours results agree with these. In subjective color there were differences within LW breed for the Hal-- and Hal +- (2.87 vs 20.3) whereas this differences has not been seen in the LR (2.79 vs 2.58). In bone content of the ham and fat and bone content of the loin a halothane x slaughter weight interaction has been found.

The overall conclusion of this study indicate that halothane gene causes advantages on carcass and weight distribution of the ham, and a poor meat quality. The effect of the breed is important on cutting yield. Increasing slaughter weight from 90 to 110 kg should not affect carcass characteristics and meat quality. In this study, the expression of the halothane gene is modified by the breed. The effect is more notorious in the LW than in LR breed.

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Table 1.- *Least-squares means and residual standard deviation (RSD) of carcass measurements, weight distribution (%) and their composition and meat quality of the ham and loin by breed, halothane genotype and slaughter weight.*

	Breed		Halothane		Slaughter Weight		RSD
	LW	LR	Hal^{--}	Hal^{+-}	90 kg	110 kg	
Carcass measurements							
· Killing-out (g/kg)	788.8	785.0	782.8^a	790.9^b	781.1^a	792.6^b	13.6
· Carcass conformation	2.6	2.9	3.1^a	2.4^b	2.8	2.7	0.6
· Carcass lean content (g/kg)	553.8^a	527.6^b	531.3^a	550.2^b	546.3	535.1	38.2
Weight distribution of joints (g/kg)							
· Ham	245.0^a	236.9^b	236.3^a	245.6^b	238.5	243.4	8.7
· Loin	122.5^a	126.7^b	123.9	125.3	123.5	125.7	9.4
Composition of main joints (g/kg)							
Ham · Lean	700.6^a	674.6^b	681.5	695.9	691.6	695.9	37.0
· Fat	213.9^a	234.9^b	229.2	219.6	220.4	228.4	37.4
· Bone	85.3	88.2	89.3^a	84.3^b	88.1	85.5	7.4
Loin · Lean	575.5^a	546.1^b	555.0	566.6	567.0	554.6	50.0
· Fat	292.6^a	325.7^b	312.7	305.6	302.4	315.9	58.1
· Bone	131.6	128.4	132.3	127.7	130.5	129.4	15.7
Economic yield (pts/kg)	265.5	261.8	261.0^a	266.3^b	263.8	263.5	
Meat quality							
· pH45 LT	6.17	6.20	6.28^a	6.08^b	6.15	6.21	0.29
· pH45 SM	6.20	6.20	6.27^a	6.13^b	6.18	6.22	0.29
· pHu LT	5.65	5.64	5.65	5.64	5.66	5.63	0.11
· pHu SM	5.62	5.63	5.63	5.62	5.64	5.60	0.10
· QM45 LT	4.61^a	5.19^b	4.56^a	5.24^b	5.02	4.77	1.19
· QM45 SM	4.39	4.53	4.52	4.40	4.33	4.59	0.64
· QMu LT	4.89	5.05	4.08^a	5.85^b	5.85	4.36	1.90
· QMu SM	6.57	5.67	5.21^a	7.02^b	5.74	6.50	2.32
· Subjective color	2.45	2.69	2.83^a	2.31^b	2.58	2.56	0.56
· Intramuscular fat (mg/g)	9.3^a	7.4^b	9.2^a	7.5^b	8.2	8.5	3.99

LT, SM: Longissimus Thoracis and Semimembranosus. PHu ,Qmu: at 24 h p.m. Different letters within main effects are different ($P < 0.05$).