EFFECT OF PIG GENETICS ON MYOSIN HEAVY CHAIN AND BIOCHEMICAL CHARACTERISTICS OF MUSCLE *LONGISSIMUS THORACIS*

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Introduction

Skeletal muscle biochemical profile greatly influences its metabolic responses during pre-slaughter handling and, subsequently, postmortem conversion of muscle to meat. One of the main factors determining muscle biochemical pathways is fibre type composition: skeletal muscle is composed of different types of fibres, which are the results of co-ordinated expression of distinct sets of structural proteins and metabolic enzymes (Schiaffino and Reggiani, 1996). Fibre types are often defined by the isoforms of myosin heavy chain (MyHC) that are present. There are four major fibre types in postnatal pig muscle characterised by the expression of the slow/I/β, 2a, 2x and 2b MyHC gene isoforms. The slow/I/β and 2b fibres, also known as slow-oxidative and fast-glycolytic, respectively, represent two extreme metabolic profiles. The 2a and 2x fibres are intermediate fast oxidative-glycolytic fibres (Chang and Fernandes, 1997). In addition, fibre type is affected by several environmental factors as diet or physical activity (Karlsson *et al.*, 1993; Petersen *et al.*, 1998). The aim of this work was to study the effect of pig genetics on the biochemical characteristics of the muscle *Longissimus thoracis* (LT) from three porcine lines. The contractile and metabolic traits as well as meat quality characteristics of this muscle were studied and compared according to the genetic line.

Material and Methods

Animals and carcass measurements

Female pigs (324 animals) from three genetic lines free of the halothane gene (A, B and C) kept by PIC at its Genetic Nucleus were used in this study. All animals were fed the same diets and slaughtered under similar conditions. They were distributed in a balanced way and slaughtered in 24 batches. Live weight (106±10.9 kg) was recorded on farm and hot carcass weight was obtained at one h *postmortem* (pm), and used to calculate the killing-out (%). Measurement of fat depth was recorded by a Fat'o'Meater (FOM) equipment at the level of 3/4 last rib. Lean % was obtained after dissection of the carcass following the procedure described by Walstra and Merkus (1995). Carcass conformation was assessed visually by 3 operators; the scores ranged from 1 = very good conformation to 4 = very poor conformation.

Meat quality measurements

The left side of the carcass was used to perform meat quality and biochemical measurements on the LT muscle. Muscle pH at 45 min and 24 h pm was measured using a portable pH meter equipped with a Xerolyt electrode. Electrical conductivity (EC) was measured at 24 h pm at the last rib level using a Pork Quality Meater. Intramuscular fat (IMF) content was determined by a NIT (Near Infrared Transmittance) apparatus. Muscle samples for MyHCs and enzyme activity analyses were obtained 24-26 h pm at the last-rib level, from the muscle core. They were frozen in liquid nitrogen and stored at -80°C until use. For the determination of haem pigment content, samples were minced, vacuum-packed and stored at -20°C until analysis.

Muscle Biochemical Analyses

The contractile traits of the muscle were determined by enzyme-linked immunosorbent assay (ELISA). The objective of this assay was to determine the percentage of slow myosin heavy chain (MyHC I) in the muscle with a specific MyHC I monoclonal antibody. Muscle extracts were diluted to a concentration of 2.4 µg of protein / µl (Bradford, 1976), and the microtiter-plate wells were filled with 50 µl each (triplicates). The percentage of the MyHC I in each sample was calculated by means of a standard curve prepared from bovine *Masseter* (100% MyHC I) and bovine serum albumin (0% MyHC I). The standard curve was run in each microplate (Picard *et al*, 1994).

The metabolic traits of the LT muscle were determined by measuring the lactate dehydrogenase activity (LDH) according to Ansay (1974) and the isocitrate dehydrogenase activity (ICDH) according to Briand *et al.* (1981). LDH activity was measured at 28°C, with 2.5 mM sodium pyruvate and 0.24 mM β-NADH in the reaction medium (pH 7.5). ICDH activity was measured at 28°C, with 0.7 mM trisodium isocitrate and 0.72 mM β-NADP in the reaction medium (pH 7.3). Enzyme activities were expressed as µmol / min per gram of wet weight.

The haem pigment content was assessed according to Hornsey (1956). Results are given in µg of acid haematin per g of wet weight.

Results and Discussion

The means and the standard deviations of carcass characteristics defining each pig population are presented in Table 1. The three lines showed similar killing-out percentages. Line B presented the highest backfat depth and line C was the best conformed.

Table 2 shows the least squares means and standard errors for meat quality and biochemical traits in LT muscle. Ruusunen and Puolanne (1997) found different percentages of type I fibres when comparing the histochemical properties of *Longissimus* from three pig breeds: 15.2% for Hampshire, 13.2 % for Finnish Landrace and 9.9% for Yorkshire. In the study of Henckel *et al.* (1997), Landrace pigs had 12.8% of type I fibres and LDH activity of 2811 µmol/min.g, whereas Large White pigs had 13.0% of type I fibres and LDH activity of 2976 µmol/min.g. Petersen *et al.* (1998) reported values of 12% for type I fibres in the *Longissimus* of (Danish LandracexLarge WhitexDuroc) crossbreed pigs. Different proportions of type I fibres and of haem pigment content were found in Landrace pigs (9.09% and 39.5 µg haematin /g, respectively) and in Iberian pigs (12.09% and 47.9 µg haematin /g, respectively) (Serra *et al.*, 1998). The values of type I fibres percentage reported in the literature were generally higher than the results of our study. This can be explained, to a large extent, by different technique used (ELISA) and by the sampling region, apart from the particular traits of the three lines studied. The most oxidative characteristics were found in line B: highest percentage of MyHC I and ICDH

activity and lowest LDH activity and LDH/ICDH ratio. This line also presented good meat quality traits from the technological and eating quality aspects: high pH at 24 h pm and high IMF content. On the contrary, the most glycolytic traits were found in the LT muscle from pig-group A: lowest ICDH activity and pigment content and highest LDH/ICDH. Meat quality traits of the LT muscle from the pig-group A were also characterized by lower pH at 24 h pm compared to pig-line B, and lower IMF content compared to pig-line B and line C. Pig-line C showed intermediate values for ICDH activity and LDH/ICDH ratio. This line is of a significant practical importance because it presents the best carcass characteristics – best confomation, high lean % - and also good meat quality traits; i.e., pH_{45}, especially when compared to the results presented for very lean and/or conformed lines being Halothane gene carriers (nN) (Oliver *et al.*, 1993; Sellier *et al.*, 1988). The results of this study clearly indicate the importance of the genetic component: i.e., composition of LT muscle MyHC and its biochemical profile, in breeding and selection to achieve the desirable balance between body conformation, high carcass lean percentage and meat quality.

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References

Ansay, M. (1974). *Ann. Biol. Anim. Bioch. Biophys.* 14, 471-486.
Bradford, M. M. (1976). *Anal. Biochem.* 72, 248-254.
Briand, M., Talmant, A., Briand, Y., Monin, G., Durand, R. (1981). *Eur. J. Appl. Physiol.* 46, 347-358.
Chang, K.C. and Fernandes, K. (1997). *DNA Cell Biol.* 16, 1429-1437..
Henckel, P. Oksbjerg, N., Erlandsen, E., Barton-Gade, P., Bejerholn, C.(1997). *Meat Sci.* 47, 311-321.
Hornsey, H.C. (1956). *J. Sci.Food Agric.* 7, 534-540.
Karlsson, A., Enfält, A.C., Essén-Gustavson, B., Lundström, K., Rydhmer, L. Stern, S. (1993). *J.Anim. Sci.* 71, 930-938.
Oliver, M.A., Gispert, M., Diestre, A. (1993). *Meat Sci.* 35, 105-118.
Petersen, J.S., Henckel, P., Oksbjerg, N., Sorensen, M.T. (1998). *Animal Sci.* 66, 733-740.
Picard, B., Leger, J., Robelin, J. (1994). *Meat Sci.* 36, 333-343
Ruusunen, M. and Puolanne, E. (1997). *Meat Sci.* 45, 119-125.
Schiaffino, S. and Reggiani, C. (1996). *Physiol.Rev.* 76, 371-423.
Sellier, P., Mejenes-Quijano,A., Marinova, P., Talmant. A., Jacquet, B., Monin, G. (1988). *Livestock Prod. Sci.* 18, 171-186.
Serra, X., Gil, F., Pérez-Enciso, M., Oliver, M.A., Vázquez, J.M., Gispert, M., Díaz, I., Moreno, F., Latorre, R., Noguera, J.L. (1998) *Livestock Prod. Sci.* 56, 215-223.
Walstra, P. and Merkus, G.S.M. (1995) DLO- Research Institute for Animal Science and Health.

Table 1. Carcass characteristics (Means and (SD)) of three porcine genetic lines.

	n	*Killing-out (%)*	*Conformation scores*	*Fat thickness (mm)*	*Lean (%)*
A	93	76.9	2.7	14.1	56.7
		(3.50)	(0.62)	(3.30)	(3.71)
B	75	78.1	2.5	16.3	55.0
		(3.72)	(0.51)	(3.29)	(3.15)
C	80	78.9	1.6	12.6	60.4
		(3.52)	(0.53)	(1.93)	(2.10)

Table 2. Effect of genetic line on meat quality and biochemical characteristics (Least squares means and (SE)) of *Longissimus thoracis*.

	pH45	pH at 24h	EC at 24h	IMF (%)	Haem pigment (µg haematin/g)	MyHC I (%)	ICDH activity (µmol /min.g)	LDH activity (µmol /min.g)	LDH/ICDH (µmol /nmol)
A	6.43	5.61 a	3.76	0.73 a	31.20 a	7.34 a	1.42 a	3365.1 b	2.53 c
	(0.03)	(0.01)	(0.17)	(0.04)	(0.70)	(0.38)	(0.04)	(44.3)	(0.06)
B	6.45	5.67 b	3.67	2.02 c	33.60 b	10.03 b	1.78 c	3231.1 a	1.92 a
	(0.03)	(0.01)	(0.19)	(0.04)	(0.77)	(0.41)	(0.04)	(49.2)	(0.07)
C	6.46	5.61 a	3.71	0.85 b	33.54 b	7.79 a	1.58 b	3397.4 b	2.29 b
	(0.03)	(0.01)	(0.18)	(0.04)	(0.74)	(0.40)	(0.04)	(47.5)	(0.07)

Least squares means with different superscripts are different (P<0.05).