4 - 42 INFLUENCE OF BREED AND HALOTHANE SENSITIVITY ON SOME TRAITS OF PIG MUSCLES

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INTRODUCTION

Among the breeds available for modern pig production, the Belgian Landrace and Pietrain breeds are particularly interesting from the point of view of carcass quality. The superiority of these breeds is now well-established, with respect to the lean tissue content of the carcass, and they are commonly used as components of sire lines in crossbreeding schemes in European countries. However, rather little is known, particularly in the Belgian Landrace breed, regarding muscle characteristics influencing meat quality, as for example fibre types distribution and contents of collagen, pigment and lipids. This study was designed to investigate these aspects, by comparing the two meaty breeds Pietrain and Belgian Landrace to the less muscular Large White breed, and assessing the influence of halothane sensitivity, which is very common in the Pietrain and Belgian Landrace (WEBB, 1981).

MATERIAL AND METHODS

The study involved 25 pigs, i.e. 5 of each of the following genetic types : Large Whites, halothane-negative and halothane-positive Belgian Landraces, halothane-negative and halothane-positive Pietrains. The animals were submitted to a halothane test at a liveweight of 25 - 30 kg. They were fattened till a liveweight of 100 kg, then killed in usual industrial conditions by electric stunning and exsanguination.

Samples were taken from the muscles Longissimus dorsi (LD), Semimembranosus (SM), Rectus femoris (RF) and Triceps brachii caput laterale (TB) as soon as possible after exsanguination. They were frozen in liquid nitrogen and kept till use for histochemical analysis.

Fibre types were classified according to ASHMORE & DOERR (1971) as αW (fast twitch-glycolytic), αR (fast twitch-glycolytic oxidative) and βR (slow twitch-oxidative), after staining of serial sections for myofibrillar ATPase and succinate dehydrogenase.

Samples obtained at 24 h after slaughter were used to determine hydroxyproline (BERGMAN & LOXLEY, 1963), haeminic iron (HORNSEY, 1956) and lipids by ether extraction using a SOXHLET apparatus. Collagen content was calculated as [hydroxyproline] x 7.5 and myoglobin as [haeminic iron] x 304.4.

Statistical analysis was made by two ways-variance analysis. Effects of genetic type, muscle, breed (using the data relative to the 3 halothane-negative groups) and halothane-sensitivity (using the data relative to the Belgian Landrace and Pietrain pigs) as well as their interactions were determined.

RESULTS

1 - Histochemical characteristics

	Muscle	HS(1)	Breed	M x HS(2)	M x B(2)
αW	***	***	***	NS	**
αR	***	***	***	**	**
βR	***	***	***	*	**

Table 1 : Variance analysis for histochemical characteristics
NS : Non-significant * $P < 0.05$ ** $P < 0.01$ *** $P < 0.001$
(1) HS : Halothane sensitivity
(2) M x HS : Muscle x HS interaction ; M x B : Muscle x breed interaction

Table 1 shows the results of variance analysis. Muscle, halothane sensitivity and breed had highly significant effects on the fibre types distribution. There were also significant muscle x halothane sensitivity and muscle x breed interactions. Detailed results are given in table 2. LD muscle had the highest proportion of αW fibres (except in HN Belgian Landrace), whereas SM muscle had the highest percentage of βR fibres. Large White pigs had by far less αW fibres and more αR fibres than the 4 other genetic types in every muscle. There were some differences in fibre distribution pattern between the Belgian Landraces and the Pietrains, but they were not consistent from one muscle to another.

Striking differences were observed between HP and HN pigs in both Belgian Landrace and Pietrain pigs. Muscles of HP animals contained more αW fibres and less βR fibres, the differences being generally significant.

2 - Collagen, myoglobin and lipids

The results of the variance analysis are reported in table 3 and the detailed results for each muscle and genetic type in table 4.

	Muscle	HS	Breed	M x HS	M x B
Hydroxyproline	***	NS	**	NS	**
Myoglobin	***	NS	***	NS	**
Lipids	***	NS	**	**	*

Table 3 : Variance analysis for contents of hydroxyproline, myoglobin and lipids
The notations used are the same as in table 1

Muscle and breed effects were highly significant for the 3 traits under study. The TB muscle had the highest levels of collagen and of myoglobin (except for the latter in the Large White pigs). The collagen content was generally higher in muscles from Large Whites and Belgian Landraces than in muscles from Pietrains, except in the RF muscle. Muscles of the Large Whites, except

Muscle	Fibre type	Genetic type LW(-)	LB(-)	LB(+)	P(-)	P(+)
LD	αW	42 ± 4^{a}	64 ± 3^{b}	82 ± 4^{cd}	76 ± 5^{c}	83 ± 3^{d}
	αR	51 ± 5^{d}	30 ± 2^{c}	14 ± 1^{b}	15 ± 4^{b}	9 ± 1^{a}
	βR	7 ± 2^{ab}	7 ± 2^{ab}	5 ± 1^{a}	10 ± 1^{c}	8 ± 2^{bc}
SM	αW	33 ± 5^{a}	68 ± 4^{b}	73 ± 2^{c}	60 ± 4^{d}	68 ± 4^{b}
	αR	53 ± 3^{a}	19 ± 4^{bd}	19 ± 3^{bd}	26 ± 3^{c}	23 ± 3^{cd}
	βR	14 ± 3^{b}	14 ± 3^{b}	8 ± 1^{a}	14 ± 3^{b}	9 ± 2^{a}
RF	αW	39 ± 3^{a}	64 ± 4^{b}	72 ± 3^{c}	61 ± 3^{b}	66 ± 3^{b}
	αR	57 ± 3^{c}	26 ± 4^{ab}	23 ± 3^{a}	29 ± 2^{b}	28 ± 3^{b}
	βR	5 ± 1^{a}	11 ± 2^{b}	5 ± 1^{a}	10 ± 2^{b}	6 ± 1^{a}
TB	αW	40 ± 4^{a}	57 ± 3^{b}	72 ± 2^{d}	57 ± 3^{b}	62 ± 3^{c}
	αR	49 ± 6^{d}	38 ± 3^{c}	24 ± 2^{a}	32 ± 3^{b}	30 ± 2^{b}
	βR	11 ± 2^{bc}	6 ± 1^{a}	5 ± 1^{a}	12 ± 2^{c}	9 ± 1^{b}

Table 2 : Influence of genetic type on histochemical characteristics of the LD, SM, RF and TB muscles

Mean ± s.d. ; means on the same line with the same superscript are not different at the 5 % probability level

TB, contained noticeably more myoglobin than muscles of the other genetic types (+ 63 % in LD ; + 46 % in SM ; + 44 % in RF ; - 27 % in TB). Lipids were particularly abundant in the LD, SM and RF muscles of the Pietrain pigs, whereas there was no difference between breeds in the TB muscle. The latter contained less lipids than the three other muscles.

Halothane sensitivity had no influence on any of these traits.

DISCUSSION AND CONCLUSION

The distribution of fibre types in the LD muscle of Belgian Landraces and Pietrains was similar to that observed by previous authors using comparable procedures of classification (NOSTVOLD et al., 1979 ; LINDHOLM et al., 1979 ; ESSEN-GUSTAVSSON & LINDHOLM, 1984 ; SUZUKI & CASSENS, 1980, working on 16 week-old pigs). However, for the Large White pigs, we found an unusually large percentage of αR fibres. These pigs appear to possess muscles with a markedly larger aerobic capacity than the other animals under study. This is reflected in the high myoglobin content of their LD, SM and RF muscles. Important breed variations in myofibre types distribution was previously reported by MERKEL (1971) in American pig breeds, with the Yorkshire having much more "intermediate" fibres than the other breeds studied by this author, as well in the LD as in the RF muscles. On the other hand, our results do not agree with those from MONIN & SELLIER (1985), who found more pigment in the LD muscle in Pietrain pigs than in Large White pigs.

The LD muscle appears to be the "whitest" and the "fastest" of the four muscles under study. This agrees well with the histochemical observations from BEECHER et al. (1965) and RAHELIC and PUAC (1980) and the biochemical results from JORGENSEN (1981) and LABORDE et al. (1985).

Our present finding of a lower aerobic capacity, as indicated by the smaller percentage of αR + βR fibres and the greater percentage of αW fibres in HP pig muscles than in HN pig muscles, confirms previous results from LINDHOLM et al. (1979) and ESSEN-GUSTAVSSON & LINDHOLM (1984). There is an apparent discrepancy between this result and the fact that halothane sensitivity had no effect on the pigment level ; this latter observation agrees with previous results from one of the authors of the present work, who found no difference in the pigment content of the LD muscle between HN and HP pigs of the Pietrain breed (MONIN et al., 1982 ; MONIN & SELLIER, 1985) and of the Belgian breed (SELLIER & MONIN, unpublished data). However, the latter authors observed a lower pigment content in HP than in HN Pietrain pigs. The effect of halothane-sensitivity on aerobic capacity of muscle needs further investigation, using perhaps more "direct" criteria, as oxygen consumption for instance.

Muscle	Trait	Genetic type LW(-)	LB(-)	LB(+)	P(-)	P(+)
LD	Collagen	3.8 ± 0.4^{b}	3.7 ± 0.6^{b}	3.5 ± 0.2^{b}	2.8 ± 0.4^{a}	3.3 ± 1.0^{ab}
	Myoglobin	1.25 ± 0.43^{b}	0.62 ± 0.21^{a}	0.78 ± 0.17^{ba}	0.96 ± 0.30^{ab}	0.77 ± 0.13^{a}
	Lipids	14 ± 4^{a}	19 ± 4^{ab}	20 ± 1^{bc}	27 ± 9^{bc}	30 ± 10^{c}
SM	Collagen	3.5 ± 0.5^{a}	3.5 ± 0.9^{a}	3.9 ± 1.0^{a}	3.3 ± 0.2^{a}	3.3 ± 0.9^{a}
	Myoglobin	1.90 ± 0.36^{b}	1.34 ± 0.22^{a}	1.15 ± 0.26^{a}	1.43 + 0.33^{ab}	1.33 ± 0.38^{a}
	Lipids	13 ± 3^{a}	18 ± 7^{ab}	21 ± 10^{ab}	25 ± 7^{b}	24 ± 10^{b}
RF	Collagen	3.6 ± 0.7^{b}	2.5 ± 0.2^{a}	3.0 ± 1.0^{ab}	3.2 ± 0.9^{ab}	3.6 ± 0.8^{b}
	Myoglobin	2.43 ± 0.57^{b}	1.37 ± 0.33^{a}	1.58 ± 0.54^{a}	2.27 ± 0.99^{ab}	1.75 ± 0.19^{a}
	Lipids	11 ± 4^{ab}	8 ± 1^{a}	10 ± 3^{a}	16 ± 4^{b}	18 ± 6^{b}
TB	Collagen	4.8 ± 0.9^{abc}	5.5 ± 0.4^{b}	5.0 ± 1.4^{abc}	3.7 ± 0.9^{ac}	4.7 ± 0.4^{ac}
	Myoglobin	1.65 ± 0.16^{a}	1.79 ± 0.47^{ac}	2.22 ± 0.56^{ad}	2.86 ± 0.21^{b}	2.48 ± 0.51^{bcd}
	Lipids	27 ± 11^{a}	25 ± 6^{a}	24 ± 6^{a}	23 ± 5^{a}	24 ± 8^{a}

Table 4 : Contents of collagen, myoglobin and lipids in various muscles of pigs from five genetic types

All values are expressed in mg/g fresh tissue

The high level of lipids observed in Pietrain pigs, as compared to the Large White pigs and Belgian Landrace pigs, is in contrast with the results from MONIN & SELLIER (1985) and SELLIER & MONIN (unpublished data), who observed no significant difference between these breeds on the LD muscle. This disagreement could be due to the fact that the Pietrain pigs of the present study were slaughtered at the same liveweight as the other pigs, whereas in the works of the cited authors, there was a difference of around 10 kg between Pietrains and Large Whites (MONIN & SELLIER, 1985) or Pietrains on one hand and Large Whites and Belgian Landraces on the other hand (SELLIER & MONIN, unpublished data). It is well-known that the lipids content of the muscles increases with the age (or weight at slaughter) of the animals. It is worth noting that FABBRI et al. (1971) observed on the LD muscle more lipids in Pietrain pigs than in Large White pigs, for animals slaughtered at the same slaughter weight of 91 - 93 kg.

Regarding breed differences in collagen content, our results agree well with the finding of BOCCARD (1968) that muscles from Large Whites contain more collagen than muscles from Pietrains, and with recent results of SELLIER & MONIN (unpublished data) that both Belgian Landraces and Large Whites have more collagen than Pietrains in the LD muscle. The latter authors, as well as MONIN et al. (1982) and BALAND & MONIN (1984) found no influence of halothane sensitivity on the collagen level in LL muscle, as we did in the present study. So it appears that the well-established low content of collagen existing in the muscles of the Pietrains is a "breed" character, rather than a trait linked to the high muscular development of these pigs -as hypothethized by BOCCARD (1968)- since the very muscular Belgian Landraces do not present it, and because this property is not related to halothane sensitivity, whose positive influence on muscular development is well-known (OLLIVIER et al., 1978).

In conclusion, according to the results of the present study, Large Whites largely differ from Belgian Landraces and Pietrains, and HP pigs from HN pigs, by the distribution pattern of myofibre types. Concerning muscle composition, Belgian Landraces are very close to Large Whites, whereas Pietrains are characterized by a low collagen content, but strong interactions between breed and type of muscle are observed.

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