A COMPARATIVE STUDY OF MUSCLE FIBERS AND MEAT QUALITY FROM LARGE WHITE AND UPTON-MEISHAN PIGS

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Background

Pork meat from the most common breeds used in Europe and North America are now generally considered as being too lean from a quality point of view. Purebred and crossbred Chinese pigs on the other hand have the reputation of giving a meat of high palatability as shown by Touraille et al. (1989) who reported meat from half-Chinese crossbred pigs to be more tender, juicier and tastier than that from purebred European pigs. According to Suzuki et al. (1991), the water-holding capacity (WHC) of meat from Chinese purebred and crossbred pigs is also slightly higher than that from crosses between Landrace and Duroc. However, Lan et al. (1993) observed that meat from Yorkshire had the highest WHC in comparison to that from Meishan. Increasing proportions of Meishan genes led to some improvement in meat quality but at the expense of growth and carcass traits (Bidanel et al., 1993). These traits are influenced by muscle fiber characteristics which, in turn, influence meat quality (Larzul et al., 1997). Yet, the literature contains no information on muscle fiber characteristics in association with meat quality of pigs from Meishan breed or composite Meishan lines.

Objective

The objective of this study was to compare muscle fiber characteristics and meat quality from purebred Large White and Upton-Meishan crossbred pigs.

Methods

Forty (40) Large White purebred (LW) and 40 Upton-Meishan crossbred (UM, 50% LW x 50% Chinese Meishan) pigs with equal number of castrates (20) and gilts (20) within breed were brought to a final slaughter weight of 108.18 ± 2.52 kg under standard procedures, followed by a 12 hour fasting period before being shipped to a commercial slaughterhouse.

Rate and extent of post mortem glycolysis were assessed at 50 min (pH_1) and at 2 (pH_2) and 24 h (pH_u) post mortem by measuring pH in the Longissimus dorsi (LD) muscle. Within 1 h after slaughter, a sample was taken from LD (at ¾ last rib) and was frozen in isopentane cooled in liquid nitrogen until further histochemical analyses.

At 24 h post mortem, the following measures were conducted on a chop cut from the LD (at ¾ last rib) muscle: color of the meat after a 30 min blooming with a Minolta CR200 (L*, a*, b*), subjective marbling using a 5-point scale ranging from 1 (devoid) to 5 (abundant) (NPPC, 1994) and drip loss (%) according to Rasmussen and Andersson (1996).

Transverse serial sections (16µm-thick) were obtained with a cryostat and were stained for myosin ATPase after an alkali preincubation (pH 10.4) to determine fast and slow twitch muscle fibers and were also stained for the activity of succinate dehydrogenase (SDH) to determine metabolic fiber type. For each staining procedures, 5 bundles were analyzed for an approximate total of 210 fibers per pig. Muscle fibers were classified into three types (slow twitch oxidative [SO], fast twitch oxidative-glycolytic [FOG] and fast twitch glycolytic [FG]) with Sigmascan Pro5 software. Individual fiber cross sectional area (CSA) was also calculated on samples from males. The relative area (RA) occupied by each fiber type was calculated from the corresponding numerical percentages and mean CSA. The ANOVA was carried out with the GLM procedure of SAS (1999) with breed and sex as main effects.

Results and discussion

Sex had no single or combined effect with breed on quality measurements and histochemical traits and data were therefore pooled across sex within each breed. Except for the amount of fibers per bundle, the effect of breed was significant for all fiber type percentages and cross sectional areas (Table 1). Large White pigs had higher percentages of SO and FOG fibers but lower percentages of FG fibers in the LD compared to UM. Despite this higher proportion of SO fibers in LW, CSA of these fibers was half that of UM ($P \leq 0.004$). Fast twitch fibers of the LD, however, were much larger in LW than in UM. Bonneau et al. (1990) found no differences in fiber type composition of the LD between purebred LW and Meishan pigs but measured larger CSA in LW type IIB fibers only, which they reported to contribute to the larger LD area of LW pigs along with a higher fiber number. In our study, mean CSA of fibers was smaller in LD of UM pigs compared to LW ($P \leq 0.03$). Fiber bundle CSA was also significantly smaller in the LD of UM pigs (data not shown). These results could account in part for the smaller LD area of these UM pigs which was reported by Faucitano et al. (2001).

Except for the larger RA of FOG fibers from LW pigs, no other significant differences in RA were observed (Table 1). As for RA, differences in histochemical traits between LW and UM did not translate into important changes in meat quality of the LD (Table 2). LW had slightly redder (a*) LD, which is probably attributable to its larger proportion of oxidative fibers in comparison with LD from UM. Drip losses, however, were higher in LW than in UM, which seems difficult to explain in light of all histochemical traits and pH values. The larger RA of FOG fibers in LW could be implicated although this effect did not translate in differences in pH values (Table 2). Surprisingly, marbling score did not differ between LW and UM ($P > 0.05$).

Table 1. Means (standard deviations) of histochemical traits of the L. dorsi muscle

Parameter	Large White	Upton-Meishan	p
# fibers/bundle	40.83 (7.86)	43.44 (8.45)	0.17
% SO fibers	11.7 (4.0)	7.3 (3.0)	0.0001
% FOG fibers	16.1 (6.0)	13.0 (4.0)	0.006
% FG fibers	72.2 (6.0)	79.8 (4.0)	0.0001
CSA SO fibers (μm^2)	921 (900)	2037 (1274)	0.004
CSA FOG fibers	3641 (942)	2821 (705)	0.006
CSA FG fibers	6456 (1442)	4998 (1413)	0.004
Mean CSA (μm^2)[1]	5337 (1167)	4462 (1075)	0.03
Relative area SO (%)[2]	2.0 (2.0)	3.0 (2.0)	0.10
Relative area FOG (%)	12.3 (5.0)	8.5 (3.0)	0.02
Relative area FG (%)	85.8 (6.0)	88.5 (4.0)	0.10

[1] Mean CSA = (% SO x CSA SO) + (% FOG x CSA FOG) + (% FG x CSA FG)
[2] Relative area = [(% fiber type x CSA fiber type) ÷ Mean CSA] x 100

Table 2. Means (standard deviations) of meat quality traits of the L. dorsi muscle

Parameter	Large White	Upton-Meishan	p
pH_1	6.44 (0.31)	6.52 (0.25)	NS
pH_2	6.19 (0.30)	6.28 (0.26)	NS
pH_u	5.59 (0.08)	5.62 (0.11)	NS
L*	52.96 (2.91)	52.74 (2.45)	NS
a*	7.15 (0.94)	6.16 (1.12)	***
b*	4.06 (1.07)	3.59 (1.03)	0.07
Drip loss (%)	7.81 (2.24)	5.99 (2.20)	**
Marbling score[+]	1.34 (0.46)	1.26 (0.36)	NS

[+] Evaluated on a 5-point scale (1= devoid to 4= abundant, NPPC, 1994)
** ($p \leq 0.01$), *** ($p \leq 0.001$), NS: not significant

Conclusion

Differences in muscle fiber composition and size between LW and UM did not bring about many significant effect in terms of meat quality. Yet, with its lower drip loss, meat from UM would be of better quality than that from LW.

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