FIBER TYPE PROFILE AND CHEMICAL COMPOSITION OF THREE MARONESA VEAL MUSCLES

Costa, P[1], Roseiro, L.C.[1], Oliveira, D.[1], Gonçalves, H[1], Alves, V[2] and Santos, C[1]

1 Instituto Nacional de Engenharia, Tecnologia e Inovação, DTIA, Estrada do Paço do Lumiar, 1649-038 Lisboa
2 Universidade de Trás-os-Montes e Alto Douro, Quinta dos Prados-Apartado 202, 5001 Vila Real,
Paulo.Costa@mail2.ineti.pt

Background

In recent years, consumers have become more concerned about dietary fat and cholesterol associated with meat consumption, since these compounds are referred to as playing important roles in predisposition of human coronary disease (Salvatori *et al*. 2004), obesity and cancer (Chizzolini *et al*. 1999; Erickson, 1998). The Maronesa, an autochthonous cattle breed reared in the north part of Portugal is used for meat production uniquely based on calves produced under Protected Denomination of Origin (PDO). This type of veal is perceived as healthy due to the friendly extensive system applied on animal production, and is highly appreciated for its extraordinary eating quality.

A number of different factors, such as muscle location, muscle fibre type composition, sex and nutritional status, have been reported to influence the content of cholesterol and fat in meat. According to Calkins (2003) the amount of fat and the fibre characteristics of the muscle may contribute to the eating quality experienced by consumers.

Objective

The aim of this study was to evaluate the lipid composition, and the content of total collagen and haem pigment in various muscles with respect to muscle fibre types in Maronesa-PDO meat.

Material & Methods

About 1 hour after slaughter, samples from *Longissimus dorsi* (Ld), *Supra spinatus* (Ss) and *Biceps femoris* (Bf) of eight Maronesa calves of both sexes, with ages ranging from 6 to 9 months were taken for histochemical analysis. Transverse serial sections (10μm) were cut in a cryostat at –24ºC and stained for myofibrillar ATPase after pre-incubation at pH 4.45 as described by Brooke & Kaiser, 1970. The succinic dehydrogenase protocol described by Sheehan & Hrapchak (1987) was also used to define fibre metabolic properties. The percentage of each fibre type was calculated from a minimum of 400 units, by counting the total number of each type and dividing it by the total number of fibres. Differentiation into type I, type IIa and type IIb was based on staining intensity.

Samples for chemical analysis were collected 24 h after slaughter. Total lipids were extracted by the procedure of Folch *et al*. (1957) and then separated into neutral and polar fractions as described by Juaneda & Rocquelin (1985). Cholesterol was determined by HPLC according to Roseiro *et al*. (2002). Total collagen was measured following the ISO 3496:1994 procedure.

The samples were analysed for pigment content according to Hornsey (1956). Results were expressed as mg haematin/100g wet tissue, using a standard curve of a commercially available haematin instead of the factor used by Hornsey (1956).

Data were analysed using one-way analysis of variance (ANOVA) and significant differences were determined using Tukey´s HSD post hoc test requiring a probability value of less than 5 % ($p<0.05$) (Statistica 6.0-StatSoft Inc., 2001).

Results & Discussion

Muscle fibre type composition and metabolic profile

Fibre type composition and metabolic profile of the analysed muscles are indicated on Table 1. The Ss muscle showed a mean percentage of type I fibres significantly lower (P<0.01) than the other two muscles, yet it was the most oxidative unit of the three. This could be due to the fact that oxidative pattern is not only determined by fibre type I content but also by the incidence of such type of metabolism among types IIa (Zerouala & Stickland, 1991) and IIb fibres. On the other hand, the percentage of glycolytic fibres, classified by SDH procedure, was much lower than that of type IIb fibres, classified by ATPase. Ruusunen & Puolanne (1997) made a similar observation. These authors, by using NADH method to evaluate metabolic fibre type profile, reported that some IIb fibres analysed by the myosin ATPase method were in fact oxidative by metabolism.

According to the histochemical analyses, all studied muscles can be considered, predominantly, having oxidative metabolism. This may be related to the age of the animals. Fiedler *et al.* (1998) observed a decrease in the proportion of the oxidative fibres and concomitantly an increase in the glycolytic metabolism of the muscle along growth. Similarly, Johnston *et al*. (1981) showed that Ld and Bf muscles from older animals presented predominantly glycolytic metabolism. Nevertheless, in our case, Ld muscle showed lower mean percentage of IIb and a higher mean percentage of IIa fibers than those observed by Guinot *et al*. (1992), for Friesian-Holstein calves (carcass weight of 105-120). These results suggest that weight at slaughter may not have an important effect on muscle fibre type profile and that this issue may be affected to a larger extent by other factors such as breed, diet and handling. A study from Roseiro *et al* (2004) on Barrosã calves of similar age and weight at slaughter showed muscles with lower oxidative metabolism, higher percentage of type IIb and lower percentage of type IIa fibres than those of Maronesa calves.

Table 1. Cholesterol and intramuscular fat contents of different muscles of Maronesa calves.

	Muscle			F-value	P
	Ld	Bf	Ss		
Intramuscular characteristics					
Total lipids (g/100g)	1.38^{b}	1.48^{b}	1.80^{a}	8.11	*
Neutral lipids (g/100g)	0.71^{b}	0.73^{b}	1.02^{a}	3.10	*
Polar lipids (g/100g)	0.66^{b}	0.79^{ab}	0.84^{a}	3.65	*
Cholesterol (mg/100g)	48.50^{b}	51.50^{ab}	62.20^{a}	2.79	*
Haem pigment (mg/100g)	19.61	19.89	21.23	0.31	Ns
Total collagen (mg/g)	6.45^{b}	11.89^{ab}	13.38^{a}	3.95	*
ATPase (pH 4.6)					
Fibre type I (%)	21.42^{a}	24.99^{a}	16.69^{b}	3.60	*
Fibre type IIa (%)	33.84	27.27	35.86	2.99	Ns
Fibre type IIb (%)	44.74	47.73	47.45	0.55	Ns
SDH					
Oxidative (%)	55.41^{b}	55.88^{b}	68.40^{a}	12.04	**
Glycolytic (%)	44.59^{a}	44.12^{a}	31.70^{b}	12.04	**

In same row, means with different letters are significantly different. * p<0.05; ** p< 0.01; ns not significant.

Intramuscular chemical characteristics

As presented in Table 1, the amount of intramuscular fat, cholesterol and collagen was affected by anatomical location (P<0.05). The Ss muscle, the most oxidative among the analysed, showed significantly higher total (1.80 mg/100g) and neutral (1.02 mg/100g) lipid contents than Ld (1.38 and 0.71 mg/100g, respectively) and Bf (1.48 and 0.73 mg/100g, respectively). In relation to the polar lipids and cholesterol, Ss muscle also presented higher mean values (P<0.05) than LD muscle but did not differ significantly from those obtained from the Bf.

The oxidative fibres have greater aerobic metabolism, which is supported by lipids. For this reason they contain higher levels of intra-fibre lipids than their glycolytic counterparts. Although other authors have observed no significant differences in cholesterol content between muscles with distinct anatomical location

(Cifuni *et al*., 2004; Bohac & Rhee, 1988), Browning *et al*. (1990) did find differences among them, as we did. As previously reported, the content of total lipids, phospholipids and triacylglycerols depend on the metabolic type of muscles. The oxidative muscles contain more lipids and more triglycerides than the glycolytic ones (Alasnier *et al*., 1996).

Total haem pigment is an indicator of the redness of muscle and is closely related to its oxidative activity (Meynier & Gandemer, 1991). Although there were no significant differences in the oxidative activity between muscles, the Ss muscle, the most oxidative one, showed mean haem pigment content higher than Ld and Bf muscles.

As presented in Table 1, the collagen content of muscles was ranked as Ss>Bf>Ld. The same tendency for Bf and Ld muscles was observed by Seideman (1986). Beatty *et al.* (1966) found that the proportion of white fibres in the muscles were positively correlated to their collagen content. In this study, despite the small number of animals involved, the Ss and Bf muscles presented a higher proportion of white fibres (IIb) than Ld suggesting a possible relationship between these two issues. According to Kirchofer *et al*. (2002), muscles with increased type IIb fibres have more connective tissue and are less tender than muscles with more type I fibers. Many researchers have reported significant relationships between collagen content of the meat and its tenderness. However, the usefulness of collagen as a predictor of meat tenderness is still controversial. Muscles with more α-white fibres had more connective tissue, less intramuscular fat, and were less tender than muscles with more β-red fibres (Calkins *et al*. 1981).

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