FIBRE TYPE CHARACTERISATION IN BARROSÃ CALVES ACCORDING TO MUSCLE ANATOMICAL LOCATION

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Background

Meat quality evaluation involves the judgement of several attributes whose impact on its overall acceptability depends on the individual perspective. However, color and intramuscular fat (IMF) content are generally considered the most relevant on determining the consumer purchase decision. Both meat characteristics showed to be, in some extent, determined by the prevailing fibre typing of muscles. A significant and positive correlation has been found between IMF and the frequency of glycolytic fibres, increasing the importance of both parameters with the age of the animal (Hawkins, *et al.*, 1985; Seideman *et al.*, 1986). Despite the positive relationship also verified between the fibre composition and the phospholipid content in muscles (Alasnier *et al.*, 1996), a clear effect of muscle fibre composition on the meat palatability has not been, so far, fully established.

The fibre type composition of muscles is highly variable, depending on several factors such as breed, sex, ambient temperature and exercise (Lefaucheur, 2001). However, within an animal, muscle type is considered the most important factor, with those involved in posture (deep location) having more type I oxidative fibres than more superficial muscles (Ono *et al.*, 1995). Due to the lack of pressure directed to meat production improvement, some rustic Portuguese cattle breeds probably have muscle biochemical properties highly distinguishable from those animals genetically prepared for intensive production handling.

Objective

Characterisation of fibre type distribution and prevailing metabolic profile in a large number of muscles from Barrosã calves, of both sexes.

Materials & Methods

Barrosã calves of both sexes, with ages ranging from 5 to 9 months were used in this study. About 1 hour post-mortem samples were picked up from the superficial portion of muscles, including the *Psoas major* (Pm), *Longissimus dorsi* (Ld), *Semimembranosus* (Sm), *Semitendinosus* (St), *Biceps femoris* (Bf), *Gluteus superficial* (Gs); *Gluteus medium* (Gm), *Supraspinatus* (Ss) and *Infraspinatus* (Is). Since the task for the orientation of fibres was concluded, the muscle pieces were immediately frozen by immersion in isopentane cooled in liquid nitrogen during 30 seconds and then stored at –80°C until analysis.

Transverse serial sections (10 µm) were cut in a cryostat at –24°C and stained for miofibrillar ATP-ase after preincubation at pH 4.6 (Brooke & Kaiser, 1970). Sections were enlarged (x100) and photographed in order to make the different fibres count easier. The percentage of each fibre type was calculated from a minimum of 400 units, by counting the total number of each type and dividing by the total number of fibres. type I, type IIA and Type IIB were discriminated according to the staining intensity .

The cross-sectional area of the different fibre types was evaluated by cutting and weighting about 200 fibres from each of two randomly chosen fields from each muscle section. For the conditions used in this study to an area of 0.25 cm^2 in the photograph corresponded an effective fibre area of 1064.71 μm^2.

The influence of sex and muscle type on the results was determined through a factorial model analysis of variance (ANOVA). Multiple range analysis of means was performed by the LSD test (Least Significant Difference Test) for 95% of probability.

Results & Discussion

Fibre type I, IIa and IIb frequencies on different studied muscles of Barrosã calves are depicted on Table1. Irrespective of the sex of the animal, fibre type IIb prevailed in the large majority of muscles. This condition was more evident in muscles from the leg (> 50%) than in those from the other anatomical regions. This trend was not confirmed in muscle Gs (both sexes) and in muscles Pm and Ss (females), where fibre type I predominated. Among muscles, fibre composition diverged significantly with Gs, Ld2 and St muscles showing the highest incidence of fibre type I, type IIa an type IIb, respectively. Excepting St muscle, females showed mean counts of fibre type I generally slightly higher than in males, with the differences being significant ($p<0.05$) on Gm, Gs, Ld2, Pm, Ss and Is muscles. The comparison of results between Barrosã and Limousine male calves (Jurie *et al.*, 1995) with similar age at slaughter (6 months) indicated similar fibre type distributions, with the former showing slightly higher mean frequencies of fibre type I (14.5% vs 9%) and type IIb (70% vs 61%). The numbers were almost the same if the comparison was done with Saler/Limousine (Jurie *et al.*, 1999) and Norwegian animals (Totland *et al.*, 1988), 10 months old. A progressive increasing of muscle glycolytic metabolism due to the transformation of fibre type IIa into type IIb has been referred in cattle up to 1 year old (Seideman *et al.*, 1986; Klosowski *et al.*, 1992; Brandstetter *et al.*, 1998). This conversion rate slows down afterwards and constitutes a sign of sexual maturity (Jurie *et al.*, 1999). In this case, the Barrosã animals seem to reach this state of physiological development earlier. The higher number of fibre type I in Barrosã calves could be associated to differences existing on handling procedures during this production phase, feeding included.

In females, samples collected from Ld at the level of 4th lumbar (Ld1) or 13rd dorsal (Ld2) vertebra were not significantly different in fibre type distribution. However, in males, muscle from the last site showed a higher incidence ($p<0.05$) of fibre type IIa and lower mean counts ($p>0.05$) of fibre type I. These results do not mean loose of oxidative potential on the anterior section of Ld muscle in male calves (results not included).

The number of fibres counted in 0.916 mm^2 of different muscles from both sexes Barrosã calves are shown in Table 2. The values ranged from a maximum of 417 units in Sm and a minimum of 323 units in Ld1 for males. In females the degree of variation was more pronounced (455 units in Pm and 262 in Ld1). The influence of the sex of the animals on the results was not evident and depended on muscle location. In general, fibre type IIb showed the bigger mean transversal section, with the IIa type in an intermediate position (Table 3). However, in Ss muscle on males and in Is muscle on females the higher mean transversal area has been measured in Fibre types IIa and I, respectively. Fibre type IIb mean area was higher in females than in males (3005.71 μm^2 vs 2510.46 μm^2), but the difference appeared significant ($p<0.05$) only for Ld1 muscle (4477.7 μm^2 vs 3493.2 μm^2). By the contrary, mean area of fibre type I was superior in males (2029.12 μm^2 vs 1914.64 μm^2) with the differences being significant in a larger number of muscles (Gs, Ld1, Ld2, and Pm). Ld muscle presented the bigger fibres irrespective of their type. Fibre dimension of Barrosã calve muscles reached higher mean values those of Frisian individuals (Vestergaard *et al.*, 2000) and were only slightly lower than those evaluated in Angus and Charolais breeds (Solomon *et al.*, 1985).

Acknowledgements

This research work was supported by the Fundation for the Science and Technology (FCT). The authors grateful to the Hospital Santa Maria, Laboratório de Neuropatologia for providing facilities and assistence in the implementation of histochemical techniques.

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Table 1 – Variation on different fiber type frequencies in muscles of Barrosã calves from both sexes.
Type I: slow oxidative; Type IIa: fast oxidative/glycolytic; Type IIb: fast glycolytic.

Muscle	Type I		Type IIa		Type IIb	
	Male	Female	Male	Female	Male	Female
Sm	9,59 ^{g}	10,97 ^{e}	^{x} 30,59 ^{bc}	^{y} 19,20 ^{de}	^{x} 59,82 ^{b}	69,83 ^{a}
St	14,56 ^{f}	11,18 ^{e}	18,96 ^{e}	21,77 ^{cd}	69,99 ^{a}	67,06 ^{a}
Bf	20,03 ^{e}	23,65 ^{d}	^{x} 23,52 ^{d}	^{y} 16,97 ^{e}	56,46 ^{b}	54,38 ^{c}
Gm	^{x} 15,19 ^{f}	^{y} 22,78 ^{d}	^{x} 28,34 ^{c}	^{y} 16,33 ^{e}	^{x} 56,47 ^{b}	^{y} 60,89 ^{b}
Gs	^{x} 48,83 ^{a}	^{y} 59,35 ^{a}	^{x} 14,59 ^{f}	^{y} 19,32 ^{de}	^{x} 36,59 ^{f}	^{y} 21,34 ^{g}
Ld1	23,72 ^{de}	25,04 ^{d}	27,34 ^{c}	27,54 ^{ab}	49,44 ^{c}	47,43 ^{d}
Ld2	^{x} 20,44 ^{e}	^{y} 25,34 ^{d}	^{x} 35,35 ^{a}	^{y} 29,99 ^{a}	47,71 ^{cd}	44,68 ^{d}
Psoas	^{x} 35,15 ^{b}	^{y} 40,70 ^{b}	19,73 ^{e}	19,96 ^{de}	^{x} 45,13 ^{de}	^{y} 39,38 ^{e}
Ss	^{x} 27,40 ^{cd}	^{y} 42,99 ^{b}	^{x} 33,16 ^{ab}	^{y} 23,88 ^{bc}	^{x} 39,44 ^{f}	^{y} 33,13 ^{f}
Is	^{x} 29,50 ^{c}	^{y} 34,86 ^{c}	27,20 ^{cd}	25,70 ^{b}	^{x} 43,30 ^{e}	^{y} 39,44 ^{e}

x, y – In same row and for each fiber type, means with different letters are significantly different.
a, b, ...g - In same column, means with different letters are significantly different.

Table 2 – Variation on mean transversal area of different fiber types in muscles of Barrosã calves from both sexes. Type I: slow oxidative; Type IIa: fast oxidative/glycolytic; Type IIb: fast glycolytic.

Muscle	Type I		Type IIa		Type IIb	
	Male	Female	Male	Female	Male	Female
Sm	1372,2 ^{d}	1620,2 ^{cd}	^{X} 1300,8 ^{e}	^{y} 1837,0 ^{cd}	2383,1 ^{cd}	2648,4 ^{cd}
St	1593,7 ^{d}	1456,3 ^{de}	1800,0 ^{cd}	1654,4 ^{d}	2645,3 ^{bcd}	2565,1 ^{cd}
Bf	1379,0 ^{d}	1165,4 ^{e}	1600,0 ^{de}	1827,0 ^{cd}	2266,9 ^{d}	2592,4 ^{cd}
Gm	1618,9 ^{d}	1699,7 ^{cd}	^{X} 2086,0 ^{bc}	^{y} 2562,0 ^{ab}	2643,3 ^{bcd}	3152,8 ^{bc}
Gs	^{X} 2363,3 ^{bc}	^{y} 1808,6 ^{c}	^{X} 1925,0 ^{cd}	^{y} 2541,3 ^{ab}	2530,1 ^{bcd}	2876,3 ^{cd}
Ld1	^{X} 2685,8 ^{a}	^{y} 2341,8 ^{b}	2838,1 ^{a}	2883,7 ^{a}	^{X} 3493,2 ^{a}	^{y} 4477,7 ^{a}
Ld2	^{X} 2565,3 ^{ab}	^{y} 1873,2 ^{c}	2662,2 ^{a}	2453,8 ^{b}	3447,6 ^{a}	3722,3 ^{b}
Psoas	^{X} 2093,3 ^{c}	^{y} 1753,0 ^{cd}	2273,5 ^{bc}	2198,2 ^{bc}	^{X} 2933,7 ^{abc}	^{y} 2644,2 ^{cd}
Ss	^{X} 2248,9 ^{c}	^{y} 2743,3 ^{a}	2442,5 ^{ab}	2598,1 ^{ab}	2276,0 ^{d}	2869,3 ^{cd}
Is	^{X} 2370,8 ^{bc}	^{y} 2684,9 ^{a}	2113,0 ^{bc}	2324,9 ^{b}	3126,1 ^{ab}	2508,6 ^{d}

x, y – In same row and for each fiber type, means with different letters are significantly different.
a, b, ...g - In same column, means with different letters are significantly different.