

MORPHOLOGICAL CHARACTERISTICS OF MUSCLE FIBRES IN DOUBLE MUSCLED AND NORMAL CATTLE

LAZZARONI C., SEMPRINI D., ABRATE M., PAGANO M. and TOSCANO-PAGANO G.

Dipartimento di Scienze Zootecniche, Università di Torino, Italy

S-III.25

SUMMARY

To improve knowledge of double muscled animals fibre dimensions of some muscles were measured in hypertrophic and normal cattle.

The trial was performed on 48 young bulls, 24 double muscled (H: 12 Piemontese, HP, and 12 crossbred Piemontese x Friesian, HPxF) and 24 normal (N: 12 Piemontese, P, and 12 Friesian, F). At slaughtering samples were taken from 3 muscles: Cutaneus trunci (Ct), Pectoralis profundus (Pp), and Adductor femoris (Af), influenced by double muscling (Ct and Pp heavier in double muscled animals and Af lighter). Muscle samples were kept in formalin and slides were prepared after paraffin inclusion of samples, with slices thick 4-5 μ m stained by trichromic haematoxylin-eosin. Muscle fibres were measured by using a semi-automatic image analyser and 5 dimensions were recorded: area, perimeter, equivalent diameter, maximum and minimum axis. Data were studied by ANOVA, using a mixed hierarchical and factorial model ((2 x 2) x 3) with 12 replications.

In double muscled cattle fibre dimensions were lower than in normal cattle (area 2787.84 ± 318.96 vs 2953.13 ± 426.87 μ m², perimeter 228.38 ± 12.25 vs 233.82 ± 16.42 μ m, and equivalent diameter 55.88 ± 3.33 vs 60.53 ± 4.34 μ m, $P \leq .01$) except for the minimum and the maximum axis (50.63 ± 3.47 vs 51.90 ± 4.21 and 75.44 ± 5.50 vs 77.70 ± 6.75 μ m, not significantly different). Differences were found among muscles only for the maximum axis (Af 78.24 ± 8.16 μ m \leq Pp 76.59 ± 5.23 μ m \leq Ct 74.88 ± 4.54 μ m, $P \leq .05$), and no differences were found among genetic groups.

These results allowed us to define double muscling in HP and HPxF as hyperplasia (increased number of cells) rather than hypertrophy (increased dimensions of cells).

Introduction

In bovine carcasses of the same weight the total mass of the musculature is greater in double muscled animals than in normal ones. Muscular hypertrophy - or double muscling - was detected and described long time ago, but many aspects of this character must be investigated still now.

Expression of double muscling varies according to the breed, sex and age of animals. Some research papers on macroscopic and microscopic structure of different muscles show a general hyperplasia of muscular fibres (Bailey et al., 1982; Bellardi and Bruno, 1983; Hanset and Ansay, 1972; Hanset et al., 1982; Mattei, 1988; Swatland, 1973), more or less pronounced according to muscles, so it seems that hypertrophy is not generalised.

The most hypertrophied muscles are those with a large surface area, such as the Cutaneus trunci, the Latissimus dorsi or the Pectoralis profundus (Boccard, 1981). Generally the muscles of the round and shoulder are more hypertrophic (Boccard and Dumond, 1974) and the muscles of the neck, shank and leg are less hypertrophic (Hanset and Ansay, 1972). Instead some other muscles, the deep ones such as the Adductor femoris or the Diafragma, are lighter in double muscled animals. So in hypertrophic animals compared to normal, the muscles are defined hypertrophied, isotrophied or hypotrophied according to their size.

The study of muscle and fibre dimensions was performed on the French, Anglo-Saxon and Belgian breeds, but very few researches involved the Piemontese breed. To improve knowledge of double muscled Piemontese cattle and crossbred Piemontese x Friesian fibre dimensions of some muscles were measured and compared to normal Piemontese and Friesian.

Materials and methods

The trial was performed on 48 young bulls reared in the same environmental conditions. The animals, 24 with muscular hypertrophy (H: 12 Piemontese, HP, and 12 crossbred Piemontese x Friesian, HPxF) and 24 normal (N: 12 Piemontese, P, and 12 Friesian, F), were slaughtered at 14-16 months of age and at 450-500 kg of live weight.

In one hour after slaughtering samples were taken from 3 muscles: Cutaneus trunci (Ct), Pectoralis profundus (Pp), and Adductor femoris (Af), influenced by double muscling (Ct and Pp heavier in double muscled animals and Af lighter). Muscle samples were kept in formalin and slides were prepared after paraffin inclusion, with slices thick 4-5 μ m stained by trichromic haematoxylin-eosin.

Muscle fibres were measured by using a semi-automatic image analyser and 5 dimensions were recorded: area, perimeter, equivalent diameter, maximum and minimum axis. For each sample about 50 cells were measured and mean data were studied by ANOVA, using a mixed hierarchical and factorial model ((2 x 2) x 3) with 12 replications.

Results and discussion

Data collected allowed to specify fibre dimensions at a typical slaughtering age in young bulls with muscular hypertrophy (HP and HPxF) compared to young bulls without hypertrophy (P and F).

As showed in tables 1-2 and 3, in double muscled cattle fibre dimensions were lower than in normal cattle (area 2787.84 ± 318.96 vs 2953.13 ± 426.87 μ m², perimeter 228.38 ± 12.25 vs 233.82 ± 16.42 μ m, and equivalent diameter 55.88 ± 3.33 vs 60.53 ± 4.34 μ m, $P \leq .01$). The minimum and the maximum axis (50.63 ± 3.47 vs 51.90 ± 4.21 and 75.44 ± 5.50 vs 77.70 ± 6.75 μ m) are not significantly different (table 4 and 5).

These results confirm that also in Piemontese cattle and their crossbred muscle hypertrophy arises not from an increase in the size of the fibres, but from a hyperplasia.

No differences were found among the studied breeds (tables from 1 to 5).

The analysed muscles, two of them heavier in double muscled animals (Ct and Pp) and the other lighter (Af) showed significant differences only for the maximum axis (Af 78.24 ± 8.16 μ m \leq Pp 76.59 ± 5.23 μ m \leq Ct 74.88 ± 4.54 μ m, $P \leq .05$; table 4), but the mean values suggest to continue the studies.

Conclusion

The results of this trial allowed us to affirm that fibre dimensions (area, perimeter, and equivalent diameter) are lower in double muscled young bulls of Piemontese breed and in their crossbred than in normal Piemontese and Friesian cattle.

Therefore, at least for fibre dimensions, the expression of the muscular hypertrophy in the Piemontese cattle follows the general rule observed in the other breeds.

The observed differences among muscles suggest to continue this research to improve the knowledge of this very interesting breed.

Acknowledgement

Research supported by National Research Council of Italy, Special Project RAISA, Sub-project 3, Paper No. 1624.

References

- Bailey, A.J., Enser, M.B., Dransfield, E., Restall, D.J. and Avery, N.C., (1982). Muscle and adipose tissue from normal and double muscled cattle: collagen types, muscle fiber diameter, fat cells size and fatty acid composition and organoleptic properties. In: King, J.W.B. and Menissier, F. (eds.). Muscle hypertrophy of genetic origin and its use to improve beef production. M. Nijhoff Publ., The Hague, 178-202.
- Bellardi, S. and Bruno, R. (1983). Diametro delle fibre muscolari e contenuto di idrossiprolina in alcuni muscoli di bovini di razza Piemontese "della coscia" e Frisona. *Ann. Fac. Med. Vet. Torino*, 29, 184-196.
- Boccard, R. (1981). Facts and reflections on muscular hypertrophy in cattle: double muscling or culard. In: Lawrie, R. (ed.). *Developments in meat science - 2*. Applied Science Publ., London, 1-28.
- Boccard, R. and Dumond, B.L. (1974). Consequences de l'hypertrophie musculaire hereditaire des bovins sur la musculature. *Ann. Genet. Sel. Anim.*, 6, 177-186.
- Hanset, R. and Ansay, M. (1972). Regions privilegiees d'hypertrophie musculaire chez le bovin culard. *Ann. Med. Vet.*, 116, 17-25.
- Hanset, R., Michaux, C., Dessy-Doize, C. and Burtonboy, G. (1982). Studies on the 4th rib cut in double muscled and conventional cattle: anatomical, histological and biochemical aspects. In: King, J.W.B. and Menissier, F. (eds.). Muscle hypertrophy of genetic origin and its use to improve beef production. M. Nijhoff Publ., The Hague, 341-349.
- Mattei, V. (1988). Alcune caratteristiche morfometriche della fibra muscolare di 6 tipi genetici bovini derivati da incrocio e loro relazione con le caratteristiche qualitative della carne. Tesi di Dottorato di Ricerca, Univ. Napoli, 1-114.
- Swatland, H.J. (1973). Innervation of genetically enlarged muscles from double muscled cattle. *J. Anim. Sci.*, 36, 355-362.