MUSCLE STRUCTURE INFLUENCED BY AGE ON CHIANINA BEEF

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INTRODUCTION

Beef quality is determined by different physical, chemical and biological aspects of meat and fat. In different times and in previous reports (Nicastro et al.1993a; b; 1997; Youling L. Xiong et al. 1995) we found the relatioship between these parameters and the skeletal muscle fiber characteristics. Although the muscle structure is influenced by both inherited and envronmental conditions, such as breed, sex, age and feeding practice (Nicastro et al. 1991; 1994; Solomon et al. 1986) , there are no certain conclusions so far, but each condition needs to be further investigated. Physiological and biochemical aspects of the fiber types, as well as the muscularity, change according to the maturity of the beef. In this study histochemical properties of the longissimus thoracis muscle were examined in Chianina bulls slaughtered at three different ages.

MATERIALS AND METHODS

Animals

For this experiment thirty six-month old Chianina bulls after weaning, were equally divided into three treatment groups: group A (slaughter time at 13 months), group B (slaughter time at 20 months) and group C (slaughter time at 20 months). All animals received a diet with 0.82 Meat FU Kg/DM, energy level.

Sampling procedure

The longissimus thoracis (LT) muscles were used for fibre type classification and intramuscular fat cells. Samples of the above mentioned muscles were taken from the left side of the carcass 1h post-mortem.

Histochemical and biochemical analyses

Transverse serial cross sections (10 μm thick) were cut in a Reichert-Jung cryostat and stained with NADH-Tr (Engel and Broke, 1966) and myofibrillar adenosine triphosphatase (ATPase) reacted at alkaline pH (Guth et al. 1970).Fibers were classified into Red (βR), intermediate (αR) and white (αW) according to Nicastro (1992). In order to stain fat cells in the intercellular space, sections from said muscles were stained with OIL-Red-O and Hematoxylin according to Lillie (1965). Mean fiber diameter, percentage type for each fibre type (%), fat cells diameter (μm), fat cells number and percentage-area for each fiber type were calculated (Nicastro and Maiorano, 1993a; 1993b), using an Image Analyzer by Zeiss.

Statistical analysis

Data were analyzed by the least squares method using the GLM procedure (SAS, 1989) assuming a mathematical model including three ages.

RESULTS AND DISCUSSION

Least squares means for muscle fibre diameter, percentage type and percentage area are shown in table 1. Differences in muscle fibre characteristics between the three ages of slaughter were found. The LT muscle presented the largest fiber diameter in bulls slaughtered at 20 months compared to 13 months for the slow-oxidative fiber type (53,2 vs 48,4 μm; $P < 0.01$). Our results support a previous study by Laflamme et al.(1973) who showed a gradual increase in fibre size as the body weight increase. As noted previously by Johnston et al.(1981) αW fibers tended to be larger in diameter than βR or αR fibers in LT, matching our results.

More presence of Red fibers and controversely less presence of Intermediate fibers are observed in younger bulls (22.4; 32.2 %; $P < 0.01$). These results support the Cornforth et al.'s ones (1973), who reported a general decrease in the percentage of red fibers in Holstein and Hereford muscle as animal age increased. Such findings suggest that βR fiber transformation to αR and after to αW type, occurs during postnatal development as reported by different authors (Ashmore et al. 1971; Johnson et al. 1981).

The LT shows a significant presence of α-Red and α-White fiber percentage area (19.2 and 57.7 %), in the oldest bulls while the largest presence of β-Red fibers is evidenced in animals slaghtered at 13 months.

Figure 1, shows the effect of age of slaughter on fat cell diameter and number. The morphological parameters of adypocites increased with age or maturity (diameter (μm), 31,7 vs 48,5; $P > .01$ respectively at 13 and 20 months). The same trend was also found for fat cells number (12 vs 25; $P < .01$)

CONCLUSIONS

The LT muscle fibre characteristics of Chianina cattle seem to be influenced by the age of slaughter considered in this study. Of the tested ages, LT muscle evidenced better results in bulls slaughtered at 20 months of age with higher presence of slow-oxidative and intermediate fibers.

REFERENCES

-Ashmore, C.R., and L. Doerr. 1971. Postnatal development of fiber types in normal and dystrophic chick muscle. Exp. Neurol. 30:431

-Cornforth D. P., Schwartz W. C. and Cramer D.A., 1973. Growth and differentiation of muscle fibers in cattle. *J. Anim. Sci.*, 36, 1196-1197.

-Engel, W.K. and Brooke, M.H. 1966. Muscle byopsy as a clinical diagnostic aid. In: Neurological Diagnostic Technique, pp.90-146. Fields, W.S. (Ed.) Charles C. Thomas, Springfield, IL.

-Guth, L., Samaha, F.J. and Albers R.W. 1970. The neural regulation of some phenotypic differences between the fiber types of mammalian skeletal muscle. Exp. Neurol. 26, 126-135.

-Johnson D.M., W.G. Moody, J.A. Boling and N.W. Bradley 1981 Influence of breed type, sex, feeding systems and muscle bundle size on bovine fiber type characteriostics. J. Food Science 46:1760.

-Laflamme L. F., Trenkle A. and Topel D.G., 1973. Effect of castration or breed type on growth of the longissimus muscle in male cattle. *Growth* , 37, 249-263.

-Lillie, R.D. 1965. Histopathologic Technic and pratical Histochemistry. McGraw-Hill Book Co. New York.

-Nicastro, F. 1992. Relazioni tra fibre muscolari e qualità delle carni negli ovini. Convegno UNAPOC: "La qualità delle carni ovi-caprine italiane nel contesto comunitario", Pisa 16 ottobre 1992, Italia. Pisa

-Nicastro, F., Maiorano G., Berni P., Campodoni G., Preziuso G. and Cianci D. 1991. Influenza della dieta sulle caratteristiche istologiche del muscolo longissimus thoracis in vitelloni di razza Chianina. Atti IX Congresso Nazionale ASPA , 731-735.

-Nicastro, F. and Maiorano G. 1993a. Histological characteristics of Chianina breed related to meat quality. International Workshop on protelysis and meat quality. Clermont-Ferrand (France), 23-28 May 1993.

-Nicastro, F. and Maiorano G. 1993b. The influence of age and diet on muscle fibre type in the Chianina breed. 39th International Congress of Meat Science and Technology, Calgary, Alberta, Canada August 1-6, 1993.

-Nicastro F. and Maiorano G. 1994 - Histological characteristics of Chianina breed related to meat quality. International Workshop on "Espression regulation and role of proteinases in muscle development and meat quality". Clermont-Ferrand, France, May 24-28, 1993. Sciences des Aliments Vol.14, 4, 423-430.

-Nicastro F. and Maiorano G. 1997 - Atti Seminario : Tecnologie innovative nella determinazione della carne bovina di qualità:"Caratteristiche tissutali delle carni in relazione alla loro qualità", Bari 11 Novembre 1996, Taurus, Ass. Naz. All. Bov. It. Car., n.3-4, 1997.

-S.A.S. Istitute Inc. (1989) - SAS/STAT User's guide;statistics. Version 6. Fourth Edition., SAS Institute Inc., Cary, North Carolina, USA.

-Solomon, M. B., West, R. L. And J. F. Hentges, JR. 1986. Growth and muscle development characteristics of purebred Angus and Brahman bulls. Growth 50, 51-67.

-Youling L. Xiong, Francesco Nicastro and Suzanne P. Blanchard 1995 - Functionality of myofibrillar proteins from cattle at different maturities. International Congress of Meat Science and Technology. San Antonio, TX, U.S.A. August 20-28 1995.

Table 1. Least squares means for muscle fiber composition and diameter in M. longissimus thoracis adiacent to the 10th thoracic vertebra of Chianina bulls according to age

Item	n	Area of muscle fiber, (%)			Populations, % of total			Muscle fiber diameter (µm)		
		βR	αR	αW	βR	αR	αW	βR	αR	αW
Age, m										
13	10	30,4**Aa**	15,8**a**	53,8**a**	22,4**A**	32,2**A**	45,4	48,4**Aa**	47,5**a**	55,7
20	10	26,5**b**	17,0	56,5	15,1**B**	38,9**B**	46,0	53,2**B**	49,1	54,2
24	10	23,1**Bc**	19,2**b**	57,7**b**	14,6**B**	39,0**B**	46,4	51,1**b**	50,0**b**	54,6

Mean values in the same column bearing different letters differ (P < .01:A,B; P < .05 : a,b)

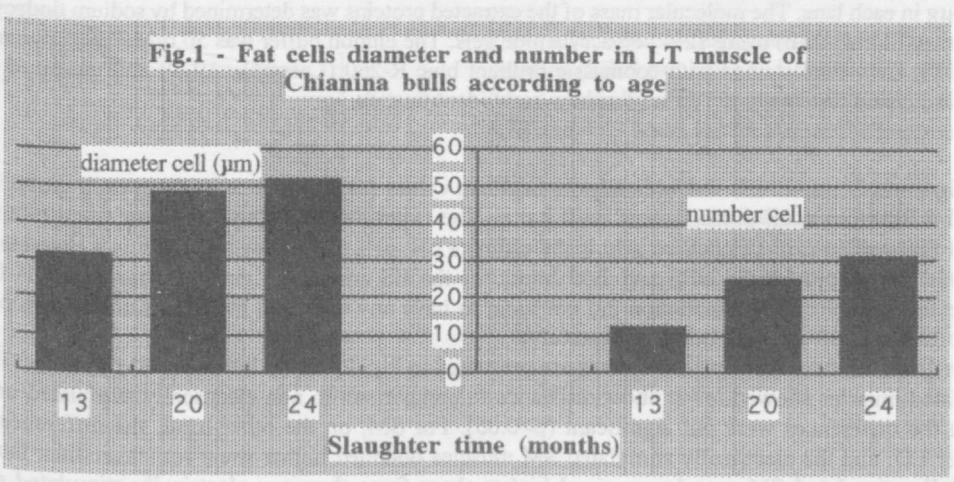

Fig.1 - Fat cells diameter and number in LT muscle of Chianina bulls according to age