# EFFECT OF DIET ENRICHED WITH OMEGA–3 ON BEEF MEAT QUALITY: HISTOLOGICAL CHARACTERISTICS

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## Introduction

In the last few years the interest in omega-3 fatty acids has greatly increased both in the medical-scientifical field and public opinion. Number of studies have shown that such a class of polynsaturate_fatty acids owns favourable effects on the human health and is particularly effective in preventing different kinds of deseases. Omega-3 fatty acids are of vital importance for the human being because, this last like all animal species, is not able to synthetize them autonomously starting from base food components. However, man is able to elongate the molecules of fatty acids of this family. He is able, then, to produce long chain- omega-3 fatty acids from an omega-3 fatty acid available in plants, that is the alpha-linoleic acid. Such a transformation mechanism is characterized by a variable effectiveness over different ages of life. Long chain – omega-3 acids (particularly the eicosapentenoic acid, or EPA and docosaexenoic acid, or DHA, which account for the compounds of this family very important for the human body ) must be derived from food. Among other things, these compuonds are present in most common food, except for fish and its derivatives.

A further contribution of omega-3 fatty acids to man's nutrition, can be obtained by means of fish oils consumption and by feeding stock-farming with feed enriched in omega-3 acids. It is notewhorty the transfer of omega-3 in meats especially the cattle ones, in order to improve meat quality (Nicastro et al. 2001; Nicastro et al. 2002; Nicastro F. 2003). The aim of this work is to investigate histological characteristics relevant to morphometric study (surface and diameter) of muscle fibres associated with different feed diets.

## Methods

Twelve Bruna Italiana breed calves have been used. They were fed with weaving feed over a 30-day period, and later with growth feed added with omega-3. The most representative fatty acid ω 3 was DHA with a presence of 10,8%.

Calves were divided in three groups according to the following treatments: I group Post weaning rationing with no omega-3 in diet; II group Post weaning rationing with diet containing 3% of omega-3; III group Post-weaning rationing with diet containing 6% of omega-3.

Bulls were slaughtered at 12 month of age and the carcasses were chilled at 3° C for 24-36 h. Samples of *longissimus dorsi* (LD) and *semimembranosus* (SM) muscles were collected from all animals 4h after slaughter for the histochemical characterization of the muscular fibres. Some pieces of said muscles have been taken, and then immersed in liquid nitrogen for about 10 seconds. Cross section were cut and mounted on spindles before sectioning 15 mm thick using a Reichert-Jung freezing microtome. Serial sections mounted on glass microscope slides were stained with NADH-Tr, myofibrillar ATPase reacted at alkaline pH to differentiate muscle fibre type according to their oxidative and glycolitic capability (Nicastro, 1989), and hematoxylin according to the procedure outlined by Lillie (1965) in order to stain fat cells in the intercellular space. Fibers were classified on the basis of stain reactions using the technique of Ashmore and Doerr (1971): Beta-red fibers were dark brown, Alpha-red fibers were clear in the middle and surrounded by a blue ring, Alpha-white fibers were clear. Sections were analysed using an Image Analyzer Vidas by Zeiss to determine fiber diameter and fiber percentage type for each fiber type.

## Results and Discussion

Details of production performance and meat quality results are given in a separate paper (Nicastro et al., manuscript submitted). Detailed fibre type and intercellular fat was conducted on the LD and SM muscles of bulls from Bruna Italiana breed, reared on three different diets. Least square means for longissimus fiber type diameter and percentages for each dietary group are shown in Figg. 1 and 3. There is a significant effect ($P < .05$) on the fiber size of red and white muscle fibers after cattle had been on feed control and 6% of omega-3 fatty acids respectively. The alpha-white fibers tended to be larger in diameter than alpha-red (Intermediate) and beta-red fibers (57 μm compared to 44 μm and 40 μm respectively). The diet enriched with omega-3 did not influence the distribution of fiber types. However, a significant ($P < .05$) decrease in percentage of alpha-red fibers was noted in the cattle fed with 6% of fish oil.

Muscle fibers characteristics for the SM are presented in Figg. 2 and 4. The least square means of all three fiber types (red, intermediate and white) in this muscle revealed little variation ($P < .05$) in muscle fiber size in cattle that were fed three different levels of feed added with omega-3. However, feed appeared to have had a significant effect on red and white muscle fiber size and percentage of cattle in group one (control) and three (6% of fish oil). Mean fiber size of the three fiber types showed the same pattern as the LD muscle where alpha-white fibers appeared larger than beta-red or alpha-red (intermediate). Variation of fibre type distribution within muscles is important when studying fybre type composition in relation to meat quality. Muscles involved in posture are more oxidative than those involved in movements (Totland and Kryvi, 1991; Henckel, 1995). Unfortunately, no definite conclusions can be drawn to associate fiber trasformation with animal feed-age, since the experiment was terminated before long term effects could be observed. More research is needed using a biopsy technique to observe fiber types in animals over a longer age span before giving definite answers can be to this important issue.

Figg. 5 and 6 shown the diameter of intracellular fat in LD and SM muscles for each dietary group. In both muscles the diameter of the adipocytes was larger in cattle fed with 6% of fish oil. The intracellular fat content is an important factor that affects sensory quality. Lipids are mainly stored in beta-red and some alpha-red fibers (Essen-Gustavsson et al. 1994). However, Henckel et al. (1997) found that the intracellular fat content was positively correlated with the frequency of alpha-white fibres. Essen-Gustavsson and Fjelkner-Modig (1985) concluded that meat tenderness is related to the metabolic muscle profile.

## Conclusions

Within a carcass there is considerable variation in meat quality characteristics between various muscles. The inter-muscle variation is often directly related to the metabolic and contractile properties as determined by their muscle fiber type distribution. The present study relates to the influence of dietary omega-3 fatty acids on the fiber type characteristics, but no clear pattern was obtained in this experimental design.

Fig. 1 - Least squares means for diameter (μm) of fiber in *longissimus dorsi* muscle of bulls Bruna Italiana fed different amount of omega-3 fatty acids.

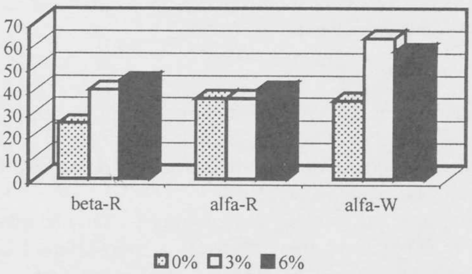



Fig. 2 - Least squares means for diameter (μm) of fiber in *semimembranosus* muscle of bulls Bruna Italiana fed different amount of omega-3 fatty acids.

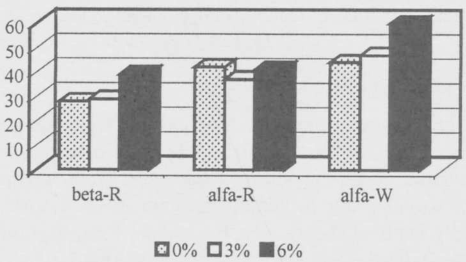



Fig. 3 - Fibers percentage of *longissimus dorsi* muscle of bulls Bruna Italiana fed different amount of omega-3 fatty acids.

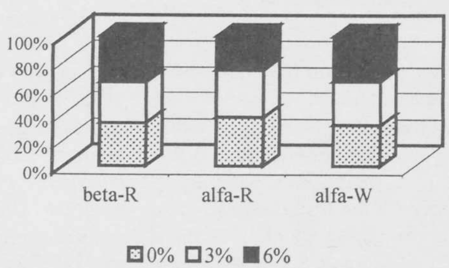



Fig. 4 - Fibers percentage of *semimembranosus* muscle of bulls Bruna Italiana fed different amount of omega-3 fatty acids.

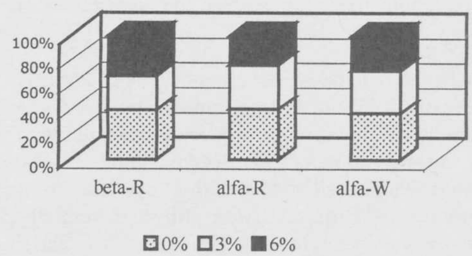



Fig. 5 - Diameter (μm) of intramuscular fat cells of LD muscle.

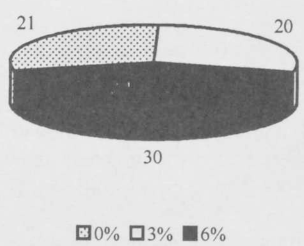
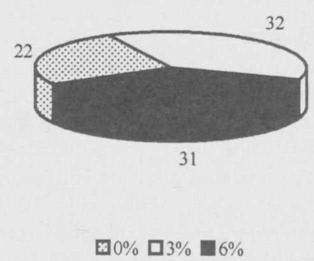



Fig. 6 - Diameter (μm) of intramuscular fat cells of SM muscle.

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