# RELATIONSHIPS BETWEEN FIBER TYPING AND MEAT TENDERNESS IN 15 HEAVY LAMB MUSCLES

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**Abstract- The aim of this study was to describe the relationships between fiber typing and sarcomere length, instrumental and sensory meat tenderness in 15 heavy lamb muscles, as well as in selected homogeneous groups of muscles. Samples were taken from muscles *Semitendinosus*, *Longissimus lumborum*, *Longissimus thoracis*, *Semimembranosus*, Cranial *Gluteobiceps*, *Adductor*, *Gluteus medius*, *Triceps brachii caput longum*, *Triceps brachii caput laterale*, *Psoas major*, *Rectus femoris*, *Vastus lateralis*, *Serratus ventralis*, *Infraspinatus* and *Supraspinatus* of five crossbred heavy lambs. Contractile fiber types were revealed histochemically, and muscles were arbitrarily classified according to the percentage volume of slow fibers. Sarcomere length, instrumental (WB-shear force) and sensory tenderness were determined 24 h after slaughter in all muscles. Although significant correlations were detected between fiber typing and meat quality across all (pooled) muscles, grouping muscles according to their fiber type characteristics resulted in finding important intermuscular differences in the way fiber typing and meat quality were associated. Therefore, our results suggest that in heavy lambs, associations between fiber typing and meat quality vary depending on muscle fiber type characteristics.**

## I. INTRODUCTION

Although it is accepted that muscle fiber diversity can affect meat quality, identification of a superior fiber type composition for meat quality has not been reported and may vary between species (1).

In the ovine species, some studies report associations between fiber typing and meat tenderness (2-3) whereas some do not report such associations (4).

Furthermore, since meat quality is affected by a complex combination of intrinsic and extrinsic factors, such as postmortem pH decline rate, muscle temperature and buffering capacity (5-6), some of which can show intermuscular variations (7), we hypothesize the existence of some degree of heterogeneity (muscle-type dependent) in the way fiber typing and meat quality is associated.

Thus, the aim of this study was to describe the associations between meat tenderness and fiber typing in 15 heavy lamb skeletal muscles as well as in selected contractile groups of muscles.

## II. MATERIALS AND METHODS

Five 14-month-old Poll Dorset crossbred heavy-ram lambs (71.9 ± 1.67 Kg) were used. Immediately after slaughter, samples were taken from the mid superficial belly of the *Semitendinosus*, *Longissimus lumborum*, *Longissimus thoracis*, *Semimembranosus*, Cranial *Gluteobiceps*, *Adductor*, *Gluteus medius*, *Triceps brachii caput longum*, *Triceps brachii caput laterale*, *Psoas major, Rectus femoris, Vastus lateralis, Serratus ventralis, Infraspinatus* and *Supraspinatus* muscles. Samples were frozen in liquid nitrogen, included in cryostat embedding medium (Cryomatrix, Thermo Shandon Limited, USA), and 24 µm-thick sections were cut in a cryostat. Histochemical fast (type II) and slow (type I) fiber types were revealed using the mATPase stain after alkaline (pH=10.35), and acid (pH=4.35) preincubations (8). The proportions, mean diameters and percentage volumes (%V) of type I and II fibers were determined using an image analysis system (Infinity analyze®, Toronto, Canada). An arbitrary criterion was followed to classify muscles according to their contractile characteristics. Muscles in which the %V occupied by type I fibers was lower than 10% were classified as fast twitch muscles. Muscles in which the %V occupied by type I fibers was between 10 and 20%, were considered intermediate twitch muscles, while muscles in which type I %V was higher than 20% were classified as slow twitch muscles. Sarcomere length was determined histologically in 2.5 % glutaraldehyde fixed samples. Instrumental tenderness was determined in cooked meat through Warner Bratzler (WB) shear force with an Instron series 3342. Sensory tenderness was determined through consumer panel sessions including 180 consumers (110 male and 70 female). A balanced incomplete block design and a ten point discontinued scale were used. Pearson correlation coefficients between fiber typing and meat quality traits were generated across all (pooled) muscles, as well as within selected contractile homogeneous groups of muscles.

## III. RESULTS AND DISCUSSION

### *III.I. Muscle classification*

Fast twitch muscles included muscles *Semimembranosus*, *Rectus femoris*, *Semitendinosus* and *Longissimus lumborum*. Muscles classified as intermediate twitch were Cranial *Gluteobiceps*, *Triceps brachii caput longum*, *Vastus lateralis*, *Gluteus medius*, *Longissimus thoracis* and *Adductor*, while slow twitch muscles included muscles *Serratus ventralis*, *Infraspinatus*, *Supraspinatus*, *Psoas major* and *Triceps brachii caput laterale* (Fig. 1).

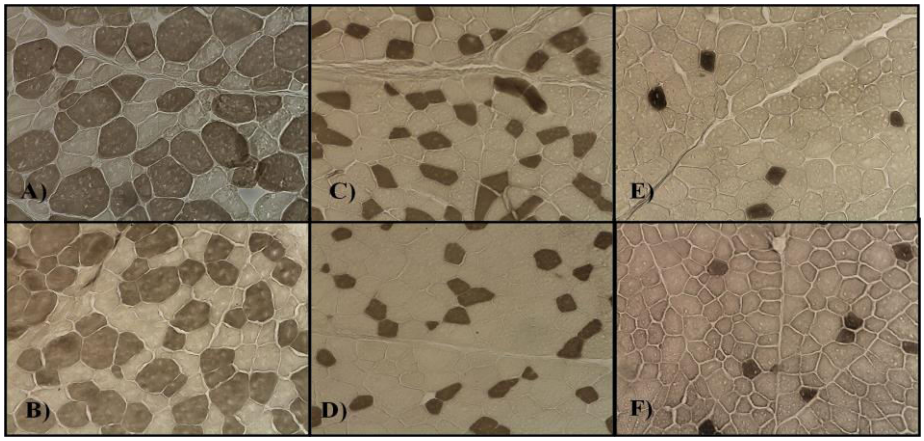


Fig.1. Histological sections of different heavy lamb muscles treated with the myosin ATPase stain after acid pre-incubation. A (*Serratus ventralis)* and B (*Supraspinatus*): slow twitch muscles; C (*Triceps brachii caput longum)* and D (*Adductor*): intermediate twitch muscles; E (*Semitendinosus)* and F (*Longissimus lumborum*): fast twitch muscles. Slow fibers stain dark while, fast fibers stain light beige.

*III.II. Correlations between fiber typing and meat quality traits*

The correlations between fiber typing and meat tenderness found in all (pooled) muscles (Table 1) are consistent with the higher calpastatin activity of slower muscles (4). Moreover, the detected intermuscular differences regarding correlations between meat tenderness and fiber typing (Table 1), suggest that although fiber typing can be useful to explain intermuscular differences in meat tenderness within a large and heterogeneous group of muscles, these relationships may not necessarily apply to smaller and more homogeneous groups of muscles. This could be one of the reasons why in studies covering a reduced number of muscles, no clear associations are apparent between fiber typing and meat tenderness. In fact, within muscles *Longissimus dorsi*, *Tensor fasciae latae*, *Semitendinosus*, *Trapezius* and *Supraspinatus* of rams, no correlations were found between fiber typing and meat tenderness (4).

Regarding sarcomere length, our results comprising all muscles disagree with the theory which states that slow fibers are associated with shorter sarcomeres (9). Nevertheless, Aalhus and Price (10) reported that among different ovine muscles, fiber typing could not predict sarcomere lengths, since the degree of stretching during hanging would influence this relationship. However, in the present study sarcomere length proved to be a variable with markedly different behavior depending on the muscle group. This could help to explain why in studies covering a heterogeneous group of muscles no negative association can be found between slow fibers and shorter sarcomeres (11).

Table 1: Pearson correlation coefficients between fiber typing and meat quality traits in: all (Pooled), slow twitch (SlTw), intermediate twitch (InTw) and fast twitch (FsTw) muscles.

| | WB shear force | | | | Sensory tenderness | | | | Sarcomere length | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pooled | SlTw | InTw | FsTw | Pooled | SlTw | InTw | FsTw | Pooled | SlTw | InTw | FsTw |
| % Type I | | | | | -0.29 ** | -0.62 *** | | | | | | |
| Type I mean diameter | 0.38 ** | 0.71 ** | | | -0.36 ** | -0.48 * | -0.45 ** | | | | 0.52 ** | -0.77 *** |
| % V type I | | | | | -0.31 ** | -0.53 ** | -0.59 *** | | | | | -0.77 *** |
| Type II mean diameter | | | | | | | | | -0.36** | | | |

*P<0.1; **P<0.05; ***P<0.01.

## IV. CONCLUSION

The present study contributes to a better understanding of the influence of fiber typing on intermuscular meat quality diversity, suggesting that although fiber diversity may explain intermuscular differences in meat tenderness, these associations can also vary among different contractile groups of muscles.

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