EFFECTS OF LOW VOLTAGE ELECTRICAL STIMULATION ON BOVINE LONGISSIMUS AND ADDUCTOR MUSCLES

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Introduction

Electrical stimulation (ES) of beef carcasses is frequently used by industry to enhance meat tenderness. There is a general consensus that ES is beneficial in terms of quality, however reported results of the effectiveness of ES on improving meat tenderness show considerable variation (Hildrum *et al.*, 1999). Moreover, depending on their location on the carcass, it is expected that muscles will respond differently to ES. It is well known that ES will increase the biochemical activity in the muscle cells, leading to ATP and creatine phosphate disappearance, accumulation of lactate and accelerated pH decline. However, the biological and physiological changes induced by ES are poorly understood. Metabolic profiling (proteomics) should provide a promising tool to investigate these effects.
In the present on-going study, the effects of low voltage ES on meat quality parameters of two different bovine muscles (*Longissimus dorsi* (LD) and *Adductor* (AD)) are investigated. Proteomics is used in order to investigate the up- and down-regulation of metabolic and structural muscle proteins. Understanding the molecular changes stimulated by ES may lead to development of new strategies for optimisation of the ES processing parameters.

Materials and Methods

Young bulls of the Norwegian Red breed (n=7) from a performance test station (GENO) were slaughtered at a commercial abattoir, and carcasses were halved. One half received low voltage ES (90 V, 15 Hz, 32 sec) which was applied through muscles in the neck and leg approximately 40 min (± 4 min) after stunning, while the other half served as a non-stimulated control (NES). At approximately 1h *post mortem*, the LD and AD were removed from both halves of each carcass, further subdivided, packed in polyethylene bags and stored at 4°C for 8 days. Muscle pH was measured at 1, 3, 6, 10 and 24 h after ES treatment for both muscles, while sarcomere lengths were measured at 48 h *post mortem* for LD only, as described by Rødbotten *et al.* (2001). Following the 8-day aging period, 4-cm thick slices of the muscles were vacuum-packed in polyethylene bags, heated in a water bath at 70°C for 50 min and chilled in iced water for 50 min. The meat slices were cut into pieces of 1x1 cm^2 thickness and ten parallels were sheared perpendicular to the fibre direction with a Warner-Bratzler (WB) shear force device attached to an Instron Materials Testing Machine (Model 4202, Instron Engineering Corporation, High Wycombe, UK). The average maximum force for the ten parallels was used in the data analysis. For metabolic profiling, muscle samples were separated by 2-dimensional gel electrophoresis (2-DE) according to the method described by Jia *et al.* (2006).

Results and Discussion

The results in Figure 1 reveal an effect of ES on the initial pH decline in both muscles. The pH is lower in the AD than in the LD muscles the first 6 hours after ES. However the ultimate pH, attained after 24 hours, does not differ between treatment or muscle. The results in Figure 2 demonstrate that there is a positive effect of ES on tenderness in the LD. In contrast, there was no observed effect of ES on AD tenderness after 8 days storage. No effect of ES on sarcomere length was observed in the LD. Thus the changes observed in tenderness for the LD is not due to changes in sarcomere length. A preliminary investigation of metabolic proteins from the muscles is being conducted using 2-DE. A representative image of water-soluble proteins from LD is shown in Figure 3.

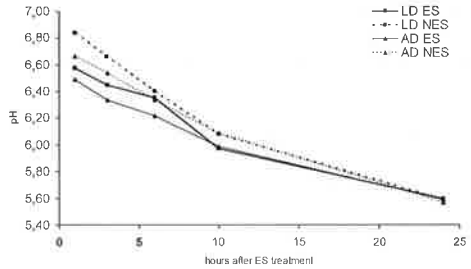

Figure 1: Mean pH measurements during the first 24 h *post mortem* in ES- and NES-treated LD and AD muscles from animals.

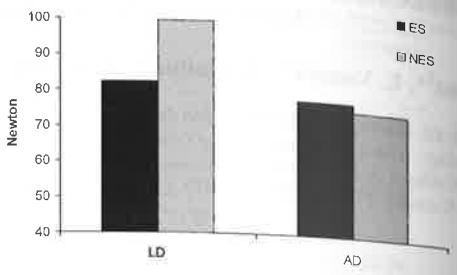

Figure 2: Mean WB shear force measured 8 days *post mortem* in ES- and NES-treated LD and AD muscles from 7 animals.

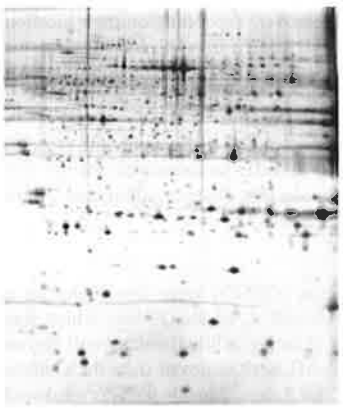

Figure 3: 2-DE image of water-soluble proteins from LD separated on a pH 4-7 gradient in the first dimension (left-right), followed by separation on 12% SDS-PAGE (top-down). Gels are silver stained.

Conclusions

We observed an effect of ES on the pH decline in LD and AD muscles of Norwegian Red cattle. However, an effect of ES on tenderness was only observed in the LD. Proteomics is a powerful tool to study the metabolic changes in muscle and will be used to unravel the metabolic mechanisms occurring during low voltage ES of bovine carcasses. Work is in progress to elucidate protein changes related to ES treatment, and up- and down-regulated proteins will be identified by MALDI-tof MS analysis.

Acknowledgements

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