RELATION BETWEEN MUSCLE FIBER TYPES, POST-MORTEM PROTEOLYSIS AND MEAT QUALITY TRAITS IN SUCKLING BEEF CALVES KEPT ON ALPINE PASTURES

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Abstract – Relationships between muscle characteristics and meat quality traits are important for early prediction of meat quality and control of the ante-mortem parameters influencing beef quality. These relationships have not yet been fully unraveled, and the results obtained so far were not verified for alternative production systems. Therefore, relationships between muscle fiber types, post-mortem proteolysis and meat quality traits were investigated in suckling calves slaughtered from an extensive production system. The most thriving correlations were found between the different muscle fiber types and meat color as well as shear force, partly confirming previous results, whereas post-mortem proteolysis showed little correlation with these meat quality traits.

Key Words – meat color, meat tenderness, muscle characteristics.

I. INTRODUCTION

Correlations between traits describing muscle metabolism, muscle fiber type, post-mortem proteolysis and meat quality were reported mainly for pork [1], but also for beef [2, 3]. They may get important tools to predict and control beef quality [4]. However, the correlations reported are inconsistent depending on production system (e.g. age and weight at slaughter) and duration of the ageing post-mortem [5, 6, 3]. Suckler beef production on alpine pastures is an extensive system which responds to societal, environmental and health concerns of the West-European consumers. However, the physical activity practiced by cattle on alpine pastures (or other extensive pastures such as rangelands) may influence muscle metabolism and further specifically affect intrinsic meat quality traits such as color and tenderness [7]. In this context, it is important to understand the correlations between muscle characteristics and meat quality traits. The present study aimed at unraveling these correlations in suckler beef kept on extensive alpine pastures.

II. MATERIALS AND METHODS

Twenty-four suckling calves, sired by the same Angus bull, were kept with their dams as two groups (balanced for gender, liveweight and age of the calves) on alpine pastures in the Eastern Swiss Alps at about 2000 m a.s.l. during the last 11 weeks before harvest at 277 ± 24 kg liveweight and 29 ± 3 weeks of age. At 1 h post-mortem, muscle samples were taken from the *M. longissimus thoracis* (at 8th and 9th rib) and the *M. biceps femoris* (at the cranial part) of the left carcass half, immediately frozen in liquid nitrogen and stored at -80°C. An additional sample was frozen after 7 days ageing. Ultimate meat pH was measured in both muscles 24 h post-mortem. Muscle fibers were differentiated (on the samples taken 1 h post-mortem) according to their contractile metabolism as slow-twitch (type I), fast-twitch (type IIb) and intermediate (type IIa) based on their myosin ATPase activity using an ATPase staining reaction at pH 4.6 after pre-incubation at pH 9.4. The proportion each fiber type made up on the total number of muscle fibers was calculated. The relative quantities of metavinculin, vinculin, desmin, integrin beta-1D and µ-calpain remaining in the meat at 7 days post-mortem were determined using SDS-PAGE as previously described by Bee *et al*. [8]. Meat quality traits were determined in both muscles after 21 days ageing under vacuum at 4°C. Meat color (CIE L*a*b) was determined on a fresh cut after 1 h blooming in the dark at 4°C. Warner-Bratzler shear force was determined on a meat slice previously cooked for 45 min in a water bath at 72°C. Pearson's correlation coefficients (*r*)

between variables were calculated using SAS version 9.3.

III. RESULTS AND DISCUSSION

No meat sample had an ultimate pH value above 6.0 (average: 5.8 ± 0.1), which is commonly accepted as the threshold for dark firm dry beef [9]. Furthermore, no significant correlation between either color or shear force and ultimate pH of the meat was found, probably because meat quality traits were analyzed after 21 days ageing [5].

Meat color and shear force were not correlated ($P>0.05$) with any of the traits indicative of proteolysis (7 days post-mortem), namely the relative quantities of metavinculin, vinculin, desmin, integrin beta-1D and µ-calpain, except meat redness which showed a positive correlation with the relative quantity of vinculin ($r = 0.35$; $P < 0.05$).

The most interesting and relevant correlations were found between meat quality traits and the proportions of the different muscle fiber types. Meat redness was positively correlated with the proportion of type I fibers ($r = 0.67$; $P < 0.01$) and negatively correlated with the proportions of both type IIa and type IIb fibers ($r = -0.38$ and $r = -0.70$; $P<0.05$). Similarly, meat yellowness was positively correlated with the proportion of type I fibers ($r = 0.51$; $P < 0.01$) and negatively correlated with the proportion of type IIb fibers ($r = -0.53$; $P < 0.01$). Type I fibers are generally believed to be negatively correlated with meat lightness [10] but this was not the case here, probably because pH was always within the normal range.

Shear force was negatively correlated with the proportion of type I fibers ($r = -0.62$; $P < 0.01$) and positively correlated with the proportion of type IIa and type IIb fibers ($r = 0.46$ and $r = 0.51$, respectively; $P < 0.01$). This confirms the results of Crouse *et al*. [2], although in their study the correlations vanished after more than 1 day ageing, and the results of Renand *et al*. [5] with older cattle and under intensive production conditions.

IV. CONCLUSION

The relative quantities of myofibrillar proteins remaining 7 days post-mortem did not correlate with the meat quality traits studied here. However, high correlations between meat color and shear force and muscle fiber types were observed, confirming previous results under more intensive production conditions. This suggests that fiber typing is a reliable tool for early prediction of meat quality and control of the ante-mortem parameters influencing beef quality, even under different production systems.

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