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Growth performance and meat quality of suckling beef calves as affected by alpine pasture topography

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Abstract. Summer alpine pastures have a heterogeneous topography. Since beef cattle walk long distances for grazing pasture slope could affect both physical activity intensity and energy expenditure, which may further affect muscle metabolism and meat quality. The present experiment investigated the effect of slope inclination on growth performance and meat quality under high-altitude conditions. Two groups of 12 Angus-sired suckling calves each were kept with their dams on summer alpine pastures (2000 m a.s.l.) either on a terrain with steep inclination (S) or on a flat terrain (F) for 2 months. Then, calves were slaughtered and meat quality was assessed on the *longissimus dorsi* (LD) and the *biceps femoris* (BF) muscles after 21 days of ageing. Average daily gains were lower in S-compared with F-calves (1.21 *vs* 1.35 kg/day; P<0.01), but live weights did not differ significantly between groups at slaughter (277 ± 24 kg). Carcass classification and carcass weight did not differ between groups. Shear force of BF was lower in S- than in F-calves (24.5 *vs* 27.5 Newton; P<0.05). Colour of LD tended to be brighter (37.2 and 36.4; P<0.09) and more yellow (1.44 and 0.51; P<0.07) in S- than F-calves; all other measurements showed no difference between S- and F-calves.

Keywords. Slope – Activity – Tenderness – Grazing – Beef.

Performances de croissance et qualité de la viande de veaux allaitants selon la topographie des pâturages alpins

Résumé. *Les pâturages alpins disposent d'une topographie hétérogène qui pourrait influencer l'intensité de l'activité physique ainsi que la dépense énergétique des troupeaux qui doivent y parcourir de longues distances pour pâturer. In fine, ceci pourrait influencer le métabolisme musculaire et la qualité de leur viande. L'étude présentée ici évaluait l'effet de la pente du pâturage sur les performances de croissance et la qualité de la viande dans des conditions de haute altitude. Deux groupes de 12 veaux sous la mère, issus d'un même taureau Angus, ont pâturé sur des prairies alpines (à environ 2000 m d'altitude), soit sur un terrain pentu (S), soit sur un terrain plat (F), pendant deux mois. A l'issue de cette période, les veaux ont été abattus et la qualité de leur viande a été analysée sur les muscles* longissimus dorsi *(LD) et* biceps femoris *(BF) après 21 jours de maturation. Le gain moyen quotidien des veaux S était inférieur à celui des veaux F (1,21* vs *1,35 kg/jour ; P<0,01), bien que cela n'ait pas eu d'influence significative sur le poids vif à l'abattage (277 ± 24 kg). La classification et le poids de la carcasse n'étaient pas différents entre les groupes. La force de cisaillement du BF était inférieure sur les veaux S par rapport aux veaux F (24,5* vs *27,5 Newton; P<0,05). La couleur du LD était tendanciellement plus claire (37,2* vs *36,4 ; P<0,09) et plus jaune (1,44* vs *0,51 ; P<0,07) sur les veaux S que sur les veaux F, tandis que les autres mesures n'ont pas montré de différence significative.*

Mots-clés. *Pente – Activité – Tendreté – Pâturage – Bœuf.*

I – Introduction

Beef cattle are increasingly kept on seasonal alpine pastures (SAV, 2010), likely due to the limited workforce necessary in comparison with dairy cattle. However, this period may affect growth performance, carcass characteristics and meat quality in comparison with beef cattle reared on lowland pastures. Typically, alpine pastures have a variable topography with slopes of various gradients contrasting with lowland pastures, the majority of which have a more even topography. Differences in topography require a different muscular workload depending on the slope cattle are grazing on. The burden of physical activity has been shown earlier to affect maintenance requirements and muscle physiology both in athletes (Tesch and Karlsson, 1985) and in animals. This appears to have consequences for meat quality in beef cattle (Dunne *et al.*, 2011). Nevertheless, physical activity of cattle is often confounded with diet type and altitude-related hypoxia (Leiber *et al.*, 2006). The present experiment therefore aimed at describing growth and meat quality of suckling calves kept either on pastures with high inclination or on flat pastures, with grass of similar quality and at the same altitude.

II – Materials and methods

The experiment was conducted on the alpine pastures of the ETH Zurich research station Alp Weissenstein, located in the Eastern Swiss Alps at about 2000 m a.s.l. Twenty-four suckling calves were distributed over two groups of 12 animals each, balanced for gender, live weight (185 ± 22 kg) and age (4.2 ± 0.6 months) of the calves at the beginning of the alpine period as well as for the genotype and lactation number of the dam. Calves were kept with their dam all along the experiment which started on June 20th, 2013, with the transport of the herd to the alpine site where they stayed until slaughter of the calves. Calves were all sired by the same Angus bull and had Angus × Holstein (n = 19) or Limousin × Holstein (n = 5) dams. A rotational pasture management was conducted, either on pastures with an average inclination of 40% (group S) or on pastures with close to 0% inclination (group F). Representative forage samples were taken every week and analysed for contents of dry matter (DM), gross energy, organic matter, crude protein as 6.25 × nitrogen content (all according to AOAC (1990)), neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) according to Van Soest *et al.* (1991). The pastures selected indeed offered forage of mostly similar nutritional quality (P>0.1) to the two groups except for NDF and ADL contents. On average, contents were: gross energy, 18 ± 0.3 MJ/kg DM; organic matter, 928 ± 1 g/kg DM; crude protein 128 ± 19 g/kg DM; ADF, 291 ± 21 g/kg DM. In the forage of the S group, compared to that of the F group, NDF content was lower (487 *vs* 541 g/kg DM, P<0.05) and ADL content was higher (55.8 *vs* 45.7 g/kg DM, P<0.01).

After approximately 11 weeks on their respective pastures, the calves were slaughtered on September 2nd and 5th in a commercial slaughterhouse, with 6 animals from each group slaughtered on each of the slaughter dates. The hot carcasses were weighed and classified according to the CHTAX system (similar to the EUROP classification). On the day following slaughter, samples of the LD (*longissimus dorsi*) and BF (*biceps femoris*) muscles were collected for laboratory analysis, and ultimate pH value (24 h *post-mortem*) was measured in the LD muscle. Meat composition (DM, protein calculated as 6.25 × nitrogen content, ash, crude fat) was analysed on fresh meat whereas further meat quality analyses were carried out after 21 days ageing in vacuum packaging at 4°C. Meat from both muscles was analysed for meat colour (in the L*a*b colour space), drip loss (48 h at 4°C with the bag method from Honikel (1998)), cooking loss (in water bath at 72°C for 45 min) and shear force (on the meat sample used for cooking loss) obtained with a Warner-Bratzler shear blade mounted on a TAXT2 texture analyser (Stable Micro System, Surrey, UK).

Data were analysed by SAS 9.3 (SAS Institute Inc., Cary, USA) with ANOVA using the GLM procedure for forage and growth data, and using the MIXED procedure for carcass and meat quality data. For both models, group was defined as fixed effect; slaughter date was included as a random effect for the mixed model.

III – Results

Results of growth and slaughter performances of the S- and F-calves are presented in Table 1.

Table 1. Growth and slaughter performances of suckling calves kept on steep pastures (S-calves) or on flat pastures (F-calves)

	S-calves	F-calves	P-value
Initial live weight (kg)	185	186	0.85
Average daily gain (kg/day)	1.21	1.35	0.01
Slaughter live weight (kg)	271	283	0.22
Carcass weight (kg)	146	151	0.45
pH 24h *post mortem*	5.8	5.8	0.38

Carcass conformation was classified mainly as T3 (n = 10) or T+3 (n = 4) independently of the group. Meat composition (DM, protein, ash and crude fat) of both LD and BF muscles did not differ between groups (P>0.1). Fat content of the LD muscle was on average 1.31% and fat content of the BF muscle was on average 2.35% of wet weight. Concerning meat colour, LD of S-calves tended to be brighter than LD of F-calves (brightness L*: 37.2 *vs* 36.4; P<0.09) and more yellow (b-yellowness 1.44 *vs* 0.51; P<0.07), but no difference was found in the redness (redness a*: 19.5 *vs* 19.0, P>0.32). Colour of the BF did not differ between groups with average values of 37.2 ± 0.8 for L*, 21.7 ± 0.9 for a* and 2.38±0.66 for yellowness b* (P>0.32). Drip loss and cooking loss were also similar in both groups and in both muscles (LD: 1.1 ± 0.3% and 24.9 ± 0.3%; BF: 1.1 ± 0.2% and 28.3 ± 1.8%, respectively; P>0.19). Shear force did not differ between groups for the LD muscle (43.1 ± 9.5 N, P>0.85) but differed for the BF muscle. The BF-meat of the S-calves had on average a lower shear force value than that of the F-calves (24.5 *vs* 27.5 N, P<0.05).

IV – Discussion

In the present experiment, the effect of pasture inclination on growth performance and meat quality of suckling calves was investigated. The negative influence of a steep pasture on growth performance was likely due, as hypothesised, to the higher energy demand for grazing on steep slopes. Although milk composition and intake were not recorded, ruminating and eating patterns did not differ between groups (data not presented here), suggesting similar feed intake for both groups. The effect of pasture inclination on live weight gains was, however, limited in magnitude, thus not resulting in significant live weight differences at slaughter, due to the short duration of the experiment (11 weeks) and the initial intra-group variability. Dressing percentage, carcass classification and ultimate pH were not affected by the inclination of the pasture, which translates into equivalent payments to the farmer for S-calves as for F-calves. Regarding meat quality, the inclination of the pasture had an effect in a muscle-dependent way, as was also observed by Vestergaard *et al.* (2000), although the latter could not differentiate the effect of activity from that of the diet. In cattle, LD and BF muscles differ regarding their position and, consequently, their function and metabolism. The LD muscle, located on the back, is rather a posture muscle whereas the BF muscle, located in the upper part of the hind leg, is rather a propulsion muscle. Talmant and Monin (1986) found the BF muscle had a lower glycolytic activity and a higher oxidative activity than the LD muscle, although results may vary from one study to another. The LD muscle, in contrast to the BF muscle, tended to be influenced by pasture inclination in its colour being brighter in the S-calves. Based on the results of Vestergaard *et al.* (2000), this colour difference could be related to a more glycolytic metabolism in S-calves than in F-calves. In turn, the BF muscle, in contrast to the LD muscle, was influenced by pasture inclination in its shear force. The

BF of the S-calves had lower shear force values, indicating higher meat tenderness. This characteristic could be related to several determinants, including muscle fibre type and diameter (Maltin *et al.*, 1997; Maltin *et al.*, 2003) which remain to be analysed.

V – Conclusions

Steep slopes are a typical feature of alpine pastures. Pasture inclination impaired daily gains but this without influence on final live weight and carcass characteristics in the present experimental conditions. Pasture inclination also had an influence on meat tenderness and colour depending on the metabolism and the function of the muscle from which the meat originated. Accordingly, when aiming at a more tender meat and a brighter meat colour, there could be an advantage in rearing fattening calves on steep alpine pastures rather than on flat pastures. Full understanding of the underlying mechanisms will need further analysis of muscle metabolic traits.

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