EFFECTS OF GRAZING ON THE PERFORMANCE AND BEHAVIOUR OF BEEF BULLS

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SUMMARY

We compared performance and behaviour of finishing Hereford bulls raised at pasture and in an uninsulated barn. Grazing led to leaner carcasses and improved the content of healthy fatty acids (e.g. CLA) in the meat, making the meat more compatible with consumer requirements. Differences in the time-budgets between the housing environments resulted mostly from the different feeding regimes and different space allowances. Stereotyped tongue-rolling was absent and there were no differences between the environments in time spent butting. This indicates that both housing environments were satisfactory in regard to the bulls' welfare. However, more synchronised behaviour in the pasture bulls indicates better opportunities for species-typical social behaviour at pasture.

Keywords: grazing, beef production, bulls, performance, fatty acids, behaviour

INTRODUCTION

The use of pasture for finishing bulls is not widespread in Finland because this practise has been attributed to poor growth performance of the bulls (Nisula and Hakkola 1979). However, pasture is one of the most effective diets for elevating conjugated linoleic acid (CLA) and polyunsaturated fatty acids (PUFA) content of both milk (Kelly et al. 1998) and meat (French et al. 2000). The interest in CLA research is associated to its positive effects on human cancer, cardiovascular disease, diabetes, body composition, lipid metabolism, immune system, bone health and oxidation (Scollan et al. 2006). From an animal's point of view, grazing could be commendable due to increased possibilities for behavioural freedom of the animals, especially because ethical concern over intensive animal production has increased (Sørensen et al. 2001). We investigated how grazing affects the performance, fatty acid composition of the meat, and behaviour of finishing Hereford bulls.

MATERIAL AND METHODS

The experiment was conducted at the North Ostrobothnia Research Station of MTT Agrifood Research Finland in Ruukki (64°44'N, 25°15'E). Twenty-nine Hereford bulls were used in the experiment. They were kept at pasture during their first summer 2004 and in an uninsulated barn during the following winter. At the beginning of June 2005, the bulls (average age 14 months and weight 528 kg) were assigned to six groups of 4–5 animals. Three groups of the bulls were moved to perennial timothy pastures. Each pasture group was rotationally grazed six paddocks (0.34 ha per paddock) with animals being moved to a new paddock on average once a week. Three groups of the bulls were housed in partly bedded pens (6.4–8.0 m^2/bull) in an uninsulated barn and fed grass silage *ad libitum*. Both pasture and barn bulls got barley 4.4 kg DM per animal per day. There was 0.7–0.9 m and 0.5 m feeding space per bull at the feeding trough in the barn and at pasture, respectively.

The behaviour of both barn and pasture bulls was observed directly for 24 hours in both June and July using instantaneous sampling method with a 6-min sampling interval. Observations of June and July were pooled for housing environments prior to analysis. The percentages of the observations spent on different behavioural patterns were tested with a linear mixed model. In the model, the housing environment was included as a fixed effect and the group in the housing environment as a random effect. If the residuals of the variables were not normally distributed, the variables (x) were transformed with a formula ln (x + 1). Synchronisation of the lying and feeding behaviour was tested with χ^2 –test.

Grazing season extended 62 days (1.6.–1.8.2005) and after that both pasture and barn bulls were slaughtered. The live weight gain (LWG) was calculated as the difference between the means of initial and final live weights (LW). The carcasses were scored for conformation (scale from 1 to 15) and fat cover (scale from 1 to 5) using the EUROP quality classification. Fatty acid composition of the meat was measured from *Longissimus dorsi* muscle by gas chromatographic analysis (Metcalfe and Schmitz 1961, Hara and Radin 1978). Animal performance data was subjected to analysis of variance using general linear models procedure.

RESULTS AND DISCUSSION

Live weight data of the bulls before and during the grazing season are shown in Figure 1. There was no significant difference (P>0.05) in the LWG (average 1529 g/d) between the barn and pasture bulls during the grazing season. There were no significant effects (P>0.05) of housing environment on the carcass weight (average 337 kg) and carcass conformation score (6.5). The carcass fat score of the barn bulls was higher than that of the pasture bulls (2.9 *vs*. 3.3, P<0.05). Leaner carcasses of the pasture bulls probably resulted from locomotion in a large living space (see Table 2), and occasionally rather low sward herbage mass.

The proportion of *cis-9, trans-11* CLA, 18:2 *n*-6 (linoleic acid) and 18:3 *n*-3 (α-linolenic acid) fatty acids in *Longissimus dorsi* muscle were higher in the pasture bulls than in the barn bulls (Table 1). In addition, compared to barn-housing, grazing increased proportion of 18:1 *n*-7 fatty acid and decreased proportion of 14:1 *n*-5 and 16:0 fatty acids. Also French et al. (2000) and Realini et al. (2004) have reported that grazing increases the CLA content of beef. However, according to Nuernberg et al. (2002) grazing has no effect on the CLA content of beef when grazing was compared to concentrate feeding in Simmental bulls and Holstein steers.

Table 1. Fatty acid profiles (g/kg of total fatty acids) (mean ± SD) in Longissimus *dorsi* muscle of Hereford bulls housed in barn and at pasture.

Fatty acid	Barn	Pasture	Effect
14:0	22.2 ± 7.5	19.5 ± 4.2	
14:1 *n*-5	1.3 ± 1.9	0.1 ± 0.5	*
15:0	0.0 ± 0.0	0.0 ± 0.0	
16:0	214.0 ± 16.1	201.1 ± 11.8	*
16:1 *n*-7	28.4 ± 7.4	25.3 ± 5.7	
17:0	9.4 ± 2.0	10.2 ± 2.0	
17:1	6.6 ± 0.7	6.6 ± 1.0	
18:0	179.3 ± 22.2	187.4 ± 22.0	
18:1 *n*-7	15.7 ± 1.5	18.0 ± 1.8	***
18:1 *n*-9	346.1 ± 20.1	340.6 ± 16.0	
18:2 *n*-6	68.8 ± 20.1	84.4 ± 16.7	*
18:2 *cis-9, trans-11* CLA	2.8 ± 0.9	4.2 ± 1.5	**
18:3 *n*-3	15.3 ± 3.3	20.0 ± 3.7	**
20:0	1.1 ± 0.4	1.1 ± 0.6	
20:1 *n*-9	0.5 ± 0.4	0.6 ± 0.6	
20:2 *n*-6	2.5 ± 0.8	2.5 ± 0.8	
20:3	3.8 ± 1.4	3.9 ± 1.3	
20:4 *n*-6	27.8 ± 14.0	26.9 ± 7.7	
20:5 *n*-3	5.9 ± 3.9	7.5 ± 2.4	
22:5 *n*-3	10.5 ± 4.7	10.5 ± 2.8	
Unidentified fatty acids	37.8 ± 11.6	29.5 ± 9.8	*
SFA [1]	425.9 ± 42.8	419.4 ± 31.5	
MUFA [2]	398.9 ± 21.0	391.3 ± 21.4	
PUFA [3]	137.4 ± 4.5	159.8 ± 31.7	

[1] Saturated fatty acids, [2] Monounsaturated fatty acids, [3] Polyunsaturated fatty acids.
* P<0.05; ** P<0.01; *** P<0.001.

The barn bulls ruminated more than the pasture bulls (Table 2). According to Kaustell et al. (1995), time spent ruminating and chewing increases in dairy cows as digestibility of silage decreases and fibre content increases. In our study, the neutral detergent fibre (NDF) content of silage that was offered to the barn bulls was higher (508 g/kg DM) and *in vitro* digestibility was lower (710 g/kg DM), than corresponding values of grazed grass (NDF 479 g/kg DM; *in vitro* digestibility 730 g/kg DM). This explains the higher ruminating time in barn bulls compared to the pasture bulls. The higher proportion of walking in the pasture bulls compared to the barn bulls was probably a natural consequence of the larger living area in the pasture. Walking during grazing was not taken into account in our study, and therefore the pasture bulls were actually moving even more than current results indicate. Increased energetic demand of locomotion may be partially responsible for the leaner carcasses of the pasture bulls compared to the barn bulls. Stereotyped behaviour such as tongue-rolling was not observed in either of the housing environment.

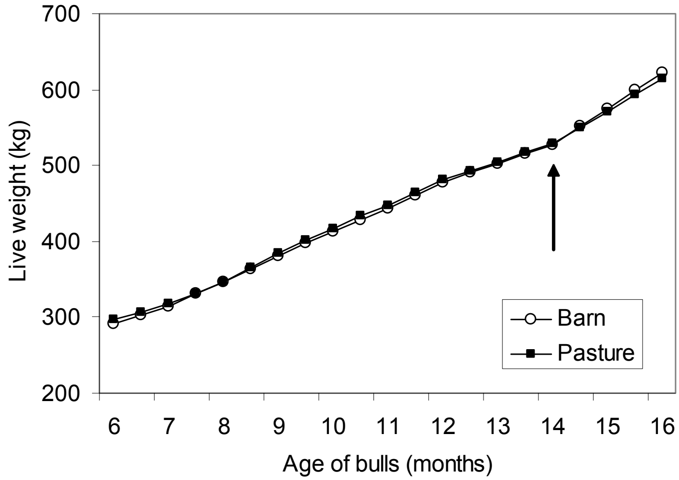

Figure 1. Live weight development of Hereford bulls housed in the barn and at pasture. The arrow indicates turnout to grazing of the pasture bulls.

Table 2. Percentage of observations (mean of observations ± SD) spent on different behavioural patterns in bulls housed in barn and at pastures.

Behaviour	Barn	Pasture	Effect
Eating silage or barley at the feeding trough	11.5 ± 1.9	3.0 ± 0.8	***
Grazing	–	18.0 ± 2.7	–
Ruminating	33.9 ± 1.4	26.6 ± 3.3	**
Manipulating objects with mouth or tongue	0.23 ± 0.22	0.12 ± 0.17	
Drinking	0.70 ± 0.42	0.28 ± 0.31	
Walking excluding walking during grazing [1]	0.63 ± 0.29	3.2 ± 0.9	**
Self-grooming [1]	3.3 ± 1.7	1.8 ± 0.9	
Social licking	1.4 ± 0.5	0.60 ± 0.37	*
Butting [1]	2.2 ± 1.0	3.6 ± 2.1	
Lying inactive or resting	32.0 ± 3.9	28.5 ± 3.1	
Tongue-rolling	0.0 ± 0.0	0.0 ± 0.0	
Other behaviours e.g. idling in standing position	14.1 ± 3.1	14.6 ± 2.8	

[1] P–values are based on comparisons of estimated marginal means of ln (x + 1) transformed variable.
* P<0.05; ** P<0.01; *** P<0.001.

Lying behaviour was more synchronised in the pasture than in the barn bulls. All bulls within a group were observed to lie simultaneously more often at pasture (63.9% of lying observations, mean of June and July, $\chi^2 = 150.7$, df = 1, P<0.001) than in the barn (37.3%). Also cows lay simultaneously more often in pasture than inside cubicle house (O'Connell et al. 1989, Miller & Wood-Gush 1991). Mogensen et al. (1997) and Nielsen et al. (1997) have found that synchrony of lying decreases as space allowance decreases. Therefore, space allowance seems to have an important impact on the synchrony of lying. In our study, the pasture bulls had ample space, whereas the barn bulls had only 3.2–4.0 m^2 bedded lying area per bull. This probably led the barn bulls to lie in less synchronised fashion than the pasture bulls.

Feeding behaviour was also more synchronised in the pasture than in the barn bulls. All bulls within the group were observed to eat silage or barley or graze simultaneously more often at pasture (16.8% of feeding observations, mean of June and July, $\chi^2 = 67.5$, df = 1, P<0.001) than in the barn (1.6%). The bulls ate alone more often in the barn (66.8% of feeding observations, $\chi^2 = 114.1$, df = 1, P<0.001) than ate or grazed at pasture (33.2%). Also Cozzi and Gottardo (2005) have found that pen-reared bulls with 95 cm feeding space per bull eat mostly alone or in pairs. Miller and Wood-Gush (1991) have suggested that the cause for unsynchronised behaviour in housed cattle is competition for resources that could lead to the animals feeding and resting at different times to avoid excessive aggression.

CONCLUSIONS

Leaner carcasses of the pasture bulls probably resulted from locomotion in a large living area, and occasionally rather low sward herbage mass. Grazing improved the content of healthy fatty acids in the meat of the pasture bulls. Behavioural study revealed some differences in time-budgets between the housing environments, which probably resulted mostly from the different feeding regimes and different space allowances. Stereotyped tongue-rolling was absent in both environment and there were no differences between the environments in time spent butting. This indicates that both housing environments were satisfactory in regard to the bulls' welfare. However, more synchronised behaviour in the pasture bulls indicates better opportunities for species-typical social behaviour at pasture.

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