PERFORMANCE AND BEHAVIOUR OF DAIRY BULLS RAISED AT PASTURE AND IN AN UNINSULATED BARN

Tuomisto, L.[1], Huuskonen, A.[1], Jansson, S.[1], Martiskainen, P.[2], Ahola, L.[2] and Kauppinen, R.[3]

[1] *MTT Agrifood Research Finland, Animal Production Research, FIN-92400 Ruukki, Finland;*
[2] *Department of Biosciences, University of Kuopio, P.O.Box 1627, FIN-70211 Kuopio, Finland;*
[3] *Savonia University of Applied Science, P.O.Box 72, FIN-74101 Iisalmi, Finland*

SUMMARY

We compared performance, fatty acid profile of the meat, and behaviour of finishing dairy bulls raised at pasture and in an uninsulated barn. Grazing had no significant effect on the live weight gain, carcass conformation score or carcass fat score of the bulls. However, grazing improved polyunsaturated and saturated fatty acid ratio of the meat. Differences in the distribution of behaviours between the housing environments resulted mostly from the different feeding regimes and different space allowances. Stereotyped tongue-rolling was almost 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.

Keywords: beef production, dairy bulls, grazing, growth, fatty acid profile, behaviour

INTRODUCTION

In countries with long grazing season steers are commonly grazed in extensive beef production systems (e.g. Rueda et al. 2003). In Finland, grazing is strongly restricted by a short growing season and use of uncastrated animals. Grazing bulls is unusual because the bulls are considered as restless grazers and they may have impaired growth at pasture (Nisula and Hakkola 1979). However, grazing may have positive effects on meat quality and on the behaviour of bulls. We compared performance, fatty acid composition of the meat, and behaviour of finishing dairy bulls at pasture and in an uninsulated barn.

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). Nineteen Finnish Ayrshire and Friesian bulls were used in the experiment. All animals were purchased as calves from local dairy farms in the spring 2003. They were kept at pasture (pasture bulls, see further) or in an uninsulated barn (barn bulls) during their first summer and in the uninsulated barn during the following winter. At the beginning of June 2004, the bulls (average age 15 months and weight 552 kg) were assigned to four groups of 4–5 animals. Two groups of bulls were housed in partly bedded pens (6.4 m^2/bull) in the uninsulated barn and fed grass silage *ad libitum*. Two groups of bulls were turned to pasture. Both pasture groups were rotationally grazed on three perennial (timothy) and two annual (oat and Italian rye-grass mixture) paddocks (0.5 ha per paddock) with animals being moved to a new paddock on average once a week. Both pasture and barn bulls got barley 4.4 kg DM per animal per day. There was 0.7 m and 0.5–0.6 m feeding space per bull at the feeding trough in the barn and at pasture, respectively.

The behaviour of the bulls was observed for 24 hours in both June and July using instantaneous sampling method with a 6-min sampling interval. The pasture bulls were observed directly from an observation tower and the barn bulls were video recorded using a time-lapse video recorder. During both observations, the pasture bulls were at annual oat and Italian rye-grass mixture paddocks. The percentages of the observations spent on different behavioural patterns were tested with a linear mixed model. In the model, the housing environment and the month of summer were included as fixed effects and the group in the housing environment and the animal as random effects.

Grazing season extended 77 days (8.6.–23.8.2004) 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 classified 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 gaschromatographic 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 890 g/d) between the barn and pasture bulls during the grazing season. However, during the first grazing weeks, pasture bulls lost a considerable amount of weight (Figure 1). Similar live weight losses have been reported also for steers at the beginning of the grazing season (McCarrick and Drennan 1972, Scollan et al. 2001). Tayler et al. (1957) have showed that most of this kind of weight loss is gut fill, associated with changes in diet digestibility and intakes.

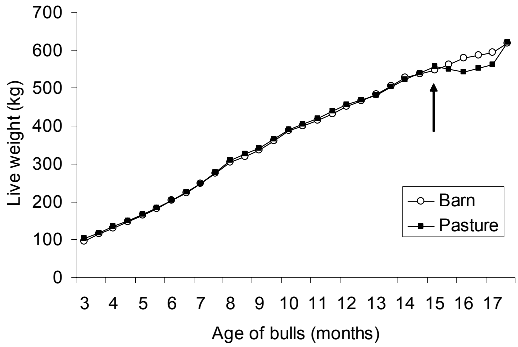

Figure 1. Live weights of dairy bulls housed in the barn and at pasture. The arrow indicates turnout to grazing of the pasture bulls.

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

Fatty acid	Barn	Pasture	Effect
14:0	22.6 ± 6.1	16.3 ± 2.9	*
14:1 *n*-5	4.7 ± 2.5	3.0 ± 0.8	
15:0	2.0 ± 0.4	1.7 ± 0.4	
16:0	238.0 ± 8.5	227.9 ± 11.2	*
16:1 *n*-7	31.3 ± 9.7	25.3 ± 11.2	
17:0	6.9 ± 0.9	6.0 ± 1.4	
17:1	5.1 ± 1.0	4.3 ± 1.2	
18:0	160.5 ± 9.0	153.0 ± 21.2	
18:1 *n*-7	14.0 ± 1.5	16.2 ± 2.1	*
18:1 *n*-9	424.0 ± 23.0	423.4 ± 18.7	
18:2 *n*-6	39.6 ± 12.3	59.7 ± 19.1	*
18:2 *cis-9, trans-11* CLA	1.1 ± 0.4	1.2 ± 0.6	
18:3 *n*-3	6.9 ± 1.6	7.8 ± 2.1	
20:0	0.8 ± 0.2	0.7 ± 0.2	
20:1 *n*-9	1.8 ± 1.0	1.8 ± 0.7	
20:2 *n*-6	0.2 ± 0.5	0.0 ± 0.0	
20:4 *n*-6	9.0 ± 3.5	15.6 ± 7.6	*
20:5 *n*-3	0.5 ± 0.5	1.3 ± 1.0	*
22:5 *n*-3	1.5 ± 0.8	2.8 ± 1.9	
Unidentified fatty acids	29.7 ± 5.5	31.8 ± 4.8	
SFA [1]	430.7 ± 12.8	405.6 ± 28.2	*
MUFA [2]	481.0 ± 22.6	474.2 ± 23.8	
PUFA [3]	58.6 ± 16.6	88.4 ± 30.6	*

[1] Saturated fatty acids; [2] monounsaturated fatty acids; [3] polyunsaturated fatty acids.
* $P<0.05$.

There were no significant effects ($P>0.05$) of housing environment on the carcass weight (average 329 kg), carcass conformation score (4.8) or carcass fat score (2.1). Compared to barn-housing, grazing increased proportion of 18:1 *n*-7, 18:2 *n*-6, 20:4 *n*-6 and 20:5 *n*-3 fatty acids and decreased proportion of 14:0 and 16:0 fatty acids in *Longissimus dorsi* muscle (Table 1). There were no significant differences between the barn and pasture bulls in the content of *cis-9, trans-11* CLA in the meat. However, there was a higher content of polyunsaturated fatty acids (PUFA) and lower content of saturated fatty acids in the meat of the pasture bulls than of the barn bulls. Also according to French et al. (2000) grazed grass was an effective diet for elevating PUFA content of meat.

Due to the different feeding regimes the barn bulls were observed to spend more time eating at the feeding trough than the pasture bulls in June and July (Table 2). Only barley was offered in the feeding trough to the pasture bulls, and, consequently, they spent a lot of time foraging grass in the paddocks. Pasture bulls were observed grazing and ruminating less in June than in July. Possibly, as the summer advanced the increase in fibre content and decrease in digestibility of the oat and Italian rye-grass mixture affected the time spent grazing and ruminating in the pasture bulls.

There was no difference between the groups in time spent licking and biting (manipulating) objects and structures of the environment (Table 2). In our study, this behaviour seemed to be mostly normal investigative behaviour, since it had only little or none stereotyped features. There was no difference in self-grooming between the groups. 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 the current results indicate. Daily exercise promotes health and agility in tethered cows (Gustafson 1993, Gustafson and Lund-Magnussen 1996), and it is reasonable to assume that exercise has positive effects also on the health of bulls.

Table 2. Percentage of observations (mean ± SD) spent on different behavioural patterns in June and July in bulls housed in barn and at pasture. P1: significance between housing environments, P2: significance within housing environments between months, P3 significance of interactive effect of housing environment and month.

		Barn	Pasture	P1
Eating silage or barley at the feeding trough	June	11.4 ± 2.0	2.3 ± 0.6	***
	July	11.7 ± 2.7	2.1 ± 1.1	***
	P2			P3
Grazing	June	–	13.8 ± 3.7	–
	July	–	15.9 ± 4.5	–
	P2		*	–
Ruminating	June	33.9 ± 3.5	22.7 ± 5.3	***
	July	33.7 ± 2.7	30.6 ± 5.2	
	P2		**	P3 **
Manipulating objects with mouth or tongue	June	1.5 ± 1.8	0.44 ± 0.43	
	July	1.9 ± 1.3	0.19 ± 0.31	
	P2			P3
Self-grooming	June	2.1 ± 0.8	1.9 ± 1.7	
	July	2.3 ± 1.1	2.8 ± 2.3	
	P2			P3
Walking excluding walking during grazing	June	1.4 ± 0.6	2.5 ± 0.7	**
	July	1.5 ± 0.8	3.0 ± 0.8	***
	P2			P3
Social licking	June	2.4 ± 1.0	2.3 ± 1.3	
	July	1.3 ± 0.9	1.2 ± 1.3	
	P2	*		P3
Butting	June	4.0 ± 1.6	4.5 ± 1.6	
	July	3.6 ± 2.4	3.7 ± 1.5	
	P2			P3
Lying inactive or resting	June	28.2 ± 5.2	32.6 ± 5.9	
	July	27.7 ± 4.5	29.2 ± 4.5	
	P2			P3
Tongue-rolling	June	0.21 ± 0.30	0.0 ± 0.0	[2]
	July	0.08 ± 0.18	0.0 ± 0.0	[2]
	P2	[3]	[3]	–
Other behaviours e.g. idling in standing position	June	15.5 ± 3.6	17.3 ± 6.4	
	July	16.6 ± 3.4	11.7 ± 5.4	
	P2		***	P3 **

Since the residuals of the variable tongue-rolling were not normally distributed, the variable was tested with nonparametric testes: [2]Mann-Whitney test; [3]Wilcoxon test.
* $P<0.05$; ** $P<0.01$; *** $P<0.001$.

Social behaviour was very similar in the barn and pasture bulls and there were no differences in social licking or butting between the groups (Table 2). This result is contradictory with other studies where a decrease in the space allowance has increased agonistic interactions in female cattle and steers (Kondo et al. 1989), and accordingly, in cows, agonistic interactions have been observed more inside cubicle houses than at pasture (O'Connell et al. 1989). Bull calves are socially more active than female calves (Reinhardt et al. 1978), and since the animals were quite young in our study, bulls' keenness for social contact may explain similar proportions of butting found in the barn and the pasture bulls. Furthermore, in both groups butting behaviour seemed to be mostly fairly harmless and often resembled mock fighting (see Reinhardt and Reinhardt 1982).

There were no differences in time spent on resting or performing other behaviours (e.g. idling in standing position) between the barn and pasture bulls (Table 2). Stereotyped tongue-rolling was very rarely observed in the bulls. Stereotyped behaviour in cattle is often associated with long-lasting frustrating situations such as restricted feeding (Redbo and Nordblad 1997) or tethering (Redbo 1992). Accordingly, this may suggest that in our study, the barn and pasture bulls were not subjected to strong long-lasting frustration, since stereotyped tongue-rolling and other stereotypies were almost absent.

CONCLUSIONS

Grazing had no effect on animal performance or carcass conformation but it improved polyunsaturated and saturated fatty acid ratio of the meat, and made it more compatible with consumer requirements. Differences in the distribution of behaviours between the housing environments resulted mostly from the different feeding regimes and different space allowances. Stereotyped tongue-rolling was almost 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.

REFERENCES

1. French, P., Standford, C., Lawless, F., O'Riordan, E.G., Monahan, F.J., Caffrey, P.J., Moloney, A.P. 2000. Fatty acid composition, including conjugated linoleic acid, of intramuscular fat from steers offered grazed grass, grass silage, or concentrate-based diets. J. Anim. Sci. 78: 2849–2855.
2. Gustafson, G.M. 1993. Effect of daily exercise on the health of tied dairy cows. Prev. Vet. Med. 17: 209–223.
3. Gustafson, G.M., Lund-Magnussen, E. 1996. Effect of daily exercise on the getting up and lying down behaviour of tied dairy cows. Prev. Vet. Med. 25: 27–36.
4. Hara, A., Radin, N.S. 1978. Lipid extraction of tissues with a low-toxicity solvent. Anal. Biochem. 50: 420–426.
5. Kondo, S., Sekine, J., Okubo, M., Asahida, Y. 1989. The effect of group size and space allowance on the agonistic and spacing behavior of cattle. Appl. Anim. Behav. Sci. 24: 127–135.
6. McCarrick, R.B., Drennan, M.J. 1972. Effect of winter environment on growth of young beef cattle. Anim. Prod. 14: 107–110.
7. Metcalfe, L.D., Schmitz, A.A. 1961. The rapid preparation of fatty acid esters for gaschromatographic analysis. Anal. Chem. 33: 363–364.

8. Nisula, H., Hakkola, H. 1979. Lihanautojen määrän vaikutus laitumen satoon. Kehittyvä Maatalous 42: 12–22.
9. O'Connell, J., Giller, P.S., Meaney, W. 1989. A comparison of dairy cattle behavioural patterns at pasture and during confinement. Ir. J. Agric. Res. 28: 65–72.
10. Redbo, I. 1992. The influence of restraint on the occurrence of oral stereotypes in dairy cows. Appl. Anim. Behav. Sci. 35: 115–123.
11. Redbo, I., Nordblad, A. 1997. Stereotypes in heifers are affected by feeding regime. Appl. Anim. Behav. Sci. 53: 193–202.
12. Reinhardt, V., Reinhardt, A. 1982. Mock fighting in cattle. Behaviour 81: 1–13.
13. Reinhardt, V., Mutiso, F.M., Reinhardt, A. 1978. Social behaviour and social relationships between female and male prepubertal bovine calves (Bos indicus). Appl. Anim. Ethol. 4: 43–54.
14. Rueda, B.L., Blake, R.W., Nicholson, C.F., Fox, D.G., Tedeschi, L.O., Pell, A N., Fernandes, E.C.M., Valentim, J.F., Carneiro, J.C. 2003. Production and economic potentials of cattle in pasture-based systems of the western Amazon region of Brazil. J. Anim. Sci. 81: 2923–2937.
15. Scollan, N.D., Sargeant, A., McAllan, A.B., Dhanoa, M.S. 2001. Protein supplementation of grass silages of differing digestibility for growing steers. J. Agr. Sci. Camb. 136: 89–98.
16. Tayler, J.C., Alder, F.E., Rudman, J.E. 1957. Fill and carcass changes of yard-fed and overwintered beef cattle turned out on to spring pasture. Nature 179: 197–198.