THE EFFECT OF FEEDING REGIME ON EARLY *POST MORTEM* BIOCHEMICAL INDICATORS OF BEEF QUALITY

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Background

Hofmann (1987), has defined meat quality as the sum of all sensory, nutritional, hygienic, toxicological and technological properties of meat. Nutritional status has a major impact on the rate of muscle protein turnover (Millward *et al.*, 1975). Jones *et al.* (1990) observed that myofibrillar degradation and synthesis decreased during the restriction period and increased following subsequent repletion. It has been suggested that growth rate of cattle before slaughter affects meat palatability, particularly tenderness, and that rapid growth rate may be a more important determinant of tenderness than the length of time that cattle are fed a high energy diet (Aberle *et al.*, 1981). Cattle growing rapidly prior to slaughter have been reported to produce more tender meat (Devine *et al.*, 1993; Vestergaard *et al.*, 2000). This has been attributed to increased protein turnover resulting in a higher concentration of proteolytic enzymes in the tissue at slaughter (Wood *et al.*, 1996). However, the variability in product is still considerable despite these procedures (Valin, 1995). Pre-slaughter factors such as feeding regimes may help to reduce this variability in quality because they may be effective in a more uniform manner than treatments in the carcass (*e.g.* aitch bone hanging, electrical stimulation).

Objectives

The purpose of our study was to determine the effect of feeding systems as they relate to beef quality parameters, and to examine whether optimised feeding regimes contribute to the production and processing of consistently good quality beef in terms of tenderness, flavour, colour and palatability. As texture is generally considered a major attribute of meat quality (Wood *et al.*, 1996) this quality trait and its biochemical parameters received special attention. In addition colour, flavour and juiciness were recorded.

Methods

Holstein Friesian cross steers (n=47) of similar weight and age, were assigned to one of 4 treatment groups in a randomised block bodyweight (BW) design for a period of 16 weeks. They were in the live-weight range 390 to 420 kg and were 1.5 years old. Sufficient concentrates of sugar beet pulp, beans, standard mixture of vitamins, fat and hay (100 g/kg total diet) were offered to all animals. To achieve the following target growth rates, supply patterns were imposed to each group: *Treatment 1:* 16 weeks with 0.72 kg gain in weight per day; *Treatment 2:* Low level of concentrates for the first 8 weeks (0.336 kg gain per day) with a week of transition to a high level for the remaining 7 weeks (1.08 kg gain in weight per day); *Treatment 3:* High level of concentrates for the first 7 weeks with a week of transition to a low level for the 8 weeks prior to slaughter; *Treatment 4:* Low level of concentrates for the first 2 weeks, followed by 11 weeks of 0.72 kg gain in weight per day, then a week of transition followed by 2 weeks of high level of concentrates.

The animals were slaughtered and hung conventionally. The right hand side longissimus muscles (randomly lumbar or thoracic region) were used for all measurements and sampling. Colour measurements were carried out according to the procedure of Strange *et al.* (1974). The redness (Hunter a values), the yellowness (Hunter b values) and the lightness (Hunter L values) of each sample were measured using a Hunter lab Ultra Scan XE colorimeter with Universal Software Version 2.2.2. Warner Bratzler shear force (WBSF) measurements were carried out according to the procedure of Shackelford *et al.* (1991). An Instron Universal testing machine equipped with a Warner Bratzler shearing device was employed and results were expressed as load in kilograms (kg) per 1,25 cm ø core. Seven peak values for each steak (*i.e.* 7 cores) were recorded. Sensory analysis was performed by an eight member trained panel on steaks grilled to an internal temperature of 70 °C (AMSA 1978). Trained panellists were offered grilled steaks and were asked to assess the following attributes: tenderness, juiciness, overall flavour, overall firmness, residual chewiness, overall texture, overall acceptability. The enzymes calpain I, II and their inhibitor calpastatin were extracted according to the procedure of Beltrán *et al.* (1997). Chromatographic separation was carried out in a two-step procedure using FPLC (Fast Performance Liquid Chromatography). The levels of calpain I, II and calpastatin activity were determined according to the procedure by Iversen *et al.* (1993).

Analysis at variance was done for the 4 treatments. Means and standard deviations were used to calculate correlations between meat quality attributes by using SPSS procedures.

Results and discussion

Table 1 includes the average Hunter L (lightness), a (redness) and b (yellowness) values obtained for the energy-level diet samples at 14 days *post mortem*. Diets 2 and 3 rendered slightly higher L values indicating a lighter colour, and lower a values, indicating less redness than other diet samples. In accordance with drip loss values (data not shown), samples of diets 1 and 4 had lower L values (indicating meat samples were darker) and higher a and b values (indicating greater redness and yellowness). However, these differences were not significant, ($p>0.05$). The changes in peak shear force values for the energy level diets are shown in Table 1. Shear force, decreased clearly over the ageing period, which is consistent with findings of Koohmaraie (1988). Shear force values in all treatment groups were similar ($p>0.05$). Panel evaluation of tenderness corresponded with those obtained by WBSF. While regardless of diet, all animals showed increase in tenderness in the course of ageing at 14 days *post mortem*, meat of animals on diet 1 was significantly more tender ($p<0.05$) than meat of animals on diets 2 and 3 (Table 2). Flavour scores of meat of animals on diet 1 differed significantly ($p<0.001$) from diet 4. Chewiness and overall acceptability scores of diet 1 meat differed significantly from diets 2 and 4 and diets 2 and 3, respectively. Results indicate that a continuous energy level feeding is most advantageous for tender meat.

In contrast to findings of other authors (Moody 1976, Vestergaard et al. 2000), the effects of feeding system on meat quality characteristics were not evident in our study. The mean levels of calpain I, II and calpastatin activity for longissimus muscle samples, taken at 3 h and 24 h *post mortem* are shown in Table 3. The levels of calpain I and II decreased over time, while calpastatin levels increased and enzyme activity in all 4 diet groups was similar. The large variation in enzyme activities may be due to a natural animal effect (Valin, 1995; his Fig. 1). Although at 3h *post mortem* calpain I activity in diet 1 differed significantly ($p<0.05$) from diets 2 and 4, this was not reflected in different tenderness values.

Conclusion

The data do not support the hypothesis that pre-slaughter growth rate increases tenderness. However, higher rates of protein turnover may affect muscle composition (Moloney, 2000).

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Table 1: *Influence of energy-level diets on colour at 14 days* post mortem *[mean L (lightness), a (yellowness) and b (redness) values], and mean WB shear force (in kg) at 2, 7 and 14 days* post mortem *of bovine longissimus muscle*

		Diet 1	Diet 2	Diet 3	Diet 4
Colour	**L 14d**	36,3	37,4	37,2	36,5
	a 14d	15,3	15,4	15,6	15,9
	b 14d	9	9,2	9,3	9,2
WBSF	**2d**	6,3	7,4	6,2	6,8
	7d	4,2	5,4	4,5	4,6
	14d	3,9	4,5	4,3	3,8

None of the values differed significantly ($p>0.05$)

Table 2: *Mean palatability scores from sensory analysis at 2, 7 and 14 days* post mortem *of bovine longissimus muscle. In rows, figures with superscripts not containing a common letter differ significantly, ($p<0.05$)*

		Diet 1	Diet 2	Diet 3	Diet 4
Tenderness	**2d**	3,6	3,6	4,5	4
1= extremely tough	**7d**	5,4	5,0	5,4	5,1
8= extremely tender	**14d**	6^{x}	$4,9^{y}$	$5,3^{y}$	$5,3^{xy}$
Juiciness	**2d**	5,2	4,6	5,2	5,1
1= extremely dry	**7d**	4,7	5,2	4,8	4,3
8= extremely juicy	**14d**	5,2	5	5	4,9
Overall flavour	**2d**	3,7	3,7	3,8	3,7
1= very poor	**7d**	3,9	4	3,8	4
6= extremely good	**14d**	$3,8^{xy}$	$3,8^{x}$	$3,5^{xy}$	4^{y}
Chewiness	**2d**	4,2	4,3	3,7	4
1= extremely chewy	**7d**	3,1	3,4	3	3,3
6= not chewy	**14d**	$2,7^{x}$	$3,4^{y}$	3^{xy}	$3,1^{y}$
Overall acceptability	**2d**	2,9	2,9	3,2	2,7
1= extremely acceptable	**7d**	3,7	3,5	3,6	3,5
6= not acceptable	**14d**	$3,9^{x}$	$3,5^{y}$	$3,5^{y}$	$3,7^{xy}$

Table 3: *Mean calpain I, II and calpastatin units of activity ($kg^{-1}\ h^{-1}$) of bovine longissimus muscle at 2, 7 and 14 days* post mortem. *In rows (per time of assessment), figures with superscripts not containing a common letter differ significantly, ($p<0.05$)*

	Diet 1		Diet 2		Diet 3		Diet 4	
	3 h	**24 h**	**3 h**	**24 h**	**3 h**	**24 h**	**3 h**	**24 h**
Calpain I	355^{x}	182	223^{y}	91	225^{xy}	281	167^{y}	147
Calpain II	1044	319	927	274	785	448	926	193
Calpastatin	16845	14914	7393	11473	11170	1284	7399	9526