MANIPULATION OF LEAN DEPOSITION IN FORAGE-FED CATTLE

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Introduction

Forage-fed cattle often exhibit poor growth responses but with a high ratio of fat to protein in the carcass. Nutritional manipulation or modification of the animal's hormonal status can effect improvements but the predictability of the response is poor and the mechanisms require further elucidation.

Materials and Methods

In experiment one, 24 Friesian steers (12 weeks old) were offered grass silage alone or supplemented with fishmeal (150 g/kg silage dry matter (DM)). Half the animals in the fishmeal group were ear-implanted with oestradiol (Compudose 365) and half the animals on silage alone were administered the beta-agonist cimaterol via osmotic minipumps (0.06 mg/kg liveweight/day). Half the control animals were sham implanted with osmotic minipumps. The silage had 244 g DM/kg fresh weight, 26.1 g N/kg DM, 106 g NH_3-N/kg total N and pH 4.0. After 10 weeks the animals were slaughtered and the L.dorsi and Semitendinosus muscles were dissected. Collagen content was estimated from muscle hydroxyproline and heat-soluble collagen as that soluble after heating at 77°C for 60 minutes.

In experiment 2, similar steers were offered grass silage either alone (n=12) or supplemented with fishmeal (n=6) as above. Six of the animals offered silage alone were administered cimaterol, also as above. Treatments lasted for 6 weeks after which blood samples were taken over 48 hours. The silage had 222 g DM/kg fresh weight, 24.3 gN/kg DM, 179 g NH_3-N/kg total N and pH 3.8. Samples of subcutaneous adipose tissue from the brisket region were removed at slaughter and pieces incubated with (1-^{14}C)-acetate to assess lipid biosynthesis in the presence (+) and absence (−) of insulin. Glycerol release indicated lipolytic rate in the presence (+) and absence (−) of adrenalin.

Results and Discussion

Liveweight gain, muscle weights and protein content increased with fishmeal and oestradiol (table 1). Cimaterol had no effect on growth rate but significantly increased the weight and protein content of the L.dorsi. No significant myotrophic response was seen in the Semitendinosus although the total collagen content of this muscle was reduced by cimaterol treatment, indicating some influence of this agent on this muscle. Fishmeal and oestradiol also reduced total collagen in the Semitendinosus suggesting a reduction in total connective tissue. The percentage of heat-soluble collagen (which may affect meat tenderness) was significantly reduced by cimaterol and oestradiol treatments in the L.dorsi but significantly increased in the Semitendinosus by fishmeal. In both muscles intramuscular fat was unaffected by fishmeal and oestradiol treatments but significantly reduced by cimaterol. These data indicate that all muscles do not respond equally when total body lean is manipulated and in some cases, meat quality may be affected.

In experiment two, growth rates were lower due to the poorer quality of the silage (table 2). However fishmeal stimulated growth while cimaterol further suppressed growth. The reduction in growth rate of cimaterol-treated animals and the

TABLE 1. EFFECTS ON MUSCLE PROTEIN, COLLAGEN AND LIPID CONTENT

	Silage	Silage and Cimaterol	Silage and Fishmeal	Silage and Fishmeal and Oestradiol	Pooled SED (20 df)
Daily liveweight gain (g/d)	416	365	865***	1,146***	71.1
L. dorsi					
Protein content (g)	268	333*	377**	441***	32.1
Total collagen (mg/g fresh tissue)	17.90	14.97	17.32	16.58	1.940
% heat-soluble collagen	30.53	21.33*	26.19	16.71**	4.070
Intramuscular fat (g/kg dry matter)	53.6	38.0*	55.6	54.0	6.01
Semitendinosus					
Protein content (g)	101	108	142***	160***	9.88
Total collagen (mg/g fresh tissue)	15.87	12.47**	13.64*	13.39*	1.049
% heat-soluble collagen	10.72	9.34	14.40*	12.82	1.408
Intramuscular fat (g/kg dry matter)	70.0	33.8**	63.0	74.4	11.51

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

SED Standard Error of Difference between Means

TABLE 2. EFFECTS OF CIMATEROL OR FISH MEAL ON LIPID METABOLISM AND HORMONE CONCENTRATIONS

	Silage		Silage and Cimaterol		Silage and Fishmeal		Pooled SED (14 df)
Daily Liveweight Gain (g/d)	206		34*		606***		74.9
Adipocyte volume (pl)	218.8		167.9**		221.1		14.84
[1-^{14}C]-acetate incorporation (μmol/h/10^6 adipocytes)	− .150	+ .277	− .112	+ .203	− .235	+ .447	.0761

TABLE 2. EFFECTS OF CIMATEROL OR FISH MEAL ON LIPID METABOLISM AND HORMONE CONCENTRATIONS

	Silage		Silage and Cimaterol		Silage and Fishmeal		Pooled SED (14 df)
Glycerol release (μmol/h/10^6 adipocytes)	– .255	+ .634	– .137	+ .352	– .150	+ .753	.0705
Growth hormone (ng/ml)	3.76		4.15		3.95		.499
Free T3 (pg/ml)	3.75		3.18		5.58***		.322
Insulin (μU/ml)	4.61		3.24*		7.64***		.626

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$
SED Standard Error of Difference between Means

lack of any significant effect on lipid metabolism may have been associated with the cold weather (which may exacerbate heat loss due to the vasodilatory effect of β-agonists) and the poor quality silage. *In vitro* lipid biosynthesis was significantly higher in all three treatments in the presence of insulin, whilst adipocyte cell volume was significantly reduced by cimaterol. Fishmeal significantly increased free T3 and insulin concentrations while cimaterol caused a significant reduction in insulin, again implicating insulin status in the mode of action of cimaterol (see Buttery and Dawson, 1988). The data for the cimaterol treatments especially need to be viewed in the light of the poor growth rates obtained. In a subsequent study, where similar animals were fed an *ad libitum* diet of dried grass/barley either alone or with cimaterol included in the diet at 1.5 ppm (equivalent to approximately 0.04 mg/kg bodyweight/day), growth rates of 1057 g/day were observed in the cimaterol animals and 771 g/d in controls. These results confirm the importance of the interaction between diet and the response to manipulation of endocrine status (Gill et al., 1987).

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Literature Cited

Buttery, P.J. and J.M. Dawson, 1988. Growth promotion strategies in animal production; from effects on animals to effects on humans. Proc. Nutr. Soc. Aust. 13:9-20.

Gill, M., D.E. Beever, P.J. Buttery, P. England, M.J. Gibb and R.D. Baker. 1987. The effect of oestradiol-17b implantation on the response in voluntary intake, live-weight gain and body composition, to fishmeal supplementation of silage offered to growing calves, J. Agric. Sci. Camb., 108:9-16.