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Energy supply patterns for finishing steers: Feed conversion efficiency, components of bodyweight gain and meat quality

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Abstract

The objective was to determine the effect of pre-slaughter growth rate on feed efficiency, components of body growth and on the tenderness of *longissimus* muscle from steers reared to a common age and carcass weight. Sixty Friesian steers were group-housed and offered grass silage *ad libitum* and 3.5 kg concentrates per animal daily for 5 months and then 5 kg concentrates and 1 kg grass hay for 1 month before the experiment began. The animals were then weighed and in a randomised block were assigned to one of 5 groups, for slaughter at the beginning of the experiment or to be offered concentrates and hay (900 and 100 g/kg total diet, respectively) to achieve target growths of: 0.72 kg/day continuously for 17 weeks, 0.36 kg/day for the first 8 weeks and 1.08 kg/day for the final 8 weeks (low–high), 1.08 kg/day for the first 8 weeks and 0.36 for the final 8 weeks (high–low) or 0.36 kg/day for the first 2 weeks, 0.72 kg/day during weeks 4 and 14 and 1.08 kg/day for the final 2 weeks (pulse). One week was allowed for transition to the different dietary allowances within each energy supply pattern. The mean age at the beginning and end of the study was 18 and 22.5 months, respectively. After slaughter, the weight of the carcass and kidney + channel fat depot were recorded, the pistola hind quarter was dissected into fat, lean and bone and the tenderness of the *m. longissimus thoracis et lumborum* (LTM) muscle was measured instrumentally and using a trained taste panel after 2, 7 or 14 days ageing. The pattern of energy supply did not affect carcass weight, fat score or kidney + channel fat weight. The pistola hind quarter from animals offered the low–high energy pattern had a similar composition to the continuously-fed animals but contained more muscle than that from animals offered high–low or pulse energy patterns. After 14 days ageing, LTM from the continuously-fed animals was more tender than that from animals offered the other energy supply patterns but shear force did not differ between supply patterns. The data do not support the hypothesis that pre-slaughter growth rate increases tenderness but suggest that energy supply pattern can influence body composition of finishing cattle.

Keywords: Beef; Energy; Muscle growth; Tenderness; Calpains; Sensory analysis

1. Introduction

The sensory perception of tenderness is generally considered to be a major influence on consumer decisions to (re)-purchase beef (Grunert, Bredahl, & Bunsae, 2004). Much research effort has been directed at identifying influences on tenderness within beef production systems and the consensus is that post-slaughter management has a greater influence on tenderness, as experienced by the consumer, than pre-slaughter or "on-farm" factors (Owens & Gardiner, 1999; Thompson, 2002). Pre-slaughter growth rate is one "on-farm" factor that has been reported to influence beef tenderness (e.g. Aberle, Reeves, Judge, Hunsley, & Perry, 1981; May, Dolezal, Gill, Ray, & Buchanan,

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1992). The underlying basis for hypothesising a positive influence of pre-slaughter growth rate on tenderness is the relationship between nutrient consumption/growth rate and protein turnover. Thus, Jones, Starkey, Calkins, and Crouse (1990) observed that myofibrillar protein degradation and synthesis decreased in cattle during nutrient restriction but increased following nutrient repletion. It is assumed that the proteolytic systems involved in muscle accretion also operate *post-mortem* such that an increase in protein degradation during rapid growth will be reflected in an increase in *post-mortem* proteolysis and ultimately tenderness (Wood et al., 1996). However, the data are equivocal and in many studies the apparently positive effects of growth rate on tenderness are confounded by differences in age at slaughter, carcass weight/fatness and intramuscular fat concentration, all of which may independently influence tenderness (Shorthose & Harris, 1990; May et al., 1992; Owens & Gardiner, 1999, respectively). Moreover, muscle protein degradation was not measured in the majority of the above studies. Following a statistical evaluation of data from 3370 temperate-breed cattle, Perry and Thompson (2005) concluded that when adjusted for market weight (220, 280 or 340 kg carcass), growth rate had a small quadratic effect on sensory tenderness (an increase of 2 U on a 100 unit scale for an increase in growth rate from 0.5 to 1.0 kg/day) and no effect on shear force, an objective measurement of toughness. In contrast, Warkup and Kempster (1991) statistically removed the effects of fatness *per se* and concluded that pre-slaughter growth impetus increases meat tenderness in pigs independent of an increase in fat deposition. Since consumer preference is for lean meat, it is important to confirm if tenderness can be improved without an effect on fatness in beef cattle.

We hypothesised therefore, that at a common age and carcass weight/fatness within a commercially relevant specification, an increase in growth rate prior to slaughter would not increase tenderness of beef.

2. Materials and methods

2.1. Experimental design and animal management

Sixty Friesian steers (12 months of age) were group-housed and offered grass silage *ad libitum* and 3.5 kg proprietary concentrates per animal daily for 5 months. They were then offered 5 kg concentrates and 1 kg grass hay for one month before the experiment began. The concentrate consisted of (g/kg): sugar beet pulp 802, soyabean meal 135, fat 45 and a proprietary mineral and vitamin mix 18. The chemical composition of the concentrate was: dry matter (DM) (883, SD 7.14 g/kg), crude protein (163, SD 7.6 g/kg DM), ash (70, SD 1.0 g/kg DM), acid-hydrolysed ether extract (64, SD 1.2 g/kg DM), neutral detergent fibre (386, SD 18.0 g/kg DM) and metabolisable energy (14, SD 0.1 MJ/kg DM). The hay contained 852 (SD 30.8) g DM/kg and 109 (SD 13.79) g crude protein/kg DM and had a DM digestibility of 688 (SD 19.2) g/kg. The animals were then weighed on consecutive days, and based on mean bodyweight and age assigned to one of 5 groups in a randomised block design. The 5 groups were then randomly assigned to one of 4 treatment groups or for slaughter at the beginning of the experiment. The animals were penned individually and offered the above concentrates and hay (900 g and 100 g/kg total diet, respectively). At the commencement of the experiment (mean age 18 months), one group of animals was slaughtered (details below) and the remaining groups were assigned to one of four energy supply patterns based on individual bodyweight (Fig. 1) to achieve target growth rates (AFRC (1993)) of: (i) 0.72 kg/day throughout the study (continuous), (ii) 0.36 kg/day for the first 8 weeks, transition to higher dietary allowance in week 9 and 1.08 kg/day for the final 8 weeks (low–high), (iii) 1.08 kg/day for the first 8 weeks, transition to lower dietary allowance in week 9 and 0.36 for the final 8 weeks (high–low) or (iv) 0.36 kg/day for the first 2 weeks transition to higher dietary allowance in week 3, 0.72 kg/day during weeks 4 and 14 transition to higher dietary allowance in week 15 and 1.08 kg/day for the final 2 weeks (pulse). To facilitate pre- and post-slaughter management, animals were assigned to 4 groups, balanced for treatment and on a descending block basis. The groups started the experiment in sequence with an interval of 1 week between each start date. Animals were offered their daily concentrate allowances individually, in 2 equal feeds (hay in one feed daily) and were weighed at 2 week intervals. Feed allowances were adjusted on a 4-week basis, or as appropriate to each pattern. On the day before slaughter urine was collected from each animal in the low–high and high–low groups for 4 h. Urine was acidified with 500 ml of 0.5 M hydrochloric acid/l, filtered and samples were stored at −20 °C for analysis of creatinine and methylhistidine concentrations. On each day of slaughter, (mean age 22.5 months) animals were weighed, transported 120 km to a commercial slaughter facility and slaughtered at random within 4 h of removal from their accommodation. After slaughter, cold carcass weight (hot carcass weight × 0.98) was recorded. The carcasses were classified for fat score (1 = leanest and 5 = fattest) and conformation score ($P = 1$ to $E = 5$) using the EU Beef

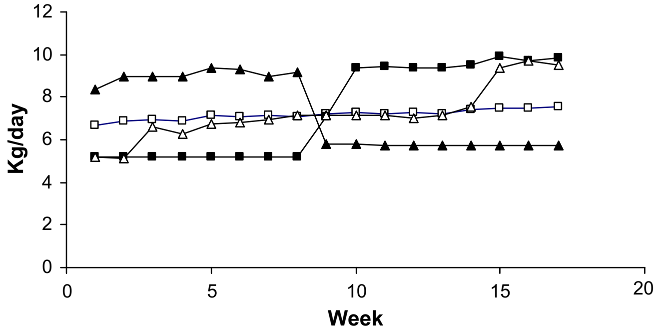

Fig. 1. Concentrate consumption patterns by Friesian steers (□ = continuous; ■ = low–high; ▲ = high–low; △ = pulse).