

EFFECT OF GROWTH RATE ON PALATABILITY IN BEEF CATTLE

Perry D, Thompson JM¹, Reverter, A², and Johnston DJ²

Cooperative Research Centre for the Beef and Cattle Industry, University of New England, Armidale, NSW, Australia 2351

¹School of Rural Science and Natural Resources, University of New England, Armidale, NSW, Australia 2351

²Animal Genetics and Breeding Unit, University of New England, Armidale, NSW, Australia 2351

Background

Variation in growth rate can arise in a number of ways. Growth rate of a group of animals can be manipulated by altering the amount or quality of the nutrients available for growth, whether this alteration is deliberate, or due to seasonal conditions. Difference in average growth rate of a group, in this case, reflects the influence of nutrition, management and the environment on the mechanisms of growth. In contrast the growth of an individual, under ad libitum or restricted feed conditions, will tend to reflect its genetic potential for growth. The mechanism for any effect of growth rate on tenderness may not be the same in these two cases.

Faster growing groups of cattle have been reported to have more tender meat than slower growing groups (Fishell et al. 1985), although others (Calkins et al 1987, Moloney et al 2000) found no relationship between daily gain and shear force or tenderness in fast or slow growing groups. Within a group, Shakelford et al. (1994) reported correlations of -0.52 (genetic) and -0.27 (phenotypic) between ADG and calpastatin activity 24hr post-mortem and -0.40 (genetic) and -0.15 (phenotypic) between ADG and Warner Bratzler shear force.

Some studies impose nutrient restrictions and subsequent re-alimentation to induce weight loss and compensatory gain, while others report the results of continuous positive growth. Once again the muscle biology or carcass characters underlying any effect of growth rate on palatability may not be the same for continuous fast growth as for compensatory growth. The length of time pre-slaughter over which gain is measured also varies between studies, yet there is evidence that changes in nutrition and subsequent growth very early in life can affect muscle and fat development (see Oddy et al 2001). It is therefore understandable that there is no clear consensus in the literature as to the effect of growth rate on palatability or toughness, nor as to the mechanism underpinning any such effect.

Objectives

The relationship between palatability and growth rate from weaning to finishing and during finishing was analysed using data from the core breeding program of the Cooperative Research Centre for Cattle and Beef Quality, Australia. The relationship was analysed separately for animals within a contemporary group and for the effect of growth rate of a group on the mean palatability of that group.

Methods

Animals and measurements. Data for 1323 temperate (Angus, Hereford, Murray Grey, Shorthorn) and 1308 tropically adapted (Brahman, Belmont Red, Santa Gertrudis) cattle were used. This was a subset of data from a larger breeding and slaughter program, the details of which are described in Upton et al. (2001). Briefly, calves from cooperating herds were purchased at weaning from 1994 to 1998 and grown-out (from weaning to entering the finishing phase) in contemporary groups on pasture in either north-eastern New South Wales (NSW), Australia (temperate environment), or Queensland (Qld), Australia (sub-tropical environment). All temperate breed cattle were grown-out and finished in NSW. Tropically adapted cattle were allocated to be grown-out and finished in either Qld or NSW. In Qld the tropically adapted cattle were finished either at pasture or in a feedlot, and in NSW they were all finished in a feedlot. Live weight was recorded at 1-6 weekly intervals (Upton et al. 2001). Cattle were slaughtered when the average weight of the group was predicted to achieve target market carcass weight for that group (220, 280 or 340 kg). For details of slaughter procedures see Perry et al. (2001). All carcasses were electrically stimulated. There were 13 feedlot and 15 pasture groups of temperate cattle, 10 feedlot and 11 pasture groups of tropical animals in Qld, and 12 groups of feedlot tropical animals in NSW. Samples of the striploin (lumbar region of *m. longissimus dorsi et thoracis*) were removed and aged for 14 days. Subjective measures of palatability for grilled striploin were obtained from untrained consumer taste panels. Details of the procedures are given in Polkinghorne et al. (1999). Briefly, five 250mm thick steaks were cut from each striploin and grilled to a medium degree of doneness (70°C internal temperature) using standard grilling equipment, temperature and time. Each steak was cut in half and served to two consumers. Consumers assessed the steaks for tenderness, juiciness, flavour and overall liking, using 4 unstructured 100mm lines. The scores obtained were used to calculate a palatability score (MQ4) using weightings of 0.4, 0.1, 0.2 and 0.3, respectively. The mean of the 10 scores for steaks from each striploin was taken as the MQ4 score for that striploin, with 0=very unpalatable, and 100=extremely palatable.

Calculation of growth rate. Growth rate was calculated separately for each animal by fitting a linear regression to all live weights for the grow-out period and all live weights taken during finishing. The regression coefficient for each period was taken as the growth rate for that period. Growth rates for contemporary groups were calculated by fitting a linear regression to all live weights for a slaughter group.

Statistical analyses. PROC MIXED (SAS) was used to examine the effect of growth rate on palatability of individual animals within market, finish (feedlot, pasture) and location (NSW, Qld), adjusted for herd of origin and a random effect of slaughter, with separate analyses for temperate and tropically adapted breeds. Growth rates for both grow-out (ADGb) and finish (ADGf) were included in the one model, as their effect may be additive, and/or there may be an interaction between the two. Both the linear and quadratic term for ADGb and ADGf were tested, as well as the interaction between them, with non-significant interactions ($P > 0.05$) sequentially deleted. The relationship between group growth rate and group palatability included breed type in the model, and the analysis was weighted for the number of records within each group. To determine whether age affected any relationship between growth rate and palatability, all analyses were repeated with age in the model as a covariate. For individual animals this adjusted age within slaughter groups, and for groups it adjusted for mean age between slaughter groups.

Results and Discussion

Animals within a contemporary group. There was no significant within group relationship between ADGb and palatability in either temperate or tropically adapted cattle grown-out and finished in NSW ($P > 0.05$). However in tropically adapted cattle finished in Qld palatability score increased $10.3 \text{ MQ4} \pm 4.86$ as ADGb increased by 1kg/day ($P > 0.05$). This effect was evident whether cattle were subsequently finished on pasture or in a feedlot, indicating that there was an environmental or nutritional effect during grow-out on the palatability of meat that was not ameliorated by finishing in a feedlot. This relationship was not affected by age at slaughter. Average ADGb for Qld reared cattle was lower ($0.43 \text{ kg/day} \pm 0.09$) than that for tropically adapted cattle reared in NSW ($0.65 \text{ kg/day} \pm 0.11$). In both temperate and tropical breeds the relationship between ADGf and palatability was quadratic and was not affected by market, finish,

location or age ($P>0.05$). Figure 1 demonstrates the small increase in palatability due to an increase of 1 kg/day in ADGf. The slope of the relationship was similar for both breed types, with linear and quadratic terms of 11.09 ± 4.43 , -4.17 ± 1.54 for temperate breeds and 9.63 ± 4.85 , -3.73 ± 1.54 for tropical breeds. Faster growing cattle within a group had the same quality of nutrition and the same seasonal and management inputs as slower growing cattle, thus their increased growth rate reflected the animal's potential for growth. The uniformity of the association with palatability for all market weights and for both pasture and grain finished cattle suggests that the underlying mechanism was with muscular structure or biochemistry rather than with level of intramuscular fat. Aberle et al (1981) proposed that there was a positive correlation *in vivo* between rate of protein synthesis and degradation, with consequent greater post-mortem protein degradation in muscle from faster growing animals. Muir et al (2001) found that muscle calpain activities were positively correlated with liveweight gain during the finishing period, and Shackelford et al. (1994) found a negative correlation between calpastatin activity 24 hr post-mortem and average daily gain. In contrast to this Angus cattle selected for high growth rate had reduced muscle protein degradation (Oddy et al 1998), increased calpastatin concentration and reduced rate of post mortem tenderisation (McDonagh 1998, Morris and Speck 1998). Alternatively Harper (1999) suggested that faster growth in cattle can decrease the formation of non-reducible collagen crosslinks, with a consequent decrease in meat toughness.

Between contemporary group effect. Group growth rate was related to the variation in management, environment, season and breed type that existed between groups, rather than to genetic potential of individuals for growth. Increasing group ADGb or ADGf by 1 kg/day improved group palatability scores by $15.72 \text{ MQ4} \pm 7.16$ ($P>0.01$), and $7.64 \text{ MQ4} \pm 4.46$ ($P=0.06$) respectively. However, when adjusted for difference in mean group age at slaughter the relationship between ADGb, ADGf and palatability became non-significant ($P>0.05$), although there was little change in the magnitude of the relationship. This suggests that much of the variance in palatability with group growth rate actually reflected difference in age at slaughter between groups. As with the comparison within contemporary group, the homogeneity of the relationship within markets, finishing regimes and breed types suggested that the causal mechanism was not fatness. There may, however, have been differences in collagen make-up, as suggested by Harper (1999) and in the proteolytic potential post-mortem, as suggested by Aberle et al (1981).

Conclusion

The improvement in palatability gained by increased growth rate of groups of cattle from weaning to slaughter was small and unlikely to be of economic benefit over and above that gained by animals reaching target slaughter weights at a younger age. There was a small positive relationship between growth rate of individuals within a contemporary group and palatability. This relationship could be exploited by a grading scheme which rewarded cuts for palatability.

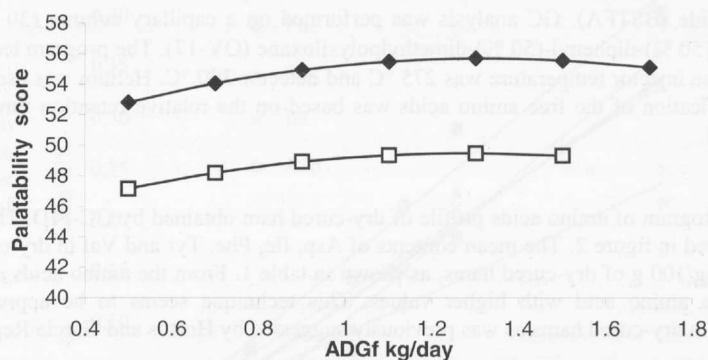


Figure 1. Relationship between growth rate during finishing (ADGf) and palatability score, within contemporary groups, for temperate (♦) and tropically adapted (□) cattle.

Pertinent literature

- Aberle ED, Reeves ES, Judge MD, Hunsley RE and Perry TW. (1981). *J. Anim. Sci.* **52**: 757-763.
 Calkins, CR., Seidman SC and Crouse JD. (1987). *J. Anim. Sci.* **64**: 1448-1457.
 Fishell VK, Aberle ED, Judge MD and Perry TW. (1985). *J. Anim. Sci.* **61**:151-157.
 Harper GS. (1999). *Aust. J. Agric. Res.* **50**: 1105-1129.
 McDonagh MB. (1998). PhD thesis. University of New England, Armidale, NSW, Australia.
 Moloney AP, Keane MG, Mooney MT and Troy DJ. (2000). In *Proc. Agric. Res. Forum.* pp. 107-188. Dublin, Republic of Ireland.
 Morris CA and Speck PA. (1998). *J. Anim. Sci.* **74**: (Suppl 1) 157.
 Muir PD, Smith NB, Dobbie PM, Smith DR and Brown MD. (2001). *Anim. Sci.* **72**: 297-308.
 Oddy VH, Herd RM, McDonagh MB, Woodgate R., Quinn CA and Zirkler K. (1998). *Livestock Prod. Sci.* **56**:225-231.
 Oddy VH, Harper GS, Greenwood PL and McDonagh MB. (2001). *Aust. J. Exp. Agric.* **41**:921-942.
 Perry D, Shorthose WR, Ferguson DM and Thompson JM. 2001. *Aust. J. Exp. Agric.* **41**:953-958.
 Polkinghorne R, Watson R, Porter M, Gee A, Scott J and Thompson JM. 1999. In *Proc. 45th ICoMST*, Yokohama, Japan. **45**: 14.
 Shackelford SD, Koohmaraie M, Cundiff LV, Gregory KE, Rohrer GA and Savell JW. (1994). *J. Anim. Sci.* **72**: 857-863.
 Upton W, Burrow HM, Dundon A, Robinson DL and Farrell EB. 2001. *Aust. J. Exp. Agric.* **41**:943-952.

Acknowledgements

We thank the numerous CRC staff who contributed to the work described here, and Meat Standards Australia for the sensory results