MEAT QUALITY IN CATTLE OF VARYING BRAHMAN CONTENT: THE EFFECT OF POST-SLAUGHTER PROCESSING, GROWTH RATE AND ANIMAL BEHAVIOUR ON TENDERNESS

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Background

Previous studies have shown that the meat quality of high *Bos indicus* content animals is often inferior to that of *Bos taurus* cattle, although the magnitude of the difference varies between studies, particularly when cattle are not optimally handled or processed (Hearnshaw *et al.*, 1998). In Australia, *Bos indicus* infused cattle are usually found in the tropics and sub-tropics, where they are well adapted to high levels of internal and external parasites and to a diet of low quality forage, (Turner, 1975). These environments are extensive and the cattle are rarely handled. Growth rates are usually low, resulting in increased age at slaughter and lighter, leaner carcasses. Temperament in *Bos indicus* cattle is very different to that of *Bos taurus* cattle, and they need to be handled and weaned using appropriate methods (Fordyce *et al.*, 1982). Given these potentially confounding influences, the true contribution of *Bos indicus* genes to poor meat quality is often difficult to determine. Most reports from the USA on meat quality of *Bos indicus* cattle show increasing proportion of *Bos indicus* content to be associated with decreased tenderness and increased variability (e.g. Cundiff *et al.*, 1990). These studies rarely used effective electrical stimulation, or tenderstretch, to control cold shortening. When appropriate post-slaughter processing was used, sensory palatability was similar for *Bos taurus* and *Bos indicus* cattle and their crosses (Wheeler (Fell *et al.*, 1998). The time taken for an animal to pass successfully through the gate was recorded. All calves were scored for ease of handling and flight speed (Burrow *et al.*, 1988).

Pre-slaughter and slaughter treatment: After weaning, cattle from both training groups were grazed together on improved temperate grass pastures on the northern tablelands of NSW. Cattle were weighed bi-monthly and, at an average of 21 months, they were trucked 350 km to the abattoir and slaughtered after being held overnight with access to water. Steers were slaughtered one week before the heifers. A blood sample for analysis of cortisol level was collected from each carcass during exsanguination. Half the carcasses from each level of %B were electrically stimulated with high voltage (800volts, HvES) about 20 minutes post-stunning; the other half were not stimulated (NoES). Temperature and pH of the *M. longissimus thoracis et lumborum* were regularly measured on a subset of 36 carcasses from 30 minutes to 5 hours post-slaughter. One striploin was removed from each carcass and divided into three portions which were aged for 1, 14, or 28 days. Samples were then frozen (-20^{O}C) until needed for analysis.

Meat quality assessment: Striploin samples for all ageing treatments from steers, and those aged for 1 and 28 days from heifers, were thawed, cooked in a water bath at 70^{O}C, and peak force (PF), compression (C) and cooking loss measured as described by Bouton *et al.*,(1971). Sixty eight of the 14 day aged striploin samples taken from heifers were cut into 25mm steaks before freezing at -20^{O}C. These steaks were thawed, cooked on an electric clam bake grill and served warm to consumers. Each consumer received seven half-steaks and each animal was tasted by 10 consumers. Consumers scored tenderness on a 100 mm line with a continuous scale (0-100, with 100 being most tender) and gave an overall assessment of palatability.

Statistical analyses: Meat quality data were examined using models which contained %B, electrical stimulation, ageing time, sex, and their interactions; with kill order, pH, cortisol concentration and growth from birth to slaughter were included as covariates. The relationships between meat quality and behavioural traits were examined using correlations. Least squares means of significant traits ($P<0.05$) only are presented.

Results and Discussion

Mean carcass weights and fat depth at the P8 site (rump) for heifers and steers were 189 and 234 kg, and 9 and 10 mm respectively. The average growth rate ranged from 434 to 805 g/day, with a mean of 587g/day for heifers and 670 g/day for steers. In this data set average growth rate was not significantly related to PF or C. Neither 'training' at weaning, nor other behavioural assessments (ease of handling, flight speed, time to pass through the gate) had any significant effect on PF. Loins from 'trained' and 'untrained' animals had similar PF values within %B, ES or ageing sub-group.

The order of slaughter significantly affected the PF of loins from heifers, with an increase of 0.02 kg PF per unit of slaughter order. Slaughter order had no significant effect on PF in steers. Cortisol levels were significantly higher in heifers than steers (161 vs 101 ± 5.4 nmol/l), although this effect was confounded with day of slaughter and number of animals slaughtered. Concentrations of cortisol were also elevated in cattle with high %B, indicating more stress at slaughter (118, 129, 134, 144 ±7.7nmol/s for 0, 17/33, 50, and 67/100%B respectively). However, cortisol level *per se* had no apparent effect on PF or C.

There was a significant interaction between %B and HvES for PF in steer carcasses, although no effects or interactions involving %B were significant for heifers. PF in steers was significantly affected by %B in the NoES carcasses, with 67/100% Brahman being least tender (Figure 1). From a practical perspective, it is important to describe the most effective post-slaughter processing for producing tender loins from steer and heifer carcasses with different levels of %B, even though the interaction between %B, ES and ageing was not significant. Large variation occurred in PF of steer loins when different processing options were used, with the 'best', most

consistent tenderness resulting from HvES and ageing for 28 days. Loins from heifers were also most tender with this processing regime. These data support that of Wheeler *et al.* (1990), and our previous data (Hearnshaw *et al.*, 1998).
Tenderness (PF) was significantly better in carcasses that had been HvES than those that had not (3.9 vs 8.5 ± 0.27 kg) although, for both heifers and steers, there was a significant interaction between ES and ageing. A greater absolute improvement in PF occurred with NoES loins than with HvES loins (2.65 vs 1.1 kg). For steer loins with NoES, the majority of improvement in tenderness occurred between 14 and 28 days ageing (65%), whereas with HvES 65% of the improvement had occurred in the first 14 days. Previous results with similar cattle have shown that a 28-day ageing treatment was worth considering to assure consistently good tenderness for consumers (Hearnshaw *et al.*, 1998). Wulf *et al.*(1996) found that most of the improvement in PF due to ageing in ES carcasses from *Bos taurus* cattle had occurred by 14 days.
It is also important to assess the risk of a consumer receiving a tough steak (PF >4kg; Huffman *et al.*,1996), as inconsistent tenderness is a major concern for beef consumers. For NoES carcasses, the percent of loins considered 'tender' was extremely low, even after 28 days ageing (0%, 1%, 11% for 1d, 14d and 28d aged, respectively). This low level of acceptable tenderness was probably due to cold shortening, as the 'k' coefficient for the decline in pH over time for NoES carcasses was significantly slower than for HvES carcasses. The percent of loins from HvES steer and heifer carcasses that were considered 'tender' increased markedly with increased ageing period (43, 58, and 85% for 1d, 14d and 28d, respectively), with no significant difference between cattle with varying %B (Figure 2). Only steers contributed data to the 14 day ageing comparisons. Consumers would have the least risk of a 'tough' steak if carcasses were HvES and loins were aged for 28 days - irrespective of genotype or sex of the carcass.
Consumers preferred the tenderness of steaks from HvES loins to those from NoES loins (scores of 57.9 vs 47.5 ± 2.3 for 14 day aged loins from heifers), with 74% of the HvES and 55% of the NoES samples having palatability scores which graded acceptable or better. Consumers' tenderness scores for steaks from carcasses with various %B were significantly different, with 50%B being most tender (59.8), 0%B and 67/100%B least tender (49.1 and 48.8), and 17/33%B being intermediate in tenderness (53.2) (av. s.e. = 4.7). The connective tissue component of toughness (C) was greater for high, compared with low %B loins (1.73 vs 1.6 ± 0.02 kg); it was higher in 1 day compared with 28 day-aged samples (1.7 vs 1.5 ± 0.02 kg); and was higher in loins from carcasses that had NoES compared with those with HvES (1.7 vs 1.6 ± 0.02 kg). All values of C were in the tender range of <2.0 kg. Cooking loss (dryness) was greater in NoES than in HvES loins (23.2 vs 22.5 ± 0.3 %).

Conclusions
Tenderness (PF), and consistency of tenderness of loins from yearling carcasses with 0 to 100%B content was markedly improved with HvES and ageing for 28 days. When this 'best' post-slaughter procedure was used, 85% of loins could be considered 'tender' (PF<4kg), regardless of Brahman content. Consumers rated HvES loins more tender than NoES loins. Pre-slaughter factors such as growth rate, behaviour and cortisol levels had little effect on PF in a 'benign' temperate environment.

Pertinent literature

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Figure 1. The effect of electrical stimulation and ageing on peak force (kg) of striploins from steers with 0-100% Brahman content

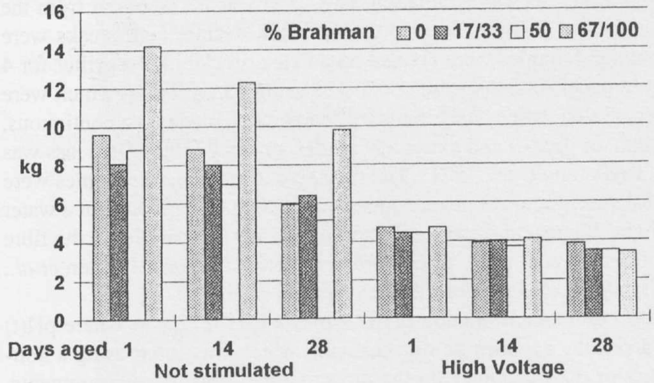

Figure 2. Percent of striploins considered 'tender' (peak force<4kg) after high voltage stimulation and ageing.