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THE EFFECT OF *BOS INDICUS* CONTENT, PRE-SLAUGHTER TREATMENT AND TENDERSTRETCH ON BEEF EATING QUALITY

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Background

The effect of *Bos indicus* (BI) content on beef palatability, notably tenderness, has been well documented (eg. Wheeler et al 1990, Hearnshaw et al 1998). However, in both these studies, the magnitude of the breed effect was dependent on the post-slaughter management of the carcasses. When the carcasses were effectively electrically stimulated and the meat was aged, the breed difference was substantially reduced. In the context of beef eating quality assurance, the adoption of abattoir best practice such as electrical stimulation, tenderstretch, optimal chilling rates and ageing are essential. With an improved understanding of the variation in eating quality due to differences in the post-slaughter management of carcasses, the attention in Australia has now focused on the effective pre-slaughter management of cattle. The process of harvesting cattle for slaughter results in inevitable losses in both carcass yield and meat quality. Effective pre-slaughter management aims at minimising these losses and to that end, the practice of directly consigning cattle to the abattoir is utilised extensively in Australia as well as in other countries. Typically, this requires the animals to be assembled and trucked the day before slaughter, fasted overnight in lairage with access to water and slaughtered as a group the following day.

Variations to this procedure such as reducing the time in lairage (Purchas 1992) and electrolyte supplementation (Schaefer et al 1990) have been shown to have positive effects through reductions in carcass weight loss and the incidence of dark cutting (pHu > 5.9). In another study, Butchers et al (1998) demonstrated that early, rather than late, arrival at the abattoir (5 days prior to slaughter) and provision of feed to feedlot cattle produced quite dramatic changes in the post-mortem rates of glycolysis and meat quality, notably, tenderness and juiciness scores. Also pertinent here are the results of Jeremiah et al (1992) who demonstrated the negative effects of feed and water withdrawal prior to slaughter on tenderness, flavour intensity and overall palatability of beef from bulls. Given these results, there would appear to be some scope for further improvement of eating quality through the investigation of alternative pre-slaughter management strategies.

Objective

The purpose of this experiment was to quantify the effects of *Bos indicus* content, different trucking and feeding treatments in lairage and alternative carcass hanging treatments on beef eating quality.

Methods

Animals: Eighty steers comprising equal numbers (n = 40) of two BI genotypes, Brahman (100% BI) and Charolais x Brahman (50% BI), were used in this investigation. The cattle were backgrounded on pasture prior to finishing in a feedlot where they received a grain ration for 77 days. The experimental design was a 2 x 4 x 2 factorial, including two genotypes (50 versus 100 % BI content), four pre-slaughter treatments and two hanging treatments/carcass (*achilles* hanging versus tenderstretch).

Pre-slaughter Treatments: Sixty animals, balanced in terms of BI %, were trucked to a commercial abattoir four days prior to slaughter. The journey took approximately 5.5 hours. Upon arrival, the steers were randomly allocated within genotype into three feeding groups (n= 20/group). One group was fed once a day for four days without any fasting period prior to slaughter (non-fasted group). The other two groups were fed for three and two days and fasted for one and two days, respectively (Fed 3d/fast 1d and Fed 2d/fast 2d groups). The remaining twenty cattle were trucked from the feedlot the day before slaughter, held in an ajoining lairage pen but not fed at the abattoir (control group). All groups had unrestricted access to water.

Slaughter: All cattle were consecutively slaughtered in their groups. The carcasses were not electrically stimulated but did receive some electrical input via the hidepuller rigidity probe (85 V peak voltage, 2 amps, 12 seconds). After splitting, one side was tenderstretched (TS) whilst the other was conventionally hung by the *achilles* tendon (AH).

Meat quality: Muscle cores (approx. 0.5 g) were removed from the *m.longissimus* of the control sides from 10 carcasses per pre-slaughter treatment group for pH determination. The pH was measured in iodoacetate homogenate (Bendall 1973) at approximately 45, 120, 180, 240 and 300 minutes post-mortem. After 24 hours chilling, the striploins were removed from both sides, vacuum packaged and aged for 14 days at 0-1°C before being cut into 25 mm steaks and frozen. The Meat Standards Australia (MSA) protocols were used in the sensory evaluation of steaks. Briefly, this involved cooking five steaks from each striploin on a Silex® cooker for a fixed time, which was designed to achieve an internal temperature of 70°C. The cooked steaks were halved and served to an untrained consumer panel. Steaks were allocated according to a randomised incomplete block design where each consumer received seven half steaks including one link steak. A total of ten different consumers tested each striploin. Eating quality in terms of tenderness, juiciness, flavour and overall liking were assessed on a 1 – 100 point scale. An overall palatability score (CMQ4) was determined using the following equation:

$$CMQ4 = 0.4 \times \text{tenderness score} + 0.1 \times \text{juiciness score} + 0.2 \times \text{flavour score} + 0.3 \times \text{overall liking score}.$$

The sensory data was analysed using a mixed model procedure where BI content, pre-slaughter treatment and hanging treatment plus all significant first order interactions were fitted as fixed effects. Animal nested within (BI x pre-slaughter treatment) was fitted as a random term.

Results and Discussion

The means and standard deviations for hot carcass weight and P8 fat depth for the two BI genotypes and four pre-slaughter treatment groups are shown in Table 1.

Table 1: Means and standard deviations for carcass weight and fat depth

Carcass Trait	Pre-slaughter Treatment Group				BI Content	
	Non-fasted	*Fed 3d/fast 1 d*	*Fed 2d/fast 2d*	*Control*	*50%*	*100%*
Hot carcass weight (kg)	229.7 ± 14.3	228.5 ± 17.9	222.0 ± 14.4	227.1 ± 18.3	236.8 ± 12.1	217.3 ± 14.0
P8 fat depth (mm)	12.1 ± 3.9	10.9 ± 3.2	9.6 ± 3.3	10.3 ± 3.8	9.5 ± 2.7	11.8 ± 4.1

There were no differences in the post-mortem rates of pH decline between the four pre-slaughter treatment groups. It is likely that any potential differences were reduced due to the electrical stimulation received during the mechanical removal of the hide.

Table 2: Significance of the main effects and least square means for tenderness, juiciness, flavour and overall palatability (CMQ4) scores

Meat Quality Traits	BI Content		Pre-slaughter Treatment				Hanging Treatment		*Significance*		
	50%	100%	Non-fasted	Fed 3d/fast 1d	Fed 2d/fast 2d	Control	AH	TS	*Breed*	*Preslaug. Treatment*	*Hanging Treatment*
Tenderness	61.5	53.4	61.0	59.2	53.5	56.0	55.4	59.5	***	*ns*	**
Juiciness	59.3	52.6	58.2	57.8	52.3	55.4	55.1	56.7	***	*	*ns*
Flavour	60.3	56.1	61.3	60.9	55.2	55.4	56.7	59.7	*	**	*
CMQ4	60.6	54.0	60.6	59.6	53.8	55.3	55.6	59.0	**	*	**

* - P<0.05, ** - P<0.01, *** - P<0.001, ns - not significant

In the analysis of the consumer data, the only significant first order interaction was breed x hanging treatment (P<0.05) for flavour score. This interaction was one of magnitude where the difference in flavour between the two hanging treatments was greater for the 50% BI compared to the 100% BI carcasses.`

Steaks from the 100% BI carcasses were rated significantly tougher, dryer, less flavoursome and less acceptable compared to those from the 50% BI carcasses (Table 2). Similarly, tenderstretching the sides resulted in a significant improvement in tenderness, flavour and overall palatability. The lack of any significant effect on the juiciness scores was probably due to the fact that the striploins were aged for 14 days. Juiciness, flavour and overall palatability were all significantly influenced by the pre-slaughter treatment. Steaks from those cattle which arrived 4 days prior to slaughter and not fasted or fasted for 1 day were rated superior to those from the group which arrived early and fasted for 2 days or the control group. These data would suggest that the relevant factor was the period of feed withdrawal rather than the arrival time at the abattoir. If so, this would tend to support the results of Jeremiah et al (1992). Although a similar trend was observed for the tenderness scores across the four treatments, it was not found to be significant. This result is quite salient because although not reported here, there were no significant differences in shear force between the four treatments. It could be interpreted that the impact of feed withdrawal prior to slaughter might be more deleterious to juiciness and flavour rather than tenderness. Whether this is the case and the mechanisms by which the improvements are elicited (eg. higher water holding capacity, residual glycogen content etc.) are the subjects of further investigations.

Finally, an analysis was done to determine the additive value in combining the optimal pre-slaughter treatment of cattle with optimal post-slaughter management of their carcasses in terms of minimising the BI effect on eating quality. When the data from the non-fasted and fed 3d/fast 1d groups, tenderstretched carcasses + 14 days ageing were pooled, all steaks, irrespective of BI content would have been accepted as 3 star under the new Meat Standards Australia beef quality grading scheme (Thompson et al 1999). The thresholds used by MSA for 3 star acceptance of a consignment are <7% below CMQ4 = 41 and <20% below CMQ4 =48. Conversely, for the control and the fed 2d/fast 2d groups, the failure rate was 42% for the 100% BI carcasses.

Conclusions

Beef eating quality was significantly influenced by BI content, the management of the cattle prior to slaughter and the method of carcass suspension. The beneficial effects of early abattoir arrival and minimising the period of feed restriction prior to slaughter on beef palatability were expressed more through enhancements in juiciness and flavour rather than tenderness. The combination of optimal pre- and post-slaughter management of 100% BI cattle and their carcasses substantially enhanced palatability.

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