SUPPLEMENTAL VITAMIN D_3 AND ELECTRICAL STIMULATION TO REDUCE THE EFFECT OF A BETA AGONIST ON MEAT QUALITY

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Introduction

Beta agonists are known to affect meat tenderness (and other quality traits) negatively due to an increase in calpastatin activity (Wheeler and Koohmaraie, 1997). Strydom et al. (1999) found that electrical stimulation (ES) and ageing had a more pronounced effect on the improvement of tenderness of loins from beta agonist-supplemented animals than on those from control animals. However, the loins from supplemented animals were still slightly tougher than loins from control animals. Similarly, Ferguson et al. (2000) found that ES cancelled the negative effect of *Bos indicus* genes on tenderness by increasing the activity of calpain.

Another method that was investigated over the past two decades to improve meat tenderness is the supplementation of vitamin D_3. Montgomery et al. (2002, 2004a) and others reported on the positive effect high levels of vitamin D3 supplemented during the last days prior to slaughter. The vitamin D_3 increased the ratio of calcium in cellular components in muscle which led to an increased activation of calpain system in the respiring muscle cell leading to improved tenderness of aged meat (Montgomery et al. 2004b).

Vitamin D_3, ES and beta agonists are also known to influence other meat quality characteristics such as colour and drip loss (or water binding)(Moloney et al., 1994, Young et al, 1999; Montgomery et al., 2002). In this study the concomitant use of ES and vitamin D_3 to overcome the negative effect of a beta agonist on meat quality was investigated.

Materials and Methods

Thirty young bulls (9 months) were grain fed for 80 days and then divided into three groups of ten. Two groups were supplemented with the 0.15 mg/kg live weight of a beta agonist (zilpaterol hydrochloride) for thirty days during the final weeks of finishing. The zilpaterol was withdrawn from the feed for four days prior to slaughter and one of the two groups were supplemented with vitamin D3 at 4 x 10^6IU/head/day for four days. The animals were slaughtered and the carcasses dressed. Within 30 minutes after stunning, one side of each carcass was electrically stimulated (400 V peak, 5 ms pulses at 15 pulses per second). Meat quality measurements were performed on the m.*longissimus thoracis et lumborum* (LTL). Sub samples of the LTL were aged for either 3 or 14 days at 2°C. Warner Bratzler shear force resistance (SF) was measured on 12.5 mm cores from steaks oven broiled to an internal temperature of 70°C. Thawing and cooking losses were measured. Drip loss of the fresh LTL was measured by hanging 50 g samples (sampled one day after slaughter) in a vented sample bottle at 2°C for 48 hours. Surface colour of freshly cut LTL bloomed for 30 minutes was measured with a Minolta meter (Model CR200, Japan) to determine lightness (L*), redness (a*) and yellowness (b*).

Results and Discussion

Shear force resistance. Zilpaterol (Z) loins were significantly tougher ($P<0.05$) than control (C) loins ($P<0.05$), while vitamin D3/zilpaterol loins (DZ) were in between (Table 1). ES loins were more tender ($P<0.05$) than those from non-stimulated carcasses (NES), while *post mortem* aging for 14 days improved SF tenderness significantly ($P<0.05$). A significant interaction between stimulation and supplementation showed that the tenderness of ES loins from C, DZ and Z carcasses were similar, while loins from Z and DZ were significantly tougher than those from C and loins from Z, significantly tougher than those from DZ when no stimulation was applied ($p<0.05$)(not shown). The relatively larger effect of ES on the tenderness of Z loins compared to C loins corresponds with the findings of Strydom et al. (1999) and can probably be ascribed to the reduction of calpastatin and increase in calpain activities as described by Ferguson et al. (2000) for ES Brahman meat. The significant effect of Vitamin D3 on the tenderness of non-stimulated Z loins corresponds with the work of Montgomery et al. (2002, 2004a) and other workers. However, it is not clear why the effect of ES overshadowed the effect of vitamin D3 and why they were not additive in their actions.

Moisture characteristics and colorimetry. ES loins was lighter (L*) and showed a higher chroma NES loins. DZ loins were lighter (L*) than C and Z loins ($P<0.05$), while Z loins had a higher chroma than DZ and C loins ($P<0.05$). However, the latter difference only occurred with ES (interaction nor showed). Montgomery et al. (2002) found that low levels of vitamin D_3 (500000 IU/day) quadratically decreased CIE a* (redness) and b* (yellowness), while L* was not affected which is the opposite of the respective measurements for DZ in the present study. Strydom et al. (2000) found higher scores for "colour acceptability" for Z loins (electrically

stimulated) which correspond with the higher chroma values of the present study. In contrast, Moloney et al. (1994) found lower values for chroma for Z loins and no mentioning of ES was made in the study.

ES loins were lighter (L*), showed a higher chroma (S) and drip loss than NES samples. DZ loins had a higher thawing loss and lost more moisture during cooking due to evaporation than C loins. Montgomery et al. (2002) reported no significant effect of vitamin D3 on moisture characteristics of LTL, while Montgomery et al. (2004b) found significantly higher drip loss at 5.0 x 10^6 IU/day vitamin D_3. They ascribed this to increased proteolysis and therefore deterioration of the protein structure.

Table 1. The influence of a beta agonist, Vitamin D_3 supplementation, electrical stimulation and ageing on shear force resistance, moisture characteristics and Hunter colorimetry of beef loin.

Treatment	L*	Chroma[1]	Drip loss (%)	Thawing loss (%)	Evaporation loss (%)	Shear force (kg)
Supplement						
Control	38.0^a	14.6^a	1.9^a	6.0^a	20.1^a	6.2^a
Vitamin D_3	39.8^b	14.4^a	3.3^b	7.9^b	22.2^b	7.0^{ab}
Zilpaterol	38.2^a	15.7^b	2.2^a	7.3^b	21.0^{ab}	7.6^b
SEM	0.441	0.352	0.17	0.337	0.390	0.331
Stimulation						
Yes	40.0^b	16.0^b	2.7^a	6.9	21.3	5.7^a
No	37.4^a	13.9^a	2.2^b	7.2	20.9	8.2^b
SEM	0.360	0.288	0.137	0.213	0.175	0.190
Ageing						
2 days				7.5^b	20.7^a	8.0^b
14 days				6.6^a	21.5^b	5.8^a
SEM				0.193	0.222	0.101

^{a,b} Means in the same row without a common superscript differ significantly ($P < 0.05$);. [1] Chroma = $(a^{*2}+b^{*2})^{½}$

Conclusions

ES was a more effective procedure to overcome the negative effect of a beta agonist on tenderness of meat than high levels of supplemented vitamin D_3. The lack of additive effect of the two procedures needs to be investigated further. The higher moisture losses experienced with Vitamin D_3 in this trial could negate its advantage with regard to meat tenderness.

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