Nutritional Interventions to decrease dark cutting in grass fed cattle

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Abstract –The rate of dark cutting in southern Australia increases in grass fed cattle during early summer as feed dries off, lowering quality and energy availability. This study aimed to test if adding an additional 25MJ of energy to the grazing cattle's diet per day would be enough to decrease dark cutting. Thirteen mobs of pasture fed cattle (n=670) were split into a treatment anda control group.Treatment cattlewere supplemented with 25MJ energy in a concentrate grain pellet for 14 days prior to slaughter on top of the pasture available, while the control remained solely on pasture. The supplemented feed did not decrease dark cutting rate, however there was an increase in muscle glycogen store of 0.1g/100g of muscle in the treatment animals (P<0.05). The carcass weight also increased by 3.0kg in the treatment animals (P<0.05). The nutritional intervention could be a method to decrease dark cutting in at risk grazing cattle.

Key Words – Meat Standards Australia; pH; Meat colour; Glycogen.

I. INTRODUCTION

Dark cutting in beef is when carcases are categorized to be abnormally dark in colour and high in pH. The Meat Standards Australia (MSA) grading system considers a beef carcase a dark cutter when the pH is greater than 5.7 (measured at greater than 18 post-slaughter, or 8 hours post-slaughter with electrical stimulation) and if the loin muscle is darker than the set meat colour threshold of 3, based on the7 point AUSmeatcolour scale. Not only is the dark meat colour unappealing to consumers, but also results in a greatly inferior quality, which consumers also reject due to poor palatability [1]. Additionally, dark cutting beef is dryer in texture, variable in tenderness and more prone to bacterial spoilage [2,3]. The reduced shelf life and consumer rejection of dark cut meat results in a downgraded and a discounted end product with large economic losses for both the producer and the processor. Estimated total losses to the Australian beef industry based on a 5.63% national dark cutting average is $19 to $55million per annum [4].

Dark cutting is predominately caused by low levels of muscle glycogen at slaughter [5]. While low levels of glycogen can be a result of stress and exercise in the animal pre-slaughter [6], it can also be an indication of poor nutrition on farm especially due to seasonal variation in pasture quality in grass fed cattle [7]. McGilchrist *et. al.* [8] showed that the incidence of dark catting in southern Australia was the lowest during the middle of spring (October) and rose sharply in the following summer months.This is likely associated with the winter dominant rainfall patterns impacting on pasture quantity and quality and thus nutritional status of the animal. Therefore, late season grass fed cattle can be identified at being at a greater risk of dark cutting as the change in feed quality could likely effect the muscle glycogen concentration pre-slaughter.

The muscle glycogen concentration in feedlot cattle is typically higher and less variable than grass fed cattle [9], while repletion of muscle glycogen is directly related to the metabolisable energy intake of the cattle [10]. Knee et. al. [11] showed that supplementing grass fed cattle with a balanced high energy total mixed ration during a typical feed gap period resulted in a rapid (within 1 week) increase in muscle glycogen, to levels similarly seen in feedlot cattle. However in other studies, supplementation with hay of moderate to good quality (approx. 8-8.5MJ of metabolisable energy/kg DM) for 3 days was not found to promote adequate repletion of muscle glycogen, while higher energy supplementation with barley (approx. 11.3MJ of metabolisable energy/kg DM) showed significant repletion of these muscle glycogen stores after depletion due to exercise [10].

This study aimed to investigate economic viability of supplementing pasture fed cattle with a high energy feed for 14 days pre-slaughter. It is hypothesised, that supplementing grass fed cattle with a high energy ration of 25MJ/head/day, during periods of pasture quality decline, will improve muscle glycogen concentrations and decrease the rate of dark cutting. The additional energy in the supplemented ration is also hypothesised to result in a live weight gain.

II. MATERIALS AND METHODS

Experimental design

During Late September to the middle of December, 13mobs of cattle across 8 different farms from the south west of Australia (n= 670) were tested. Producers were approached that had a mob of grass fed cattle of 30 or more that were consigned direct to the abattoir. The nutritional intervention would take place in the 14 days prior to transport to the abattoir. At the beginning of the trial at each farm, the cattle were weighed and the mobs were randomly split in a left/right draft into a control and treatment group. The two groups were separated on pasture by either splitting one paddock or sent to graze two separate paddocks.The treatment group was supplied with a high energy commercial pellet in a feeder or trough (13.3MJ/kg of metabolisable energy, 14.4% crude protein/kg DM, 19.1 NDF; Milnes Feeds, Welshpool, Western Australia, Australia),. The pellets were filled up daily and supplied at a sufficient rate to be greater than an additional 25MJ of energy per head of cattle per day. The control group was left to graze for the remainder of the trial. Once the feeding period was over the cattle were reweighed and sent to slaughter at a commercial abattoir. At the abattoir, a small sample of the *m.longissimus dorsi* was taken at approximately 40 minutes after death and stored at -20^{o}C for later analysis of glycogen concentration. The pH and meat colour was measured the following morning by AUS meat certified graders. The carcases were classified as dark cutting if the pH was greater than 5.7 and or the AUS meat colour score was greater than 3. In total there were 388 animals in the treatment group and 333 in the control groups.

Pasture quality

The feed on offer (FOO) was calculated by collecting 15 x 0.1m^2 quadrants of pasture in each paddock at both the start and end of the trial. The dry matter was calculated by drying the pasture in an oven and calculating the mean of the quadrants to give a value of Tonnes of feed per hectare. Additional grab samples were collected at both time points down to grazing height to measure the pasture quality, including metabolisable energy, crude protein, In Vitro True Digestibility and Relative feed value (Dairy One, Ithaca, New York, USA).

Glycogen analysis

Glycogen was measuredby the enzymatic method of Chan & Exton[12] excluding the filter paper step. The assay was performed on aOlympus AU 400auto analyser (Olympus Diagnostics, Tokyo, Japan).Glycogen analysis was only performed on samples from 7 farms (n=254) due to the loss of integrity of the remaining samples.

Statistical analysis

Data were analysed using a linear mixed effects model in SAS®. The fixed effect of treatment was used in all models to test the impact of the nutritional intervention on muscle pH, meat colour and muscle glycogen. All carcass measures that could be biased due to starting body weight, included starting weight in the model. Pasture data was analyzed with treatment and the time of sampling (start of trial or end of trial) as the fixed effect to test if the pasture quality was declining.

III. RESULTS AND DISCUSSION

Pasture quality

The quality of pasture and the FOO varied between farms and trials ($P<0.05$). There was no difference in any pasture quality measure or FOO between treatment and control paddocks. On average, there was no difference between FOO and crude protein in the pasture at the beginning and the end of the trials, whereas, by the end of the trial energy content, relative feed value and true digestibility decreased ($P<0.05$; Table 1). During this time there was also an increase in dry matter percentage from 28% to 40% in the pasture, demonstrating the turn of season and decrease in pasture quality (Table 1).

Table 1The mean (± standard error of the mean) pasture quality and Feed on offer (FOO) at the start and end of the trials.

Measure	Mean	SEM	P value
Start of trial			
FOO (Tonnes/ha)	2355.78	149.61	
Energy (MJ/kg)	9.7	0.174	
Crude Protein (%)	17.38	1.474	
Dry Matter (%)	28.9	0.0388	
Relative feed value	113.15	4.408	
True Digestibility	78.73	1.954	
End of Trial			
FOO (Tonnes/ha)	2227.25	137.62	0.5304
Energy (MJ/kg)	9.2	0.174	0.0514
Crude Protein (%)	13.73	1.474	0.0865
Dry Matter (%)	40.5	0.0388	0.0401
Relative feed value	97.04	4.408	0.0128
True Digestibility	71.92	1.954	0.0173

Animal and carcass performance

In total there were only 12 dark cutting carcasses across all carcasses tested, a total dark cutting rate of 1.8%. Of these, 7 were from the control group and 5 from the treatment groups. These values are below previously reported rates of between 8-10% for grass fed cattle in the same region at the same time of the year [8]. There was a significant increase in muscle glycogen in the treatment animals from 1.27g of glycogen/100g of muscle in the controls to 1.37g of glycogen/100g of muscle. Beef cattle will be at risk of having a pH greater than 5.7 and hence dark cutting, when the muscle glycogen stores are below 0.57g/100g of muscle [13]. When considering these numbers the cattle in the current study were not at any risk of dark cutting, hence the low rate of dark cutting observed. When cattle are at risk of dark cutting, an increase in muscle glycogen by 0.1g/100g of muscletissue,could result in a sufficient pH decline to avoid dark cutting. Thus supplementing grass fed cattle with an extra 25MJ of energy per day for 14 days did increase the muscle glycogen stores, and under different conditions could possible result in a decrease in the rate of dark cutting.

There was an observed effect of muscle glycogen decreasing as carcass rib fat increased. Across the range of rib fat (3-11mm) muscle glycogen decreased by 0.07g/100g of muscle (Figure 1). It would generally be assumed that a fatter carcass would be at a higher plane of nutrition and thus would have greater glycogen stored. However, previous studies have suggested that fatter cattle are more adrenaline sensitive and thus utilize glycogen pre-slaughter at a greater rate [14].

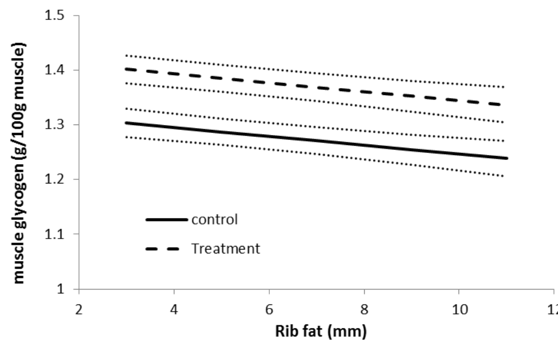

Figure 1 The effect of rib fat on muscle glycogen at slaughter in supplemented (treatment) and control animals. ±standard error of the mean.

The nutritional supplementation did not result in an increase in growth rates with the average daily gains of the treatment and control groups being1.37±0.058kg and 1.31±0.063kg per day. However, the treatment carcasses were on average 3.0kg heavier than the control carcasses, when adjusted for by starting weight ($P<0.05$). Presently for a MSA graded carcass, the producer would be paid close to $5.30/kg of HSCW. An increase in 3kg would equate to $15.90 per carcass. The current penalty for non MSA carcass is about 59c less per kg HSCW [4]. On a per 100 carcass basis an increase in 3kg would be worth between $1590 and $1413 depending on the grade. At the current price of the feed provided it would cost the producer about $25 per head for 14 days on feed, and thus the carcass weight benefit alone would not cover these costs. Assuming that carcasses were 300kg HSCW, and because of the premiums received, producers would need a decrease in dark cutting by 5-6% to cover the cost of feeding. Thus a more economical alternative needs investigation.

IV. CONCLUSION

Supplementing grass fed cattle with a high energy restricted ration will increase muscle glycogen concentration at slaughter.This may be important for grass fed cattle producers who are finishing cattle on a poor plane of nutrition. The increase in glycogen could shift cattle that are at risk of dark cutting, to being compliant to MSA grading. Moreover, because of the lack of dark cutting observed, further work is required, especially in cattle that may be at risk of dark cutting.

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