EFFECTS OF BREED AND ENERGY LEVEL ON LAMB MEAT QUALITY AND RETAIL SHELF-LIFE

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I. INTRODUCTION

Meat quality is determined by colour, consumer appeal and eating quality (tenderness, flavour, overall acceptability) [1]. Colour contributes significantly to the consumer perception of meat quality and value, and discoloration compromises its appearance resulting in discounting or removal of meat from display [2]. Meat discoloration is an oxidative process that occurs in post-mortem muscle leading to conversion of oxymyoglobin and deoxymoyoglobin to metmyoglobin [3] and muscle Vitamin E concentration plays a crucial role in delaying lipid peroxidation [4-6] We have recently further shown that retail colour stability of lamb meat is influenced by breed, muscle type, packaging, and iron concentration [7]. However, the interactions between breed, nutrition and pre-slaughter stress, and the potential impacts on meat quality development and retail shelf life of lamb meat needs to be further elucidated. Therefore, the present study was designed to test the hypothesis that Merinos are more susceptible to pre-slaughter stress than crossbreds, feeding a diet high in energy will increase the muscle glycogen content, exercise stress at 2 hrs pre-slaughter will deplete muscle glycogen, particularly in Merinos, and increasing the muscle glycogen content of the knuckle will reduce the pHu and improve the shelf-life.

II. MATERIALS AND METHODS

24 Merino and second cross [Poll Dorset x (Border Leicester x Merino)] lambs were allocated to two dietary treatments (low, 7.8 MJ ME/kg DM vs high 11.8 MJ ME/kg DM energy; 12% CP) by stratified randomisation using live weight, following an adaptation period of 7 days to oaten chaff: lucerne chaff mixed with experimental diets. Lambs were fed diets for 7 weeks pre-slaughter and were removed from feed 24 hrs pre-slaughter. At 2 hr prior to slaughter, lambs were individually removed from their pens and subjected to an exercise-stress treatment for 15 min to achieve strenuous exercise and muscular fatigue. A sample of *longissimus thoracis* (LT), and *rectus femoris* (RF) was taken within 15 min post-slaughter for measurement of glycogen and lactate. The pH and temperature of these muscles was taken at 0.5, 1.5, 3.0, 4.5 and 6.0 hr post-mortem. The LT and RF were collected from one side of each carcass at 24 hr after slaughter for measurement of colour during 6 days of retail display, ultimate pH, Warner-Bratzler peak shear force (WBSF) and cooking loss [2, 7].

III. RESULTS AND DISCUSSION

Breed ($P = 0.009$), diet, ($P = 0.047$) and the interaction ($P<0.005$) influenced muscle glycogen content at slaughter; muscle glycogen was highest in second crosses lambs on HE diet, whereas second crosses on the LE diet and Merinos on LE and HE diets had similar muscle glycogen content (Table 1). The lower muscle glycogen content of Merinos could be attributed to their greater sensitivity to pre-slaughter exercise stress, as indicated by increased blood lactate at slaughter, which is discussed below. There was no effects of diet or breed on the ultimate pH of either muscle ($P>0.05$) although the the pH24 values were higher in the RF, and considered dark-cutting (>5.7, dark-cutting) relative to the LT. The high ME diet resulted in ~~0.1 lower LT muscle pH at 4.5 hr and 6 hrs post-slaughter ($P<0.05$; data not presented). There was an interaction between breed and diet ($P=0.002$); lambs of both breeds on the LE diet had similar blood lactate at slaughter, whereas HE diet lambs had lower blood lactate in 2nd crosses, and elevated blood lactate in the Merinos. The higher plasma lactate concentration at the time of slaughter observed in Merinos in this study, also reconfirms the greater sensitivity of Merino lambs to exercise stress as compared with second-cross lambs. As was expected, the LT had higher glycolytic potential and lower ultimate pH compared to the RF. Merinos produced, or tended to produce, tougher meat at day 1 ($P=0.066$) and 6 ($P = 0.014$) post-slaughter, as

indicated by the WBSF values, relative to 2nd cross lambs. The increase in WBSF for Merinos was reflected in higher cooking losses in Merinos relative to second cross (P=0.024; data not shown). The effect of breed and diet on the retail colour stability and shelf life was investigated by measuring the R630/580 (oxymyoglobin/metmyoglobin) ratio on day 1 and 6 days of simulated retail display (Table 1). An interaction between breed and diet on colour values (P=0.050) was observed; for the 2nd cross lambs, the LE diet produced the highest R630/580 values on day 6, whereas the HE diet produced the lowest R630/580 values. Conversely for Merinos, the values were intermediate with a similar trend for the diets but a smaller difference. Thus the 2nd cross lambs on LE diet showed the greatest colour stability on day 6 of display compared to Merinos and 2nd cross lambs on the HE diet. The effect of diet on meat colour stability is quite intriguing and could stem from the slower pH fall post-mortem for lambs on the LE diet, which has previously been shown to result in better shelf-life and less browning. It could also be associated with differences in metabolic and associated mitochondrial activity.

Table 1. Effect of breed [2nd cross, Poll Dorset x (Border Leicester x Merino) vs. Merino] and diet (High energy, HE vs. Low energy, LE) on plasma lactate at slaughter, total muscle glycogen (muscle glycogen), ultimate pH (pH24), Warner Bratzler shear force (WBSF) and surface colour (R630/580) on the *longissimus thoracis* (LT) and *rectus femoris* (RF).

	2nd Cross		Merino		SED	P value		
	HE	LE	HE	LE		Breed	Diet	Breed X Diet
Muscle glycogen (umol/g) - LT	139.7[a]	115.9[b]	112.6[b]	117.1[b]	6.68	0.009	0.047	0.005
- RF	105.2[a]	79.8[b]	88.2[c]	89.6[c]	5.89	0.389	0.006	0.002
Plasma lactate (mmol/L)	3.32[a]	4.75[b]	6.21[c]	4.38[b]	0.707	0.016	0.697	0.002
WBSF (kg) - Day 1	3.67	3.14	3.97	3.67	0.310	0.066	0.062	0.601
- Day 6	1.87[a]	1.64[b]	1.97[a]	2.01[a]	0.131	0.014	0.322	0.160
pH24 - LT	5.63	5.66	5.67	5.66	0.058	0.608	0.740	0.608
- RF	5.88	6.05	6.05	6.03	0.100	0.301	0.301	0.187
R630/580 ratio LT - Day 1	3.03	3.05	2.92	2.81	0.089	0.340	0.38	0.081
- Day 6	1.68[a]	2.32[b]	1.82[a]	2.12[b]	0.051	0.340	0.032	0.05

IV. CONCLUSION

Finishing lambs on a high energy diet resulted in higher muscle glycogen content in second-cross lambs but had no effect in Merino lambs. These differences in muscle glycogen did not result in any effect on muscle ultimate pH, indicating the difficulty in decreasing muscle ultimate pH in Merinos through feeding. The higher sensitivity of Merinos to stress lead to greater glycogen depletion and produced tougher meat post-slaughter, which was also reflected in higher cooking losses. Both breeds of lambs produced better shelf-life (less browning) when finished on a low energy diet rather than high energy diet, particularly for the 2nd cross lambs.

V. ACKNOWLEDGEMENT

Funding from MLA is gratefully acknowledged

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