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## BRIEF COMMUNICATION: Comparison of meat quality characteristics of lambs weaned at eight or 14 weeks of age grazing perennial ryegrass-white clover pasture or a plantain-clover mix

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### Abstract

This study compared the meat quality of lambs grazing either perennial ryegrass-white clover pasture or a plantain-clover mix (plantain, red clover, and white clover) from eight to 14 weeks of age followed by a six-week finishing period on perennial ryegrass-white clover pasture. Ewes and their lambs were allocated to four treatments: 1) lambs weaned early (eight weeks of age) on a plantain-clover mix (EARLY), 2) lambs with dam grazing a plantain-clover mix (HERB), 3) lambs with dam grazing pasture >1200 kgDM/ha (HIGH), and 4) lambs with dam grazing pasture <1200 kgDM/ha (LOW). Following the treatment period, all lambs weighing a minimum of 35 kg were sent for slaughter and all remaining lambs were managed and finished as one mob on perennial ryegrass-white clover pasture for a further six weeks. Lambs that reached a minimum 35 kg live weight were slaughtered and meat samples from each lamb were analysed for ultimate pH, meat colour (L\*, a\*, b\*), drip loss and shear force but, no difference was found in objective meat quality characteristics of lambs from different treatments.

**Keywords:** early wean; plantain-clover mix; lamb; meat quality

### Introduction

A herb-clover mix containing plantain (*Plantago lanceolata*), red clover (*Trifolium pratense*), and white clover (*Trifolium repens*) has a higher feeding value than perennial ryegrass (*Lolium perenne*)-white clover pasture. The herb-clover mix has a higher dry matter digestibility and metabolisable energy content, allowing for a higher voluntary feed intake and nutritive value compared to perennial ryegrass pastures (Kemp et al. 2010). A plantain-clover mix can be utilised to provide targeted nutrition for priority stock classes, enabling weaned lambs to grow faster compared to lambs grazing perennial ryegrass-white clover pasture, optimising lamb liveweight gain for timely finishing during summer (Somasiri et al. 2015). The plantain-clover mix has also been utilised to allow early weaning without competition from the ewe while achieving suitable lamb growth rates (Ekanayake et al. 2018).

The type of forage provided can influence lamb meat quality characteristics, for example meat from lambs grazing a plantain-clover mix has a lower shear force value compared to meat from lambs grazing perennial ryegrass-white clover pasture (Schreurs et al. 2013). The diet may act directly on meat quality characteristics but is more likely to act indirectly through differences in carcass characteristics and meat composition that are a consequence of age and live weight at slaughter (Purchas 1989).

Early weaning of lambs can be associated with nutritional stress or behaviour constraints which may limit total energy intake, reduce growth rate and mobilise fat stores (altering carcass composition) resulting in lighter carcasses at slaughter (Geenty 1980) and potentially negatively affecting carcass and meat quality characteristics. The objective of this experiment was to determine if weaning lambs early, at eight weeks of age, on to a high-nutritive-value plantain-clover mix, influence

the meat quality characteristics of lamb compared to lambs weaned conventionally, at 14 weeks and finished on perennial ryegrass pastures, and slaughtered at a minimum live weight greater than 35 kg.

### Methods

#### *Experimental design*

The study was conducted at Massey University's Tuapaka farm, located approximately 15 km north-east of Palmerston North, New Zealand. Forty-three Romney ewes rearing twin lambs (86 lambs) were used in this study. On 31 October 2016 dams and their lambs (~ eight weeks of age) weighing a minimum of 16 kg were allocated to four different treatments: 1) lambs weaned early (eight weeks of age; 31 October) onto a plantain-clover mix (EARLY) (lambs n=23), 2) lambs with their dam grazing a plantain-clover mix (HERB) (lambs n=29), 3) lambs with their dam grazing perennial ryegrass-white clover pasture >1200 kgDM/ha (HIGH) (lambs n=22), and 4) lambs with their dam grazing perennial ryegrass-white clover pasture <1200 kgDM/ha (LOW) (lambs n=12). Lambs from treatments 2, 3, and 4 were not weaned until 14 weeks of age (12 December) (Ekanayake et al. 2018). There was an unexpected death of one lamb in each of the HERB and EARLY treatments. Treatments were balanced for sex of the lamb.

At 14 weeks of age all lambs were weighed and lambs >35 kg were sent for slaughter (n=19; first slaughter). This included five lambs in the EARLY treatment, 11 from the HERB treatment and three from the HIGH treatment. Following the first slaughter at the end of the treatment period all remaining lambs were managed and finished together as one mob on high-quality pasture (>11 MJ ME) for six weeks. After six weeks (24 January) lambs weighing

more than 35 kg were slaughtered (n=67; second slaughter). The finishing period aimed to ensure all lambs reached a minimum set live weight >35 kg at slaughter.

Lambs were slaughtered at the Alliance Group Dannevirke plant. Following commercial dressing procedures, carcasses were chilled and stored at 4°C for 24 hours with the hind leg (bone-in, short leg) collected, vacuum packed, and stored at -20°C. At slaughter, the GR (soft tissue depth at the 12<sup>th</sup> rib 11 cm from the midline) was estimated by the Alliance Group VIAscan system.

The *M. semimembranosus* muscle was dissected from each leg and assessed for meat quality using objective tests over a three-week period with forage treatments balanced across the days of analysis. Samples were thawed at 1°C for 24 hours prior to analysis. The pH of the *M. semimembranosus* was measured by pH spear (Eutech Instruments, Singapore) calibrated to standard buffers. The *M. semimembranosus* was cut and after 30 minutes exposure to air the meat lightness ( $L^*$ ), redness ( $a^*$ ), and yellowness ( $b^*$ ) were measured using a Minolta CR-200 chromameter. Meat tenderness was determined from the peak force required to shear cylindrical cores with a 13-mm diameter obtained from 25-mm *M. semimembranosus* steaks cooked in a water bath at 70°C for 90 minutes (TMS-Pilot Texture analyser, USA). Water-holding capacity was determined by measuring the drip loss from 3 cm meat cubes suspended from a metal hook in a plastic bag chilled at 1°C. Initial weight and weight after 24 and 48 hours was recorded. Remaining meat from the *M. semimembranosus*, after meat-quality analysis, was minced (Kenwood MG450, 3-mm hole-plate), vacuum packed and frozen to analyse for intramuscular fat (IMF) content by using ether extraction (AOAC 991.30).

Carcass and meat-quality measurements were analysed in SAS 9.4 using general linear models with treatment as the fixed effect. Slaughter age was fitted as a covariate to carcass and meat quality characteristics and found to be non-significant, therefore, removed from the statistical model. In addition, hot carcass weight was fitted as a covariate to carcass characteristics and ultimate pH to meat-quality characteristics and if found to be non-significant covariates were removed from the statistical model.

## Results and discussion

The aim of this experiment was to determine if weaning lambs early onto a plantain-clover mix influenced meat quality characteristics when lambs were slaughtered at a minimum set live weight. Results show carcass weights were heavier for lambs grazing the plantain-clover mix (HERB) with their dams prior to conventional weaning compared to early weaned lambs (EARLY) and lambs grazing low pasture covers (LOW) weaned conventionally ( $P<0.05$ , Table 1). The VIAscan GR and IMF were the same among treatments ( $P>0.05$ ) which is likely a consequence of lambs being slaughtered at a minimum set live weight >35 kg.

Milk has a high-energy content which is efficiently utilised by the lamb for growth (Sañudo et al. 1998) and the lack of available milk could explain the lighter carcasses produced by early weaned lambs. It should be noted that even though carcass weights were different ( $P=0.016$ ), between treatments carcass weights differed by less than 1.3 kg (Table 1) which would only be economically significant, on a per kg basis, if it resulted in lambs shifting carcass classification.

**Table 1** Carcass and meat-quality characteristics (mean  $\pm$  SEM) of the *M. semimembranosus* from lambs weaned early, at eight weeks of age, onto a plantain-clover mix (EARLY), and conventionally weaned lambs, at 14 weeks of age, grazing a plantain-clover mix (HERB), grazing pasture >1200 kgDM/ha (HIGH) and pasture <1200 kgDM/ha (LOW). All lambs were slaughtered at a minimum live weight >35 kg.

	Treatment (n)				P value of the treatment covariate <sup>1</sup>
	EARLY (n=23)	HERB (n=29)	HIGH (n=22)	LOW (n=12)	
Carcass characteristics					
Slaughter weight <sup>2</sup>	38.2 $\pm$ 0.52	39.0 $\pm$ 0.47	38.3 $\pm$ 0.53	37.7 $\pm$ 0.72	-
Carcass weight (kg)	16.0 $\pm$ 0.27 <sup>b</sup>	16.9 $\pm$ 0.24 <sup>a</sup>	16.4 $\pm$ 0.28 <sup>ab</sup>	15.7 $\pm$ 0.37 <sup>b</sup>	-
VIAscan GR (mm) <sup>3</sup>	6.2 $\pm$ 0.58	6.0 $\pm$ 0.50	5.9 $\pm$ 0.56	6.0 $\pm$ 0.78	<0.01
IMF (%) <sup>3</sup>	1.6 $\pm$ 0.20	1.7 $\pm$ 0.20	2.1 $\pm$ 0.20	2.1 $\pm$ 0.20	NS
Meat-quality characteristics					
Ultimate pH	5.50 $\pm$ 0.03	5.48 $\pm$ 0.02	5.53 $\pm$ 0.03	5.46 $\pm$ 0.04	-
Meat colour					
$L^*$ (Lightness)	39.9 $\pm$ 0.36	39.7 $\pm$ 0.32	39.9 $\pm$ 0.37	39.7 $\pm$ 0.50	<0.001
$a^*$ (Redness)	12.1 $\pm$ 0.15	12.5 $\pm$ 0.14	12.2 $\pm$ 0.16	11.9 $\pm$ 0.22	<0.01
$b^*$ (Yellowness)	3.0 $\pm$ 0.10	3.1 $\pm$ 0.08	2.9 $\pm$ 0.10	2.9 $\pm$ 0.13	<0.001
Drip loss (%)	4.8 $\pm$ 0.36	5.2 $\pm$ 0.32	4.9 $\pm$ 0.37	4.4 $\pm$ 0.50	<0.01
Shear force (kgF)	3.23 $\pm$ 0.19	3.47 $\pm$ 0.17	3.43 $\pm$ 0.19	3.35 $\pm$ 0.26	<0.001

Covariates = hot carcass weight for carcass characteristics and ultimate pH for meat-quality characteristics, -: No covariate fitted to the model, NS: Non-significant covariate.

Slaughter weight = Lamb live weight prior to transport for slaughter.

VIAscan GR = Soft tissue depth over the 12<sup>th</sup> rib 11 cm from the midline, IMF = intramuscular fat in the *M. semimembranosus* muscle.

Values within rows with different superscripts are significantly different ( $P<0.05$ ).

Restricting ewe and lamb intake during early lactation can lower ewe milk production and cause grazing competition between ewes and lambs resulting in low lamb performance and lighter lambs at weaning (Coop et al. 1972). The potential carryover effect of feed restriction could explain the lighter carcass weights seen in the LOW treatment. Meyer et al. (1964) observed that five-month old wethers provided a feed allowance equivalent to 52% of their metabolic weight (for 42 days) and subsequently fed *ad libitum* (for 42 days) did not obtain the same carcass weight as wethers continuously fed *ad libitum* (37.8 kg vs 35.3 kg respectively).

Objective meat-quality measures were similar among the different treatments ( $P < 0.05$ ). The IMF (Hopkins et al. 2006) and ultimate pH (Purchas 1990) are two intrinsic determinants of meat that can influence meat tenderness. The lack of difference among treatments in shear force is likely to be partially explained by the similar pH and IMF. Shear force values are similar to those recorded by Purchas (1979) for the *M. semimembranosus* muscle of lamb. Likewise, Schreurs et al. (2013) recorded similar shear force values for loin samples from lambs grazing perennial ryegrass-white clover pasture and plantain-clover mixes.

Ultimate pH can influence other meat-quality traits such as colour and water-holding capacity (Schreurs et al. 2013) and can be influenced by pre-slaughter factors such as under-nutrition and stress (Campbell et al. 2011). Animals were fed *ad libitum* in the last six weeks of the study and slaughtered using standard commercial dressing procedures for New Zealand lamb, hence, the similar pH values observed are not surprising given the similar pre-slaughter conditions and treatments at slaughter. In conclusion, grazing lambs on plantain-clover or perennial ryegrass-white clover pasture for eight weeks followed by a six-week finishing period on high quality pasture does not influence lamb carcass composition or meat quality when slaughtered at  $>35$ kg live weight. Early weaning produced lighter carcasses but did not affect carcass composition or meat quality.

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