BRIEF COMMUNICATION: Effect of different herbage mixes on lamb meat quality

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Introduction

In New Zealand there is increasing use of alternative forage species for finishing lambs. The alternative forages have a higher feeding value as a consequence of the dry matter yield and chemical composition providing for greater intakes and a higher nutritive value (Kemp et al. 2010). Each forage species is unique in its nutrient composition and may provide an advantage for animal production at different times of the year (de Ruiter et al. 2007). To take advantage of the unique attributes of individual forage species, herbage mixes have been proposed to further boost lamb growth.

The diet of the lamb can influence the meat quality of the lamb, most notably the flavour of the meat can be altered (Schreurs et al. 2008; Young et al. 2003). However, other meat quality attributes such as, tenderness, colour, juiciness and nutritive value of the meat for human consumption may also be changed as a consequence of the animal's diet. The diet may act directly on the meat or may act indirectly through factors such as growth rate or level of fatness (Purchas 1989).

The objective of this study was to use objective tests to assess the meat quality of lambs that completed their growth to slaughter weight by grazing a chicory- or a plantain-based herbage mix compared to conventional perennial ryegrass and white clover pasture.

Materials and methods

Romney ram lambs were obtained from a single lot at a commercial saleyard in the week prior to the experiment. On 28 March 2012 lambs were weighed and allocated to one of three finishing-diet treatments including: perennial ryegrass-based pasture (57% perennial ryegrass, 13% white clover; n = 30), chicory herbage mix (26% chicory, 34% plantain, 13% red clover, 13% white clover; n = 30) or plantain herbage mix (42% plantain, 20% red clover, 18% white clover; n = 30). Lambs were allocated to the forage treatments to balance for initial live weight. Lambs grazed the forages for 35 days and a final unfasted live weight was obtained on the day prior to slaughter.

Lambs were slaughtered at the Alliance Group Dannevirke Plant on the 3 May 2012. At slaughter the GR (tissue depth 11 cm from the midline on the 12th rib) measurement was estimated by the Alliance Group VIAscan® system. The bone-in short-loin was collected from each carcass, vacuum-packed and chilled at 1°C for a minimum of 3 weeks. Analysis of the samples was undertaken over a three-week period with forage treatments balanced across the days of analysis. After the chilling period, the loin muscle was removed from the bone. The pH of the loin was measured by pH spear (Eutech Instruments, Singapore) calibrated to pH 4.01, 7.00 and 10.01 using standard buffers. A fresh loin slice was made and after 30 minute exposure to air the muscle lightness (L^*) and redness (a^*) were measured using a Minolta CR-200 chromameter. Tenderness was assessed by the peak force required to shear 13 mm^2 cores from loin steaks cooked in a water bath at 70°C for 90 minutes (Warner-Bratzler device, square blade). Sarcomere length was measured by laser diffraction. Myofibrillar fragmentation index used a filtration method where a muscle homogenate was drained through 230 μm pore filters. Water-holding capacity was measured using the filter-paper press method and expressed as the ratio of wetted area to muscle area.

The meat quality measurements were analysed using general linear models (PROC GLM, SAS) with dietary treatment as the fixed effect. Linear effects of GR and linear and quadratic effects of pH were fitted as covariates in the tenderness model. The hot carcass weight and day of analysis were also considered as covariates in the statistical models but, were not found to be significant contributors to the variance of the meat quality attributes.

Results and discussion

Growth rate and final live weight were greatest for lambs finished on the plantain-mix and lowest for lambs finished on perennial ryegrass-based pasture with lambs from the chicory-mix being intermediate ($P < 0.05$; Table 1). The lambs finished on the plantain-mix and chicory-mix had a similar carcass weight and GR which was greater than that of lambs finished on perennial ryegrass-based pasture ($P < 0.05$; Table 1). The growth and carcass characteristics indicate that the plantain and chicory mixes were of similar feeding value but, of greater feeding value than the perennial ryegrass pasture. There are suggestions that growth rate can influence meat quality (Payne et al. 2009) however, since the

Table 1: Growth, carcass and meat quality characteristics (mean ± standard error of mean) of lambs finished on perennial ryegrass-based pasture (n = 30) compared to a chicory (n = 30) or plantain (n = 30) herbage mix. Final live weight was an unfasted live weight recorded the day before slaughter. Shear force was adjusted to an equal GR tissue depth measurement across all treatments to compare lambs of equal fatness.

Characteristic	Forage type		
	Perennial ryegrass pasture	Chicory herbage mix	Plantain herbage mix
Growth and carcass performance			
Average daily gain (g/day)	161 ± 10[c]	258 ± 10[b]	295 ± 10[a]
Final live weight (kg)	40.1 ± 0.4[c]	43.4 ± 0.4[b]	44.9 ± 0.4[a]
Hot carcass weight (kg)	15.2 ± 0.2[b]	18.9 ± 0.2[a]	18.8 ± 0.2[a]
VIAscan® GR (mm)	3.9 ± 0.4[b]	8.8 ± 0.4[a]	8.1 ± 0.4[a]
Objective meat quality			
Ultimate pH	5.83 ± 0.02	5.84 ± 0.02	5.82 ± 0.03
Colour *L** (Lightness)	40.9 ± 0.3	40.9 ± 0.4	41.6 ± 0.3
Colour *a** (Redness)	14.8 ± 0.2	14.7 ± 0.3	15.3 ± 0.3
Shear force (kgF)	3.77 ± 0.09[a]	3.18 ± 0.15[b]	2.98 ± 0.07[b]
Adjusted shear force (kgF)	3.73 ± 0.16[a]	3.42 ± 0.18[a]	2.94 ± 0.08[b]
Sarcomere length (µm)	1.72 ± 0.02	1.71 ± 0.01	1.75 ± 0.02
Myofibrillar fragmentation (%)	98.2 ± 0.08	98.2 ± 0.13	98.3 ± 0.10
Water-holding capacity ratio	2.41 ± 0.11	2.19 ± 0.11	2.37 ± 0.10

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

forage treatments in this study were intrinsically associated with different growth rates it is impossible to separate growth rate and forage effects.

The herbage grazed by the lambs did not influence the pH, colour, sarcomere length, myofibrillar fragmentation or water-holding capacity ($P > 0.05$). Meat pH is a driver of some meat quality characteristics (Purchas & Aungsupakorn 1993). The similarity in meat quality for lambs from the different dietary treatments is likely to be partially a consequence of no difference in the ultimate pH. Sarcomere length and water-holding capacity tend to be affected by post-slaughter procedures such as the rate of chilling. All carcasses were treated the same so, it is not surprising to find that the sarcomere length and water-holding capacity were similar between diet treatments. The diet of the animal can alter the colour attributes of meat (Kim et al. 2012). However, most effects are seen with colour stability due to the anti-oxidant potential of some diets (Kim et al. 2012). Colour stability was not considered in this study but, is an attribute that needs to be considered for future studies.

The lamb meat from the chicory and plantain herbage mix treatment was more tender, as measured by shear force than those on the ryegrass pasture ($P < 0.05$). Also, when comparing carcasses of an equal fat depth for tenderness, the lambs that grazed the plantain mix had a statistically lower shear force, that is they were more tender ($P < 0.05$). The GR tissue depth is an indicator of carcass fatness. An increase in carcass fat has been attributed to an increase in intramuscular fat in the loin (McPhee et al. 2008). The fat content of the loin may have accounted for some of the variation in tenderness particularly for the animals grazed on the chicory herbage mix. This effect of fatness on tenderness has been observed in other studies (Campbell et al. 2011). It is unknown why the meat from lambs grazed on the plantain herbage mix was more tender after adjustment for fatness. Regardless, the shear force values observed were all low (<5 kgF) indicating that differences in tenderness are unlikely to be detected by consumers.

The myofibrillar fragmentation index is an indicator of the extent of degradation of the muscle structure due to aging. The high myofibrillar fragmentation index values suggest that the aging activity had been substantial. The aging of the meat samples was likely to have minimised any potential issues with tenderness.

Conclusion

Finishing lambs on herbage mixes does not appear to impose any negative effects on lamb meat eating quality when assessed by objective meat quality tests. Campbell et al. (2011) also found little influence of forage treatments on the eating quality of lamb. The relatively short grazing period in this study may not have been sufficient to generate treatment effects. A study over a longer period or a serial slaughter would provide useful information about the grazing period required for the herbage mixes to have an effect on meat quality. Furthermore, the objective tests for meat quality in this study did not allow for any effects on flavour to be tested. This is something which needs further consideration.

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