Effects of early weaning onto herb-clover mixes on lamb carcass characteristics

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Abstract

Ewes and their twin lambs (weighing at least 16 kg) were allocated to three treatments: lambs with dams on ryegrass-white clover (RG-WC) pasture until 15 weeks of age (GRASS) (lambs; n=50), lambs with dams on herb-clover mixes (plantain, chicory, red and white clovers) until 15 weeks of age (HERB) (lambs; n=50), and lambs weaned early (8 weeks old) onto herb-clover mixes and dams on RG-WC pasture (EARLY) (lambs; n=50). Average daily gain, GR soft-tissue depth and muscularity of lambs in EARLY and GRASS were lower than those in the HERB treatment (P<0.05). The muscle to bone ratio of lambs in HERB treatment was higher than those in the EARLY treatment (P<0.05). Lambs can be weaned at 8 weeks of age onto herb-clover mixes to achieve similar carcass characteristics compared to lambs weaned at 15 weeks of age on RG-WC pasture. Lambs weaned early onto herb-clover mixes had lower growth rates than the lambs not weaned early on herb-clover mixes. There were no negative effects on lamb carcass characteristics and lean-meat yield (LMY) when lambs were slaughtered at a set weight.

Keywords: early wean; herb mix; lamb; carcass; lean meat

Introduction

In New Zealand, lambs are born in late winter or early spring and are weaned between 10-15 weeks of age. The average weaning live weight is 28-30 kg (Geenty 2010). New Zealand hill country ewes' milk production peaks at week 1-2 of lactation and is very limited after week 9 when assessed by milking of the ewes (Peterson et al. 2006; Paten et al. 2013). Suckling lambs will increase their herbage intake to compensate for the lack of milk from the dam in order to meet their requirements for growth. The increased herbage intake of lambs would cause lambs to compete with ewes for the same feed resources when pasture availability is low. Studies have found that early weaning of lambs between 6-9 weeks of age is a useful farm management tool when pasture availability is low to prevent feed competition between the ewe and its lambs (Kenyon & Webby 2007; Cranston et al. 2016).

Herb-clover mixes may contain plantain (*Plantago lanceolata),* chicory (*Cichorium intybus)*, red clover (*Trifolium pratense*) and white clover (*Trifolium repens*) (Cranston et al. 2015). A herb-clover mix offers a diet of higher nutritive value compared to ryegrass (*Lolium perenne*)-based pastures and has been shown to improve lamb liveweight gains before and after weaning (Corner-Thomas et al. 2014; Somasiri et al. 2015). Early weaning of lambs onto an alternative high quality pasture with higher nutritive values such as a herb-clover mix can result in a win-win situation where ewes do not compete with lambs for feed and lambs are able to have a greater liveweight gain. Likewise, removing the lactation demands, by weaning early, can allow for the ewe to divert nutrients towards gaining body condition (Cranston et al. 2016) which allows for improved reproductive performance (Scaramuzzi et al. 2006; Corner-Thomas et al. 2015). An increased liveweight gain due to higher feed quality can result in lambs achieving their target slaughter weights early (Muir et al. 2000). To maintain lamb growth rates, lambs should be weaned early onto a highly nutritive and digestible forage and the ewe can be given lower quality feed when pasture availability is low.

It was reported by Rattray et al. (1976) that lambs weaned at 4-6 weeks after birth onto RG-WC pasture had a lower dressing-out percentage (DO%) and live weight compared to those weaned at 8 weeks of age. Considerations of the effect of early weaning on carcass characteristics are scarce. Carcass characteristic measurements such as fat percentage, muscle to bone ratio (M:B), muscularity and LMY are used either directly or indirectly for carcass classification, to determine the value of the carcass. It is important, therefore, to ensure that there are no negative effects of early weaning onto herb-clover mixes on carcass characteristics. Hence, the objective of this study was to compare the carcass characteristics of lambs that were on either a perennial ryegrass-based pasture or herb-clover mixes and weaned at either 8 weeks or 15 weeks of age.

Materials and methods

Experimental design

This study was conducted at Massey University's Keeble farm, 7 km southeast of Palmerston North, New Zealand. Seventy-five Romney ewes rearing twins (150 lambs) were used in this study. Lambs were weighed, tagged and matched to their dam at birth. Lambs were drenched at docking and then every 28 days using Ancare 'Matrix' triple combination drench (Merial Ancare, Manukau City, New Zealand). All the ewes and lambs were on RG-WC pasture prior to treatment allocation.

On 21 October 2016 (56 days after middle of lambing (1 September 2016); lambs were 8 weeks of age on average), ewes that had both twin lambs weighing at least 16 kg were allocated to one of three treatments: (i) lambs with dams on

RG-WC pasture (GRASS) (lambs n=50); (ii) lambs with dams on herb-clover mixes (plantain, chicory, red clover and white clover) (HERB) (lambs n=50); and (iii) lamb weaned early at 8 weeks old onto herb-clover mixes and dams on RG-WC pasture (EARLY) (lambs n=50).

The RG-WC pasture used in this study had not been resown within the last 5 years and contained ryegrass (19.2%), other grasses (64.5%), white clover (1.7%) and weeds (1.5%). Herb-clover mixes contained chicory (54.8%), plantain (19.4%), red clover (6.3%), white clover (4.2%), and weeds (1.3%). Ewes and lambs in the HERB treatment and the lambs in the EARLY treatment that were allocated to herb-clover mixes had a 4-day adjustment period prior to the start of the experiment where they grazed herb-clover mixes for 2, 4, 8 and 24-hour periods over the 4 respective days.

Throughout the study, ewes and lambs were offered their allocated diets *ad libitum* by rotational grazing. The *ad libitum* feeding conditions were ensured with RG-WC pasture covers greater than 1200 kg DM/ha (Morris & Kenyon 2004) and herb mixes with sward heights of 7 - 20 cm (Somasiri et al. 2016) based on achieving maximum lamb intake (Kenyon & Webby 2007). Lambs were weighed on 21st October 2016 (start), 12th December 2016 (first slaughter) and 24th January 2017 (second slaughter). At 15 weeks of age (12th December 2016), lambs from GRASS and HERB treatments were weaned. Lambs from all treatments with a live weight of >35 kg were sent for slaughter (n=28). Only four lambs in the EARLY treatment achieved the set slaughter weight at 15 weeks, whereas 15 lambs in the HERB and nine lambs in the GRASS treatment achieved the set slaughter weight at 15 weeks. The remaining lambs were grazed together on RG-WC pasture for 6 weeks. After this period, lambs with a live weight of >35 kg were sent for slaughter (25th January 2017; n=93).

Lambs were slaughtered at a commercial abattoir (Alliance Group, Dannevirke). Carcasses were prepared following standard commercial dressing produces. Each carcass was given an identification number which was linked to the electronic ID of each sheep allowing tracing of individual sheep information. The hot-carcass weight was measured at the processing plant and recorded. LMY and the GR soft tissue depth (tissue depth 110 mm from the midline on the 12th rib) was obtained using the Alliance Group VIAscan® system. The carcasses were chilled at 4°C for 24 hours and then the left leg (bone-in, short-leg) was collected from each carcass, vacuum-packed with their respective carcass identification tag and frozen at -20°C. Six leg samples, however, were missed from meat sampling at the processing plant and two lambs did not have VIAscan information.

The samples were analysed over a 6-week period with the different treatments balanced across each day of analysis. The samples were thawed at 1°C for 24 hours prior to dissection. The total leg weight and thaw loss from the leg was measured by the difference between the leg weight in packaging and dry packaging weight. Eight muscles (gracilis, sartorius, pectineus, semimembranosus, adductor, biceps femoris, semitendinosis and quadriceps femoris) were dissected from individual legs and weighed individually. The total dissectible fat was obtained from the leg and weighed as well. The femur was removed from the leg and was weighed and measured length-wise to obtain muscle-to-bone ratios (M:B; Equation 1) (Johnson et al. 2005) and muscularity (Equation 2) values following the calculations developed by Purchas et al. (1991) which express muscularity as the ratio of muscle depth (square root of muscle weight (using the same five muscles in Equation 1) per unit length of an adjacent bone) to the length of an adjacent bone. The equation used are shown below:

Equation 1:

$$M{:}B = muscle\ weight\ (semimembranosus + adductor + biceps\ femoris + semitendinosus + quadriceps\ femoris){:}\ bone\ weight$$

Equation 2:

$$Muscularity = \sqrt{muscle\ weight \times (bone\ length^{-1})} \times bone\ length^{-1}$$

Calculations and Statistical analysis

The average daily gain of lambs in the first slaughter were calculated between 8 and 15 weeks of age (52 days; $ADG_{8\text{-}15w}$). The average daily gain of lambs in the second slaughter were calculated between 8 and 21 weeks of age (96 days; $ADG_{8\text{-}21w}$). Dissectible fat and bone weight were expressed as weights and percentages of the total leg weight. The LMY, hot-carcass weight, GR and carcass characteristics presented as mean and standard error of mean.

All statistical analyses were performed using general linear models (PROC GLM, SAS) with a model that had treatment as a fixed effect and age of lamb as covariate.

Results

Percentage of lambs that reached slaughter weight

The percentage of lambs in each treatment group that reached the target slaughter weight of 35 kg on the first slaughter date (12 December 2016; 15 weeks old) was greatest in the treatment HERB (30%) compared with GRASS (18%) and EARLY (8%).

The percentage of lambs in each treatment group that did not reach the target slaughter weight of 35 kg by the end of the feeding trial was greatest in the GRASS treatment (30%) compared with EARLY (20%) and HERB (8%).

Growth and carcass characteristics

The $ADG_{8\text{-}15w}$ of lambs in the HERB treatment was the greatest, followed by the GRASS treatment then the EARLY treatment (P<0.05; Table 1). The $ADG_{8\text{-}21w}$ of lambs on the HERB treatment was greater than that of lambs in the EARLY and GRASS treatments (P<0.05; Table 1). Lambs in all three treatments had a similar LMY and hot-carcass weight (P>0.05; Table 1). The GR was lowest for lambs in the GRASS and EARLY treatments and highest for lambs in the HERB treatment (P<0.05; Table 1).

Table 1 Average daily gain (ADG) and meat processor measured carcass characteristics (mean ± standard error of mean) of lambs in three treatments: (i) lambs weaned early at 8 weeks onto herb-clover mix (EARLY); (ii) lambs with dam on ryegrass-white clover pasture and weaned at 15 weeks (GRASS); (iii) lambs with dam on herb-clover mix and weaned at 15 weeks (HERB).

Carcass Characteristic	n	Treatment			P value
		EARLY	GRASS	HERB	
$ADG_{8\text{-}15w}$ (g/day)	150	206 ± 7.2^{a}	246 ± 7.2^{b}	277 ± 7.2^{c}	<0.001
$ADG_{8\text{-}21w}$ (g/day)	121	256 ± 8.0^{a}	268 ± 8.5^{a}	307 ± 7.4^{b}	<0.001
Live $weight_{pre\text{-}slaughter\ 1}$*	28	38.9 ± 0.66^{b}	36.9 ± 0.44^{a}	36.4 ± 0.34^{a}	0.009
Live $weight_{pre\text{-}slaughter\ 2}$*	121	40.2 ± 0.46^{a}	39.1 ± 0.54^{a}	41.8 ± 0.49^{b}	0.002
VIAscan® Lean-meat yield (%)	121	54.5 ± 0.39	54.3 ± 0.41	54.2 ± 0.39	0.894
Hot-carcass weight (kg)	121	17.1 ± 0.25	16.7 ± 0.26	17.4 ± 0.23	0.132
VIAscan® GR (mm)	121	6.8 ± 0.44^{a}	6.6 ± 0.47^{a}	8.2 ± 0.41^{b}	0.017

* Live weight of lambs sent for slaughter after 15 and 21 weeks.
Values within rows with different superscripts are significantly different (P<0.05).

Table 2 Leg and muscle weights (mean ± standard error of mean) of lambs in three treatments: (i) lambs weaned early at 8 weeks onto herb-clover mix (EARLY); (ii) lambs with dam on ryegrass-white clover pasture and weaned at 15 weeks (GRASS); (iii) lambs with dam on herb-clover mix and weaned at 15 weeks (HERB).

Carcass Characteristic	Treatment (n)			P value
	EARLY (38)	GRASS (33)	HERB (44)	
Leg Weight (kg)	2.4 ± 0.03^{b}	2.3 ± 0.04^{a}	2.4 ± 0.03^{b}	0.043
Gracilis (g)	47.91 ± 0.91	48.15 ± 0.97	48.52 ± 0.84	0.884
Satorius (g)	10.71 ± 0.30	10.82 ± 0.32	10.97 ± 0.28	0.817
Pectineus (g)	29.65 ± 0.79	30.11 ± 0.85	31.86 ± 0.73	0.522
Semimembranosus(g)	261.9 ± 4.4	248.1 ± 4.7	261.5 ± 4.1	0.059
Adductor (g)	108.8 ± 2.2	104.9 ± 2.4	109.8 ± 2.1	0.276
Biceps femoris (g)	284.9 ± 4.8	248.3 ± 5.1	262.5 ± 4.4	0.110
Semitendinosus (g)	96.7 ± 1.9	95.4 ± 2.1	98.4 ± 1.8	0.552
Quadriceps femoris (g)	375.7 ± 5.7	371.0 ± 6.1	381.5 ± 5.3	0.425

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

Lamb leg yield and muscle yield

Lamb leg yield was greater in the HERB and EARLY treatments compared with the GRASS treatment (P<0.05; Table 2). After the dissection of the lamb legs, it was observed that there was no difference between the individual muscles (gracilis, satorius, pectineus, semimembranosus, adductor, biceps femoris, semitendinosus and quadriceps femoris) weights (P>0.05; Table 2).

Carcass characteristics

The bone weight was greatest in lambs in the EARLY treatment, and lowest in lambs in the GRASS treatment (P<0.05; Table 2). Lambs in the HERB treatment had bone weights that did not differ from those in the other two treatments. The bone proportion, bone length and fat proportion did not differ among treatments (P>0.05; Table 2). The dissectible fat was greatest in lambs in the HERB treatment and lowest in lambs in the GRASS treatment. Lambs in the EARLY treatment had dissectible fats that did not differ from those in the other two treatments (P<0.05; Table 2). Lambs in the EARLY treatment had the lowest M:B and lambs in the HERB treatment had the highest M:B (P<0.05; Table 2). Muscularity was highest in lambs in the HERB treatment but did not differ between the lambs in EARLY and GRASS treatments (P<0.05; Table 2).

Discussion

This study was conducted to determine the effects of early weaning of lambs onto herb-clover mixes on carcass characteristics. The growth rates of twin lambs on commercial farms has been observed as 220 g/day (Litherland & Lambert 2000). Lambs in this study achieved an ADG of at least 250 g/day from weeks 8 to 21. The higher ADG of lambs in the HERB treatment indicated that the herb-clover mix has a higher feeding value in agreement with Golding et al. (2011); Cranston et al. (2015). Although the herb-clover sward had a higher feeding value, early weaning of lambs onto herb-clover did not allow an equal number of lambs to achieve slaughter weight at 15 weeks of age and 21 weeks of age when compared to lambs on the herb-clover mix with their dams (HERB).

The lack of difference in LMY and hot-carcass weight in the treatments was not surprising because lambs are slaughtered at a set weight range. Lambs in HERB treatment had the highest GR. This is likely to be because lambs in the HERB treatment had greater metabolic energy (ME) intakes over the course of the study which provided more nutrients and energy for the deposition of fat (Cranston et al. 2015). This is supported by lambs in the HERB treatment having the greatest dissectible fat.

Table 3 Physical dissection carcass characteristics (mean ± standard error of mean) of lambs in three treatments: (i) lambs weaned early at 8 weeks onto herb-clover mix (EARLY); (ii) lambs with dam on ryegrass-white clover pasture and weaned at 15 weeks (GRASS); (iii) lambs with dam on herb-clover mix and weaned at 15 weeks (HERB).

Carcass characteristic	Treatment (n)			P value
	EARLY (38)	GRASS (33)	HERB (44)	
Bone proportion (%)	7.1 ± 0.10	6.9 ± 0.11	6.8 ± 0.10	0.205
Bone weight (g)	169.8 ± 2.4[b]	160.5 ± 2.5[a]	164.9 ± 2.2[ab]	0.030
Bone length (mm)	174.2 ± 0.8	173.6 ± 0.9	172.8 ± 0.8	0.495
Fat proportion (%)	9.2 ± 0.29	9.2 ± 0.32	9.8 ± 0.28	0.221
Dissectible fat (g)	222.3 ± 8.7[ab]	211.1 ± 9.3[a]	240.4 ± 8.1[b]	0.057
Muscle to bone ratio (M:B)	6.34 ± 0.14[a]	6.65 ± 0.13[ab]	6.81 ± 0.12[b]	0.089
Muscularity	0.46 ± 0.003[a]	0.45 ± 0.004[a]	0.46 ± 0.003[b]	0.022

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

The differences in bone weight but not bone length can be due to greater ossification, which is an indicator of a greater progression in maturity. Early weaning and a change of diet which excludes milk earlier may change the proportion and types of nutrients and metabolites used for growth, thus, it is possible that this sends signals to the bone to ossify earlier (Kirton et al. 1975). When the animal is further away from maturity, a low energy concentration in the diet has less response on lowering growth rate compared with animals closer to maturity (Lewis et al. 2004). This may be occurring to the lambs in the EARLY treatment as milk is excluded from their diet earlier, lowering the ME from feed compared with that of lambs in the HERB treatment. It is also possible that the change of diet in conjunction with weaning early alters the nutrient metabolism and hormone signalling towards tissue deposition, increasing the degree of maturity (Lewis et al. 2004). More research is needed in this area to validate this concept.

The higher M:B and muscularity for the lambs in HERB treatment is likely to be a direct reflection of the greater growth rates and the lamb depositing more muscle as a consequence of better feeding. A greater muscularity is often associated with a higher M:B and LMY but this is not necessarily the case as two animals with the same M:B ratio can have different bone lengths causing the animal with a longer and finer bone to have a lower muscularity (Purchas et al. 1991). In this study however, differences in M:B and muscularity among treatments was not substantial enough to result in differences in the VIAscan® lean meat yield.

Conclusion

Lambs can be weaned early at 8 weeks of age onto herb-clover mixed swards to achieve similar carcass characteristics compared to lambs weaned at 15 weeks of age onto traditional RG-WC pasture. Early weaning of lambs onto herb-clover mixes, however, could not match growth rates of lambs that were on herb-clover mixes with their dams until 15 weeks of age. Nevertheless, when lambs were taken to a set weight for slaughter by allowing for a longer growth period, there did not appear to be any negative effect of early weaning on lamb carcass characteristics or the yield of lean meat.

References

Corner-Thomas RA, Kemp PD, Morris ST, Kenyon PR 2014. Grazing alternative herbages in lactation increases the liveweight of both ewe lambs and their progeny at weaning. Animal Production Science 54: 1741-1746.

Corner-Thomas RA, Ridler AL, Morris ST, Kenyon PR 2015. Ewe lamb live weight and body condition scores affect reproductive rates in commercial flocks. New Zealand Journal of Agricultural Research 58: 26-34.

Cranston LM, Kenyon PR, Morris ST, Kemp PD 2015. A review of the use of chicory, plantain, red clover and white clover in a sward mix for increased sheep and beef production. Journal of New Zealand Grasslands 77: 89-94.

Cranston LM, Corner-Thomas RA, Kenyon PR, Morris ST 2016. Growth of early weaned lambs on a plantain-clover mix compared with lambs suckling their dam on a plantain-clover mix or a grass based sward. Proceedings of the New Zealand Society of Animal Production 76: 65-68.

Ekanayake WEMLJ, Corner-Thomas RA, Cranston LM, Kenyon PR, Morris ST 2017. The effect of live weight at weaning on liveweight gain of early weaned lambs onto a herb-clover mixed sward. Proceedings of the New Zealand Society of Animal Production 77: 37-42.

Geenty K 2010. Lactation and lamb growth. In: Cottle D ed. International Sheep and Wool Handbook. Nottingham, UK, University Press. Pp. 259-276.

Golding KP, Wilson ED, Kemp PDet al. 2011. Mixed herb and legume pasture improves the growth of lambs post-weaning. Animal Production Science 51: 717-723.

Johnson PL, Purchas RW, McEwan JC, Blair HT 2005. Carcass composition and meat quality differences between pasture-reared ewe and ram lambs. Meat Science 71: 383-391.

Kenyon PR, Webby RW 2007. Pastures and supplements in sheep production systems. In: Rattray PV, Brookes IM, Nicol AM ed. Pasture and supplements for grazing animals. Hamilton, New Zealand, New

Zealand Society of Animal Production. Pp. 255-274.

Kirton AH, O'Hara PJ, Cairney IM, Bishop WH, Nottingham PM 1975. Determination of age of lamb carcasses from pelvic ossification. Animal Science 21: 257-264.

Lewis RM, Macfarlane JM, Simm G, Emmans GC 2004. Effects of food quality on growth and carcass composition in lambs of two breeds and their cross. British Society of Animal Science 78: 355-367.

Litherland AJ, Lambert MG 2000. Herbage quality and growth rate of single and twin lambs at foot. Proceedings of the New Zealand Society of Animal Production 60: 55-57.

Morris ST, Kenyon PR 2004. The effect of litter size and sward height on ewe and lamb performance. New Zealand Journal of Agricultural Research 47: 275-286.

Muir PD, Smith NB, Wallace GJ, Fugle CJ, Bown MD 2000. Maximising lamb growth rates. Proceedings of the New Zealand Grassland Association 62: 55-58.

Paten AM, Kenyon PR, Lopez-Villalobos Net al. 2013. Maternal nutrition during early and mid-to-late pregnancy: Comparative effects on milk production of twin-born ewe progeny during their first lactation. Journal of Animal Science 91: 676-684.

Peterson SW, Morel PCH, Kenyon PR, Morris ST 2006. Milk production in Romney ewes lambing out of season. Proceedings of the New Zealand Society of Animal Production 66: 450-455.

Purchas RW, Abdullah AY, Davies AS 1991. An objective measure of muscularity: Changes with animal growth and differences between Genetic lines of southdown sheep. Meat Science 30: 81-94.

Rattray PV, Morrison MCL, Farquhar PA 1976. Performance of early-weaned lambs on lucerne and pasture. Proceedings of the New Zealand Society of Animal Production 36: 179-183.

Scaramuzzi RJ, Campbell BK, Downing JAet al. 2006. A review of the effects of supplementary nutrition in the ewe on the concentrations of reproductive and metabolic hormones and the mechanisms that regulate folliculogenesis and ovulation rate. Reproduction Nutrition and Development 46: 339-354.

Somasiri SC, Kenyon PR, Morel PCH, Kemp PD, Morris ST 2015. Herb-clover mixes increase lamb live weight gain and carcass weight in the autumn period. New Zealand Journal of Agricultural Research 58: 384-396.

Somasiri SC, Kenyon PR, Kemp PD, Morel PCH, Morris ST 2016. Mixtures of clovers with plantain and chicory improve lamb production performance compared to a ryegrass–white clover sward in the late spring and early summer period. Grass and Forage Science 71: 270-280.