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Carcass, liver and kidney characteristics of lambs grazing plantain (*Plantago lanceolata*), chicory (*Cichorium intybus*), white clover (*Trifolium repens*) or perennial ryegrass (*Lolium perenne*)

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ABSTRACT

Plantain (*Plantago lanceolata* L.) is being evaluated in New Zealand as a potential pasture species because of its supposed medicinal attributes. Seventy-six, four month old Coopworth ram lambs were rotationally grazed on either plantain (PL), chicory (*Cichorium intybus* L.; CH), white clover (*Trifolium repens* L.; WC) or perennial ryegrass (*Lolium perenne* L.;RG) for 82 days from January to April, 1993 at an allowance averaging 1.8 kg green DM/lamb/day. At slaughter treatment differences in carcass weight were apparent (16.8, 18.3, 20.1 and 15.6kg, respectively, for PL, CH, WC and RG). After adjustment for body size no differences in carcass characteristics were apparent between treatments. However, differences still existed for liver and kidney size. WC lambs were the heaviest at slaughter and had the largest livers after adjustment. In contrast, kidney size did not follow liveweight with PL lambs having the largest kidneys after adjustment. Serum urea and creatinine levels indicate that renal function was not impaired in PL lambs relative to RG lambs.

Keywords: carcass composition; kidney; liver; sheep; growth; *Plantago lanceolata*; *Cichorium intybus*; *Trifolium repens*; *Lolium perenne*.

INTRODUCTION

Lambs fed traditional ryegrass/white clover pasture do not perform to their full potential because protein supply to the animal is sub-optimal (Hughes *et al.*, 1980). Forage types containing protein protected from rumen degradation offer the opportunity for increasing protein supply to the animal and hence maximizing animal performance. For example, lambs fed the tannin-containing plant, Lotus pedunculatus, had lower levels of fatness at the same carcass weight than their counterparts grazing white clover (Purchas & Keogh, 1984). Tannin in sulla (*Hedysarum coronarium*) also has been shown to reduce carcass fatness (Terrill *et al.*, 1992b).

Narrow-leaved plantain (*Plantago lanceolata*; henceforth referred to as 'plantain'), is a non-leguminous, perennial herb which is under evaluation because of its supposed medicinal properties (W. Rumball pers. comm.). In the herbal literature, plantain is reputed to contain tannin (Dörfler & Roselt, 1989; Launert, 1984) and have antibiotic properties (Grieve, 1931). It is reported to be highly palatable to sheep and cattle (Milton, 1933; Ivins, 1952), and have a high mineral content (Thomas *et al.*, 1952).

Chicory appears to be an excellent feed for finishing lambs and cattle in terms of animal growth rate (Fraser *et al.*, 1988; Clark *et al.*, 1990). Low levels of tannin have been detected in chicory (0.42% of the DM) and it has been suggested that the high growth rates of ruminants fed chicory may be partly attributable to tannin protecting protein from degradation in the rumen (Terrill *et al.*, 1992a). Consistent with these findings, Komolong *et al.* (1992) found that N loss from the rumen as ammonia was as low for sheep fed chicory as that reported for protected protein (Beever & Siddons, 1986). However, there has been no comprehensive work reported on the carcass composition of lambs fed chicory.

The aim of the trial reported here was to examine carcass, liver and kidney characteristics of lambs which had grazed either plantain, chicory, white clover or perennial ryegrass (high endophyte). White clover and high endophyte ryegrass were chosen as standards because they represent the high and low ends of the spectrum for animal growth rate at pasture, and since they do not contain tannin in their foliage.

MATERIALS AND METHODS

Seventy-six Coopworth ram lambs were rotationally grazed either on "Grasslands Lancelot" plantain (n=17), "Grasslands Puna" chicory (n=20), "Grasslands Huia" white clover (n=19) or "Grasslands Supernui" perennial ryegrass (n=20) at an allowance averaging 1.8 kg green DM/lamb/day, for 82 days beginning 13 January. Lambs began grazing at 15 weeks of age and 23.4 (± 1.3, s.d.) kg fasted (24 hour) liveweight. Extra lambs were used to maintain equal feed allowances across treatments.

At the end of the trial fasted (24 hour) liveweights were obtained prior to slaughter. At slaughter, the liver and kidneys of each lamb were removed and weighed. Hot carcass weight was recorded immediately. Dressing out percentage (DO%) was calculated as hot carcass weight divided by fasted liveweight (x100). Carcasses were stored in a refrigerator overnight then cut transversally at the cranial edge of the last rib with a butcher's knife. Bone and soft tissue weights from the hindquarters (loin plus legs) of the carcass were obtained after separation by two professional butchers. Soft tissue was minced twice, subsampled twice (per lamb) and freeze dried.

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Once dried, soft tissue samples were analysed chemically for fat (Soxhlet) and protein (Kjeldahl). Dry matter analyses on the mince samples were not available. Therefore, fat and muscle weights for the hindquarters were estimated using the data of Callow (1948) which shows that water in the soft tissue is associated with protein in the ratio of 0.77: 0.23, and that the percentage of dissectible fat (adipose) tissue in the carcass, X, is related to the chemical fat (lipid) percentage of the soft tissue, Y ($Y = X * 1.071 - 4.4$; r=0.99). Thus bone weights were obtained directly, fat (adipose) weight from this prediction equation and muscle weight by difference. It was assumed that composition of the loin/hindquarter is closely correlated to composition of the whole carcass.

Blood samples were taken on day 80 of the trial, centrifuged, serum removed and then frozen. Subsequently, serum from the plantain and ryegrass treatments was analysed for urea and creatinine.

Pasture samples were taken for tannin analysis on day 48 of the trial. Tannin analysis was performed using the butanol/HCL method of Terrill *et al.* (1992a).

Analysis of variance with weight blocks fitted was used to test for significant differences between treatments in pre-slaughter liveweight, hot carcass weight, DO%, liver and kidney weight. Blocking was based on initial fasted liveweight. In an attempt to remove differences in organ and tissue weights due to body size and stage of development (relative maturity), these weights were adjusted to a common pre-slaughter liveweight by analysis of covariance. Tests showed all data to be normally distributed and, together with examination of plots, that the relationships between variables were linear.

RESULTS

White clover lambs were the heaviest at slaughter (Table 1). Plantain lambs had similar pre-slaughter liveweight but 8% greater hot carcass weight than ryegrass lambs. This is reflected in the significantly lower DO% of the lambs which grazed ryegrass. Fat, muscle and bone weights when adjusted for liveweight, did not differ significantly between treatments.

Data for estimated hindquarter fat are presented (Table 2) to show that faster growing lambs had greater absolute fat weights and a greater percentage of fat but that adjustment for the effects of treatment on overall size removed these effects.

Plantain lambs had similar liver weights to ryegrass lambs and these were less than both chicory and white clover lambs (Table 3). Plantain lambs and white clover lambs had the greatest kidney weights. After adjustment for differences in body size, differences in liver size were reduced but white clover lambs still had the largest livers. After similar adjustment to kidney size, differences between the plantain and white clover lambs increased. Plantain lambs had significantly lower serum urea and creatinine than ryegrass lambs.

DISCUSSION

Differences in fat, muscle and bone weight between treatments could be attributed entirely to differences in body size and relative development and not the pasture species themselves (Tables 1 & 2). Differences in tissue percentage fat (Table 2) could be due to advanced development in fast growing lambs i.e. they were more mature (Taylor, 1985) or to reduced intake leading to lower levels of fat for a given stage of lean body development (Koong *et al.*, 1983). Similar findings have been reported by Jagusch *et al.* (1977) and Lord *et al.* (1988).

Given the lack of treatment effects on body composition, it can be concluded that protein supply may be limiting despite the possibility of a high ratio of protein supply:protein intake or that plantain and chicory do not contain useful amounts of tannin to protect protein from rumen degradation. The former would occur if intake was low and therefore total protein intake was low. In the latter case, it has been reported in herbal literature that plantain contains tannin (eg Dörfler and Roselt, 1989). However, such claims have not been substantiated by reference to scientific papers and no other

TABLE 1: Fasted (24h) liveweight pre-slaughter, hot carcass weight (HCW), dressing out percent (DO%) and adjusted fat, muscle and bone weights for lambs which had grazed either plantain, chicory, white clover or ryegrass for 82 days in summer/autumn. Tissue weights were adjusted to a common liveweight of 37.4kg. Letters represent significant differences at the 5% level ($LSD_{0.05}$) across rows. Significance of treatment (Sig trt), significance of pre-slaughter weight covariate (where fitted; Sig cov) and standard errors of differences between means (SED) are presented.

	Plantain	Chicory	White Clover	Ryegrass	Sig trt	Sig cov	SED
Pre-slaughter weight (kg)	35.1^a	38.2^b	41.6^c	34.5^a	***	-	0.7
HCW (kg)	16.8^b	18.3^c	20.1^d	15.6^a	***	-	0.4
DO%	47.9^b	47.9^b	48.2^b	45.1^a	***	-	0.5
Fat (kg)[1,2]	1.96	1.97	2.01	1.88	NS	*	0.08
Muscle (kg)[1,2]	4.52	4.48	4.39	4.59	NS	NS	0.09
Bone (kg)[2]	1.44	1.49	1.53	1.45	NS	***	0.04

[1] estimated tissue weights
[2] in hindquarters

TABLE 2: Absolute, relative (percentage of hindquarter weight) and adjusted fat weights in the hindquarter. Significance of treatment (Sig trt), significance of covariate (where fitted; Sig cov) and standard errors of differences between means (SED) are presented.

	Plantain	Chicory	White Clover	Ryegrass	Sig trt	Sig cov	SED
Fat (kg)	1.85	1.96	2.40	1.63	***	-	0.11
Fat %	24.0	24.9	26.7	22.9	**	-	1.1
Adjusted fat (kg)	1.96	1.97	2.01	1.88	NS	*	0.06

TABLE 3: Absolute and adjusted weights for liver and kidney, serum urea and serum creatinine of lambs which grazed either plantain, chicory, white clover or ryegrass for 82 days in summer/autumn. Organs were weighed at slaughter after a 24h fast and adjusted to a common liveweight of 37.4kg. Letters represent significant differences at the 5% level ($LSD^{0.05}$) across rows. Significance of treatment (Sig trt), significance of pre-slaughter weight covariate (where fitted; Sig cov) and standard errors of differences between means (SED) are presented.

	Plantain	Chicory	White Clover	Ryegrass	Sig trt	Sig cov	SED
Liver (g)	580^{a}	649^{b}	750^{c}	545^{a}	***	-	21
Kidney (g)	143^{c}	121^{b}	135^{c}	102^{a}	***	-	4
Adj. liver (g)	600^{a}	630^{a}	680^{b}	611^{a}	*	NS	19
Adj. kidney (g)	145^{d}	119^{b}	130^{c}	109^{a}	***	***	5
Serum urea (mmol/l)	7.42^{a}	NT	NT	9.41^{b}	***	-	0.50
Serum creatinine ((mol/l)	78.6^{a}	NT	NT	86.9^{b}	*	-	3.8

[1]Not tested.

evidence has been found in the scientific literature by us. Analyses for tannin in plantain from this trial showed it be present at a low level (9.55 g/kgDM). Chicory had only trace amounts of tannin (1.36 g/kgDM). There was difficulty with analyses for some samples since the normal red colour of condensed tannin (as measured by the butanol/HCL method of Terrill *et al.*(1992a)) was apparently masked by a strong green colour from plant extraction (T.N. Barry pers. comm.).

Liver weights after the 24h fast followed the same trend as pre-slaughter liveweight (Tables 1&3). Adjustment for body size and relative maturity removed most of the difference in liver size but the heaviest, fastest growing white clover lambs, still had the largest livers (P<0.05; Table 2). This is not surprising in view of the findings of Koong *et al.* (1983) where it was shown that animals which had grown faster prior to slaughter at the same liveweight had significantly larger liver, kidney and other metabolic organs as a result of these organs having to work at a faster rate prior to slaughter in comparison to those of animals which had grown more slowly.

Kidney weights after the 24h fast for ryegrass, chicory and white clover lambs followed the same trend as pre-slaughter liveweight (Tables 1&3) and remaining differences can be explained in the same way as the liver i.e. positively related to growth rate (metabolic activity). However, plantain lambs had the largest kidneys but these were not the heaviest, fastest growing animals. Serum urea and creatinine levels were within normal ranges for plantain and ryegrass lambs (Table 2), indicating that despite plantain lambs having considerably larger kidneys than ryegrass lambs, kidney function was not impaired, rather that it was enhanced. In herbal medicine plantain is sometimes used as a diuretic (Launert, 1984). Plantain contains 1.5-4.1% aucubin in leaf DM (Bowers and Stamp, 1992). Aucubin stimulates both the removal of uric acid from tissues to blood and the excretion of uric acid from the kidneys (Kato, 1946). Plantain herbage also contains catapol at 0.7-5.0% of the DM (Bowers and Stamp, 1992). Catapol is known to be the active diuretic principle of the fruit of Catapa ovata (Kimura *et al.*, 1963; Suzuki, 1964). Hence it is possible that plantain acted as a diuretic and in response to the kidneys having to work harder they grew bigger. Lower serum creatinine and urea of plantain relative to ryegrass lambs (P<0.05) supports this hypothesis. It is also interesting that it was observed at one point in the trial that plantain lambs appeared to drink more water than their counterparts grazing other pasture species.

CONCLUSIONS

Plantain and chicory did not produce leaner lambs than white clover or ryegrass when differences due to body size and development were removed. Kidney hypertrophy in plantain fed lambs did not appear to be detrimental to the animal.

ACKNOWLEDGEMENTS

The New Zealand Meat Research and Development Council (MRDC), the Foundation for Research, Science and Technology (FRST) and the Lottery Grants Board for funding. Gavin Hirst for invaluable assistance with the day-to-day running of the grazing trial. Staff at AgResearch Lincoln and Templeton farms for assistance with field work and technical staff for assistance with carcass measurements. Dave Saville for help with statistics. Dr AH Kirton for critical comment on a draft manuscript.

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