Pasture species effects on carcass and meat quality

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Abstract

Increasing concerns about food quality and animal fat in the human diet have promoted research into the effects of different forage species on carcass quality and fat content. This trial investigated the effect on carcass composition and the intensity of sheep meat flavour and odour of five different pure pasture species: Grasslands Lancelot plantain (*Plantago lanceolata*), Grasslands Puna chicory (*Cichorium intybus*), Grasslands Huia white clover (*Trifolium repens*), Grasslands Nui high-endophyte perennial ryegrass (*Lolium perenne*) and Grasslands Goldie lotus (*Lotus corniculatus*). Although pasture species did affect meat quality and fat content, there appeared to be an inverse relationship with carcass weight: larger lambs had more fat, which was related to difference in body size and relative maturity rather that pasture species. Pasture species also influenced muscle ultimate pH, sheep meat odour, foreign odours, and flavours, but did not affect sheep meat flavour.

Keywords: *Cichorium intybus*, meat flavour, *Lolium perenne*, *Lotus corniculatus*, meat odour, *Plantago lanceolata*, *Trifolium repens*

Introduction

Increasing concerns about food quality and animal fat in the human diet have promoted investigations into the effects of different forage species on carcass quality and fat content. Lambs grazing Lotus pedunculatus, which contains tannins, are reported to have lower levels of fatness at the same carcass weight than their counterparts grazing white clover (Purchas & Keogh 1984). Tannins in sulla (*Hedysarum coronarium*) have also been shown to reduce carcass fatness (Terrill *et al*. 1992a). Chicory (*Cichorium intybus* L.; Terrill *et al*. 1992b) and plantain (*Plantago lanceolata* L.; Dorfler & Roselt 1989) are reported to contain tannins, thus they, too, might affect carcass composition.

Flavour is also of concern in meat quality. Over the past 30 years many studies have been conducted to determine if diet influences the flavour of sheep meat. Several studies have shown that meat from lambs grazed on white clover pastures has a more intense flavour than that from lambs grazed on ryegrass (Cramer *et al.* 1967; Czochanska *et al.* 1970; Shorland *et al.* 1970). In contrast, a large study by Purchas *et al.* (1986) found that pasture type did not significantly affect the flavour of the lamb, although there was a trend for lambs fed on lotus or white clover to have a stronger flavour than those grazed on lucerne or perennial ryegrass.

The present study examined the effect of pasture species on animal productivity (see Fraser & Rowarth 1996), carcass quality, and sheep meat odour and flavour.

Materials and methods

Pure stands of Grasslands Lancelot plantain (*Plantago lanceolata* L.), Grasslands Puna chicory (*Cichorium intybus* L.), Grasslands Huia white clover (*Trifolium repens* L.), Grasslands Nui high-endophyte perennial ryegrass (*Lolium perenne* L.) and Grasslands Goldie lotus (*Lotus corniculatus* L.) were established in spring 1992 at AgResearch Lincoln. Grazing periods were 83 days in year 1 and 120 days in years 2 and 3. Full details of trial protocol were given by Fraser & Rowarth (1996).

Carcass weight, dressing-out %, ultrasound GR, actual GR (measured over the 12th rib, 11 cm from the midline of the spine, with a sharpened stainless steel ruler), muscle ultimate pH., and, for year 1 of trial, carcass composition including muscle:bone ratio and fat:bone ratio were measured on half carcasses from 20 lambs per treatment.

In year 3, one leg was removed from each carcass after development of rigour, frozen at -35°C, and prepared for ultimate pH determination and sensory evaluation. Ultimate pH was determined from shavings from the semi-membranous muscle of the frozen legs, placed into 10 ml distilled water and homogenised. An Orion Ross spear electrode (8130), attached to an Orion SA250 meter, was used to measure the pH of the homogenate. Two lamb legs in the pH range of 5.56–5.63 (mean pH 5.6; low pH samples) and two lamb legs in the pH range of 5.74–6.19 (mean pH 5.9; high pH samples) were selected from each pasture type to eliminate the influence of meat pH on sensory traits (Young *et al.* 1993)

Meat was separated into fat and lean, and then recombined in the ratio 3:17 before being minced twice

through a Bauknecht mincer with a 3 mm plate. Samples were frozen at -35°C and thawed before sensory evaluation. Thirty minutes before tasting, each sample was placed into a separate stainless steel pot, covered with a lid to prevent odour transfer, and cooked in a boiling water bath until just brown. At this stage 2% (w/w) caseinate and 1% (w/w) starch were stirred into each mince sample to bind the fat and water, respectively. The sample was then cooked for another 5 minutes to allow the mince to thicken slightly (Cummings 1989). Each sample was served into 30 ml polycarbonate portion cups which were placed in a Bain-marie and held until served to panellists (within 30 minutes).

For formal evaluation, trained panellists were randomly served five samples per session. Over the course of two sessions held on the same day, each panellist tasted one high and one low pH sample from each pasture type. Samples were scored for sheep meat odour and flavour and foreign odour and flavour. Each attribute was scored on a 10-point category scale where 0 = absent and 9 = intense.

Data were analysed using Genstat.

Results and discussion

Ultrasound GR (Table 1) and actual GR (Table 2) measurements were higher for white clover, lotus and chicory than for plantain and ryegrass. This was associated with greater carcass weight for white clover, lotus and chicory than for plantain and ryegrass (Fraser & Rowarth 1996). Dressing-out percentage varied with year but was always lowest for ryegrass. Carcass analysis (Table 3) showed that white clover-fed lambs had the greatest muscle:bone, but also had the greatest fat:bone. Ryegrass-fed lambs had the smallest fat:bone, but also had the smallest muscle:bone. The relationship between the two ratios was positive, indicating that increased muscle is associated with increased fat. This was supported by the results from all three years of the trial comparing GR and carcass weights (R^2=0.80).

Pasture species affected liver and kidney weights (Table 3). Adjustment for carcass weight removed some differences, but adjusted liver weights in white clover were significantly (P<0.05) higher than for other species. This is consistent with results from Koong *et al.* (1983), who showed that fast-growing animals tend to have larger organs than slow-growing animals. Adjusted kidney weights were greatest in plantain, followed by white clover, chicory and ryegrass; all species were significantly different from each other (P<0.05). The heavy kidney weight in plantain-grazed lambs may have been due to the presence of active diuretics in the plantain (Deaker *et al.* 1994).

Lambs grazing white clover or lotus had significantly lower mean pH than those fed on plantain or ryegrass (Table 4); the pH of lambs grazing chicory was intermediate between those of these two groups. Lambs fed on white clover had a significantly stronger sheep meat odour than lambs fed on ryegrass or plantain, but pasture type did not influence the intensity of the sheep meat flavour (Table 5). Lambs fed on white clover or lotus also had a significantly higher foreign odour and foreign flavours than lambs fed on ryegrass, plantain or chicory. As the possible effect of pH on odour and flavour had been taken into account in the tasting trial design, it can be concluded that although pasture type significantly affected the ultimate pH of lambs, pasture type had no significant effect on sheep meat flavour intensity. This result supports work by Purchas *et al.* (1986) and Suzuki (1985).

Conclusions

Although pasture species affected meat quality and fat content, there appeared to be an inverse relationship with carcass weight: larger lambs had more fat, which was related to differences in body size and relative maturity rather than pasture species (Deaker *et al.* 1994).

Table 1 Effect of pasture species on ultrasonically assessed GR (mm).

Year	Chicory	Plantain	White clover	Lotus	Ryegrass
One	12.2 ± 0.41	10.6 ± 0.4	12.5 ± 0.4	n/a	9.6 ± 0.4
Two	12.6 ± 0.7	8.0 ± 0.5	15.7 ± 0.5	12.1 ± 0.4	7.1 ± 0.3
Three	18.6 ± 0.6	12.3 ± 0.5	20.4 ± 0.9	19.8 ± 0.5	14.1 ± 0.6

1 Standard error

Table 2 Effect of pasture species on hot carcass weight (kg) and GR (mm).

Year	Chicory		Plantain		White clover		Lotus		Ryegrass	
	HCW[1]	GR	HCW	GR	HCW	GR	HCW	GR	HCW	GR
One	18.3	9.8 ± 0.6[2]	16.8	8.4 ± 0.4	20.1	10.8 ± 2.6	n/a[3]	n/a	15.6	7.2 ± 0.4
Two	20.8	12.4 ± 1.0	14.1	5.6 ± 0.6	23.4	16.4 ± 0.6	19.3	12.0 ± 0.7	14.6	4.7 ± 0.5
Three	26.0	17.8 ± 1.1	17.1	8.3 ± 0.9	25.1	17.5 ± 0.8	25.9	17.7 ± 1.2	18.4	9.9 ± 0.4

1 Hot carcass weight
2 Standard error
3 Not available

Table 3 Effect of pasture species on carcass weights, dressing out %, muscle:bone and fat:bone ratios, kidney and liver weights in year one. All values adjusted to constant carcass weight by covariance.

	Chicory	Plantain	White clover	Ryegrass
Carcass weight (kg)	18.3	16.8	20.1	15.6
Dressing out %	47.9	47.9	48.3	45.2
Muscle:bone	3.49	3.47	3.51	3.43
Fat:bone	0.94	0.87	1.06	0.81
Liver (g)	648.9b	579.8a	749.6c	545.4a
Kidney (g)	121.0b	142.5c	135.1c	101.5a
Adjusted liver (g/kg HCW)	35.6a	33.9a	38.4b	34.5a
Adjusted kidney (g/kg HCW)	6.74b	8.17d	7.32c	6.16a

Means within a row that do not share the same letter are significantly different at the 5% level.

Table 4 Effect of pasture species on mean, maximum and minimum ultimate pH values of meat in year 3.

	Chicory	Plantain	White clover	Lotus	Ryegrass
n	15	14	13	16	17
mean	5.75ab	5.89bc	5.66a	5.72a	5.97c
max	6.14	6.4	5.83	6.19	6.52
min	5.40	5.60	5.50	5.50	5.61

Means within a row that do not share the same letter are significantly different at the 5% level.

Table 5 Effect of pasture species on sheep meat odour, sheep meat flavour, foreign odour and foreign flavour. Higher values indicate a greater intensity; tests were done on 2 high-pH and 2 low-pH legs for each treatment.

	Chicory	Plantain	White clover	Lotus	Ryegrass
Sheep meat odour	3.9abc	3.5c	4.7a	4.4ab	3.7bc
Sheep meat flavour	5.1a	5.2a	5.3a	5.4a	5.7a
Foreign odour	0.9b	1.1b	2.2a	2.2a	0.8b
Foreign flavour	1.7b	1.7b	2.8a	2.6a	0.8b

Means within a row that do not share the same letter are significantly different at the 5% level.

Pasture species also influenced ultimate pH., sheep meat odour, foreign odours and flavours, but did not affect sheep meat flavour as assessed by a scientific panel.

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