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Meat flavour of Romney lambs grazed under *Pinus radiata*

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ABSTRACT

Significant numbers of livestock in New Zealand are now grazed on the understorey of *Pinus radiata*. Fresh foliage of radiata pine contains aromatic monoterpenes and decaying needles resin acids. As livestock grazed under trees are known to eat both fresh and decaying pine needles, a study was made to find out if the meat quality characteristics of lambs grazed under *P. radiata* were affected.

Groups of Romney wether lambs were grazed for 49 d under *P. radiata* at 100 and 200 stems/ha and on open pasture (no trees). In addition, 2 groups were stall fed for 21 d with 23 and 21% of their intake as fresh or decaying pine needles respectively. All the lambs were slaughtered on the same day. Meat samples from each were subjected to a range of meat quality tests.

Meat from the lambs grazed under the trees, or consuming fresh or decaying needles had slightly different colour and muscle pH levels, but there were no significant effects on its flavour, aroma, texture, juiciness or tenderness. It was concluded that there are no meat taints associated with lambs grazed under radiata pine.

Keywords Romney, lamb, meat, tainting, flavour, muscle pH, *Pinus radiata*, pine, fresh/decaying needles, agroforestry.

INTRODUCTION

Two types of agroforestry systems involving *Pinus radiata* D. Don have developed in New Zealand. In the first, trees are planted onto existing farmland and once the trees are established, sheep or cattle are grazed until competition from the trees reduces pasture growth to where it is uneconomic to graze. In the second, livestock are grazed on the understorey of plantation forests, primarily to control weeds such as bracken fern (*Pteridium esculentum*) (Breach, 1988) pampas grass (*Cortaderia spp.*) (Dale and Todd, 1988) and gorse (*Ulex europaeus*) (Hansen, 1988). The sowing of *Lotus uliginosus* cv Maku in plantation forests adds significantly to the quality of feed offered (West *et al.*, 1987). The type of feed in grazed forests usually makes them more suited to cattle than sheep systems.

It is estimated that in New Zealand at least 25,000 ha of existing pasture land are used as agroforest and 70,000 ha of plantation forests have grazing leases (Hammond, 1988). The numbers of livestock involved are not known.

Livestock grazed under *P. radiata* may sometimes consume fresh (green) pine needles, both directly from young trees and also from pruning and thinning debris. A Western Australian study showed

that fresh needles of *P. radiata* as a supplement to low quality pasture could provide near maintenance rations during dry periods (Anderson, 1985). Besides the fresh needles there are also decaying (brown) pine needles available to livestock. These needles are low in nitrogen and their *in vitro* digestibilities are around 20% (Hawke *et al.*, 1984). Decaying needles can form a substantial component of understorey pasture during some periods, particularly from July to November (M.F. Hawke, pers. comm.) While sheep are known to avoid eating decaying needles, some consumption of them is inevitable, especially when the pasture is closely grazed.

Fresh needles of *P. radiata* contain a number of volatile monoterpene hydrocarbons and a lesser number of sesquiterpene hydrocarbons (Franich *et al.*, 1982). The overall content of the monoterpenes is higher in young trees and the proportion of individual monoterpenes also changes with tree age. Decaying needles have a lower volatile monoterpene content but contain significant quantities of resin acids. These can be bitter (R. Franich, pers. comm.). The implication is that if pine needles caused taints of meat, the effects could be different from fresh and decaying needles.

Besides the presence of decaying and sometimes fresh needles, stock grazed under *P. radiata* have a

modified diet through changes in the pasture botanical composition. With trees on existing pastures there is a general decline in the percentages of both white clover (*Trifolium repens*) and perennial ryegrass (*Lolium perenne*) with increasing tree competition (Percival et al., 1984). These are usually replaced by a higher content of annual grasses and Yorkshire fog (*Holcus lanatus*).

Taken collectively, the diet of livestock grazed under *P. radiata* appears significantly different from those grazed only on open pasture. With the possibility that agroforestry systems could be a major land-use in New Zealand, a study was undertaken to determine if there were any effects on a range of meat quality parameters.

EXPERIMENTAL

The meat quality experiments were conducted on lambs that were either grazed *in situ* under 2 populations of *P. radiata* or stall fed with part of their diet as fresh or decaying pine needles. For both situations each group comprised 6 Romney wether lambs which were randomised by weight at the start.

Feeding Regime

The grazing treatments were either open pasture with no trees (control) or pasture under 12-year-old *P. radiata* at either 100 or 200 stems/ha. The groups grazed under the trees had access to decaying needles but not to fresh needles. All 3 groups were offered an allowance of 3 kg of green dry matter (DM)/d with a fresh paddock weekly. The feeding regime was applied for 7 weeks. The feed on offer was calculated from quadrats and percentages of green matter, dead matter and pine needles determined.

Two groups were stall fed for 3 weeks on freshly cut pasture taken from open areas (*in vitro* digestibility 78%, nitrogen 4%) and either fresh or decaying needles (*in vitro* digestibilities 41 and 32%, nitrogen 0.8 and 1.5%) as part of the diet. The objective was to feed both groups *ad libitum*, with 30% of intake as needles. The green needles were collected from 7 to 8 year-old trees and the brown needles raked from under 12-year-old stands at 100 and 200 stems/ha.

Live weights were recorded weekly. The botanical composition of the pasture was determined from a single sample for each group.

Meat Quality

All animals were transported together by truck to the Ruakura abattoir, penned together and slaughtered within 24 h of their being removed from the feeding regimes. Carcasses were graded and rumen contents inspected for the presence of needles. Muscle pH

levels were measured with a pH meter 24 h after slaughter.

Meat quality tests were made by either:-

1. In house taste panel assessment: Leg and shoulder cuts were cooked by roasting at 163°C to an internal temperature of 75°C. On completion of cooking, the muscles *m. semimembranosus*, *m. quadriceps femoris* and *m. gluteus* of the leg as well as unspecified muscles of the shoulder were removed, wrapped in aluminium foil and held on ice until required.

Immediately prior to tasting the individual muscles were trimmed of outside tissue, any fat diced, and reheated briefly in a microwave oven.

At each tasting session 40 members of staff were asked to judge 2 samples from the 5 randomized treatments for aroma, texture, flavour, juiciness and overall acceptability on a 9 point hedonic scale, where 9 = "couldn't be better" and 1 = "couldn't be worse". The 3 separate muscles of the leg and mixture of muscles from the shoulder were used at each session. Each taster received the 2 samples from the same muscle type source. In this manner 10 panelists tasted each muscle/sample pair.

2. Analytical panel assessment: Samples of homogenous minces of *m. longissimus* were prepared by separation of the lean and fat components. The lean and fat were then recombined in the proportion 75% lean/25% fat and cooked by pan-frying in a small amount of hydrogenated vegetable oil. Sodium caseinate and starch were added on completion of cooking to stabilize the fat and thicken the mince.

Thirteen panelists trained on their ability to taste subtle differences in lamb flavour were selected to assess the trial samples. They attended 2 group flavour familiarity discussions before assessment of the experimental samples commenced. At each session the panelists were asked to judge *foreign flavour* in samples representing the 5 treatments using a 0-100 open-ended line scale, where (= "no detectable foreign flavour". A sixth reference sample presented to the panel was from fresh pasture fed lamb and was not scored but was used as a standard marker on the open-ended scale.

3. Whole cuts assessment: Leg and shoulder cuts were assessed by families purchasing meat from the Ruakura Abattoir. Each was asked to roast the cut at a specified temperature for a given time and to taste the meat before adding condiments, sauces or gravy. Each family member was asked to score the meat independently on a 1-9 scale for general preference, tenderness, flavour and juiciness (Kirton, 1966). Data were obtained from an average of 5 legs and 4 shoulders for each diet group.

RESULTS

Each of the diets was fed as planned. Besides the 3kg of green DM offered to the *in situ* fed groups, lambs under the 100 and 200 stems/ha trees were also offered 0.4 and 0.7 kg DM of decaying pine needles respectively. Examination of the rumen contents of both groups confirmed that they had consumed decaying needles. There was no evidence that these had caused rumen compaction.

Mean daily intakes of the fresh and decaying needle stall fed groups were 0.74 and 0.64 kg DM respectively. Needles on average comprised 23 and 21% of DM intake for the fresh and decaying groups respectively. The group fed fresh needles tended to select against fresh needles as the experiment progresses. This was reflected in the proportion of needles in their diet falling from 27% of total DM intake in the first week to 18% in the third week. From day 12 of the experiment this selectivity was partly overcome by chopping the fresh needles into 2 to 3 cm lengths. This problem did not occur with the decaying needle group.

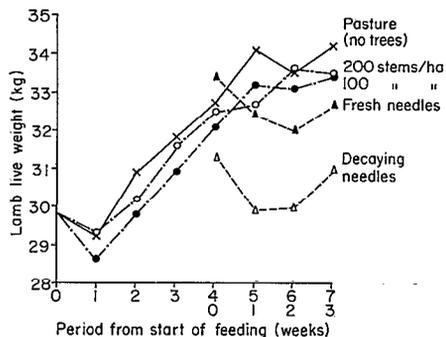


FIG. 1 Live weight of Romney lambs grazed under *P. radiata* or stall fed part of their diet as fresh or decaying pine needles.

Liveweight changes of each group over the trial period are given in Fig. 1. The *in situ* fed groups gained 3 to 4 kg over the trial but the stall fed groups lost 0.4 to 0.7 kg.

In considering the meat quality data the most important comparisons were between the open pasture, 100 and 200 stems/ha groups, or the stall fed fresh and decaying needle groups. Muscle pH values were 0.1 lower in both the 100 and 200 stems/ha *in situ* groups than those grazed on open pasture (Table 1). The 2 stallfed groups had similar muscle pH's but were slightly higher than the open pasture group. The range between the mean values was only 0.18 with no individual values outside 5.54 to 5.92.

In-House and Analytical Taste Panel assessments

These data were adjusted by covariance analysis to remove the effects of differences in the initial live weight of the lambs. The muscle samples assessed by the in-house taste panel did not show any significant differences on the aroma, texture, flavour or juiciness (Table 1). The foreign flavour intensity values were higher than expected but again there were no differences between the diet groups (Table 1). The higher than expected flavour intensities may have been associated with the spring pasture.

In addition to the quantitative assessments, the panelists also provided comments on the samples. The meat from lambs on open pasture was generally described as sweet, mild, bland and tasteless. In contrast the 200 stems/ha group comments included aromatic, meaty and initially bitter. The fresh needles group comments were meaty, stale and strong. Those for the decaying needles group were dry, strong, stale and lingering. The 100 stems/ha lambs elicited comments from all of the above, with no apparent pattern.

TABLE 1 Muscle pH and assessments by in-house tasting and analytical panels of prepared meat samples from grazed lambs under *P. radiata* or fed part of their diet as fresh or decaying needles.

Diet group	Muscle pH	In-house taste panel ¹				Analytical panel
		Aroma	Texture	Flavour	Juiciness	Foreign flavour intensity ²
Open pasture	5.71	5.9	5.9	5.9	5.0	46
100 stems/ha	5.61	5.9	6.2	5.9	5.3	49
200 stems/ha	5.61	5.8	6.1	5.9	5.3	49
Fresh needles	5.79	5.8	5.8	5.5	5.0	52
Decaying needles	5.78	5.7	6.1	5.7	5.3	50
Significance	**	NS	NS	NS	NS	NS
SED	0.04	0.2	0.3	0.2	0.4	6

¹ Scored on 1-9 scale 1 = least, 9 = greatest.

² Scored on 1-100 scale 1 = least, 100 = greatest.

TABLE 2 Ruakura taste panel assessments of leg and shoulder cuts of lambs grazed under *P. radiata* or fed part of their diet as fresh or decaying pine needles.

Diet group	General preference ¹		Tenderness ¹		Flavour ¹		Juiciness ¹	
	Leg	Shoulder	Leg	Shoulder	Leg	Shoulder	Leg	Shoulder
Open pasture	6.8	6.7	6.3	6.7	7.1	6.9	6.6	6.7
100 stems/ha	8.1	7.2	8.1	7.3	7.9	6.8	7.2	7.0
200 stems/ha	7.5	6.5	6.8	6.3	7.5	6.4	6.8	5.9
Fresh needles	7.8	7.0	8.2	6.7	8.2	7.0	7.5	6.5
Decaying needles	7.4	7.6	7.4	7.8	7.1	7.3	6.7	6.8
SED	0.6	0.7	1.0	0.9	0.6	0.8	1.0	0.8

¹ Scored on 1-9 scale 1 = least, 9 = greatest.

TABLE 3 Botanical composition of pasture offered and carcass fatness characteristics of lambs grazed under *P. radiata* or fed part of their diet as fresh or decaying needles.

Diet group	Pasture composition (% DM basis)			Carcass fatness grade ¹ (proportion in each grade)	
	Grass	White clover	Weeds	P	Y
Open pasture	81	6	9	6/6	0/6
100 stems/ha	81	9	6	5/6	1/6
200 stems/ha	61	6	29	6/6	0/6
Fresh needles	82	9	4	5/6	1/6
Decaying needles	82	9	4	3/6	3/6

¹ Backfat (GR) on Y grade lambs was less than or equal to 7mm, on P grade lambs was 7-12mm.

Whole Cuts Assessment

For each of the meat evaluation characteristics there were no significant differences between any of the diet groups (Table 2). There were suggestions in the data that the leg meat of lambs grazed under 100 stems/ha or fed partly on fresh needles was more tender, had more flavour, was more juicy and had a higher general preference.

Appearance/Eye Appeal

During meat preparation it was observed that the meat of all groups fed under the trees or partly on needles had a duller appearance than the open pasture group. There were no measurements made of this.

DISCUSSION

There was no reason to suppose that the 3 groups fed *in situ* on open pasture or under 100 or 200 stems/ha of *P. radiata* had atypical diets for stock grazing in agroforests. This was confirmed by analysis of the pasture offered to the lambs, where at 200 stems/ha there was a lower proportion of grass and a higher proportion of weeds (Table 3). This was reinforced by the presence in the rumen of decaying pine

needles in the 100 and 200 stems/ha groups and the reduced fat cover of several lambs grazed under the trees or fed part of their diet as fresh or decaying needles (Table 3).

The 2 groups of meat evaluation data, namely that from the highly controlled analytical techniques and that from the whole cuts evaluation, clearly showed that none of the feeding regimes or situations significantly affected a range of meat quality parameters. The small though significant differences in muscle pH values were of little apparent practical importance. Only when lamb muscle pH values are above 6.0 is there likely to be any concern that the higher pH may adversely affect the meat keeping quality when stored in chilled form (Chrystall *et al.*, 1980). There is no evidence to suggest that such small differences between legs in the whole cuts assessment, and comments on the meat appearance, all suggest there may be minor effects on meat quality of lambs from agroforests. If these were real, there was no consistent pattern and they were probable of no commercial significance.

In the absence of comments during cooking or tasting that suggested the presence of volatile monoterpenes, it must be assumed that either bacterial action in the gut removed such compounds or that they are not absorbed, even in low levels from the gut. It is possible that the higher than expected flavour intensity scores may have masked treatment

effects. This scenario seems unlikely, especially as over a number of years there have not been any adverse comments from staff on meat flavour of sheep and cattle grazed under radiata pine at the Tikitere Forest Farming Research Area.

CONCLUSION

There are no major aromas or taints of meat from lambs grazed under *P. radiata* or with access to fresh or decaying needles.

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