COMPARATIVE STUDIES ON THE IMPLICATIONS OF CONDENSED TANNINS IN THE EVALUATION OF *HOLCUS LANATUS* AND *LOLIUM* SPP. SWARDS FOR SHEEP PERFORMANCE

A thesis presented in partial fulfilment of the requirements for the degree of Doctor of Philosophy at Massey University, Palmerston North, New Zealand.

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This thesis is dedicated to my darling wife Adriana who helped with it more than she will ever know.

It is great beauty of our science that advancement in it, whether in a degree great or small, instead of exhausting the subject of research, opens the doors of further and more abundant knowledge, overflowing with beauty and utility, Michael Faraday 1791 - 1867.

ABSTRACT

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The series of experiments which form the basis of the present study concentrated on evaluations of: (i) diet selection, grazing behaviour, herbage intake, and sheep performance between *Holcus lanatus* (Yorkshire fog) and *Lolium* spp. (perennial or annual ryegrass) swards both associated with *Trifolium repens* (White clover), and in one study with the presence or absence of *Lotus comiculatus* (Birdsfoot trefoil), and (ii) the effects of condensed tannins (CT) on the behaviour and performance of sheep grazing those swards. The effects of CT on sheep production were assessed by twice daily oral administration of polyethylene glycol (PEG; Molecular weight 4,000) to half of the lambs on each sward combination.

Three grazing experiments are reported; the first two (Experiments 1 and 2) were carried out at Massey University (New Zealand) from 1992 to 1993, while the final trial was undertaken at INIA Tacuarembó Research Station (Uruguay) during 1994. In the first experiment (Chapter 3), relationships amongst sward, grazing behaviour, and animal performance variables were studied on perennial ryegrass/white clover and Yorkshire fog/white clover swards rotationally grazed by ewes at medium and high daily allowances (6% and 12% of liveweight as herbage dry matter respectively) during late autumn in 1992. The next experiment (Chapter 4) was designed to investigate the effects of low concentrations of condensed tannins (CT) on lambs grazing perennial ryegrass/white clover or Yorkshire fog/white clover swards at a constant height of approximately 6 cm from December 1992 to March 1993. The final experiment (Chapter 5) was carried out from August to early November 1994 to examine differences in behaviour and performance between annual ryegrass/white clover and Yorkshire fog/white clover swards, both with presence or absence of birdsfoot trefoil, rotationally grazed by lambs

Results from Experiments 1 and 2 showed that herbage intake achieved by sheep grazing perennial ryegrass swards was 15 - 27% higher than that achieved on *Holcus lanatus* swards. Bite weight was 13 - 38% greater for *Holcus lanatus* than for ryegrass, associated with the 15 - 25% greater sward bulk density. There was a consistent advantage (1 - 5%) in the organic matter digestibility of the herbage selected in favour of ryegrass swards. Sheep on both pasture types concentrated grass rather than clover in the diet. Sheep grazing on ryegrass swards had higher liveweight gains (8 - 51%), clean wool growth (6%), carcass weight (7%), GR values (22%), and carcass dressing out percentage (2%) than sheep grazing on Yorkshire fog swards. The stocking rate maintained on ryegrass plots was 25% greater than that on Yorkshire fog plots.

Similar low concentrations of CT were recorded in the diets of ryegrass and Yorkshire fog swards (≤ 0.2% on a DM basis). These results were confirmed by measurements of NH_3 concentration in the rumen fluid. The low levels of CT had no significant effects on diet selection, herbage intake, grazing behaviour patterns or lamb performance. However, the lambs grazing on Yorkshire fog swards showed small and non-persistent responses to CT in terms of faecal egg counts, wool growth and liveweight gain.

Experiment 3 indicated that the organic matter digestibility of the diet selected and the herbage intake of lambs grazing on Yorkshire fog swards were higher than those on annual ryegrass (5% and 24% respectively), reflecting the higher contents in the diet of grass green leaf and of legume and the lower content of dead material in favour of Yorkshire fog swards. Lambs grazing on both swards showed similar behaviour patterns. Those on Yorkshire fog swards had higher clean wool growth (15%), greater fibre diameter (48%), and longer fibre length (5%), greater liveweight gains (41%), final weight (11%), carcass weight (29%), carcass weight gains (29%), GR value (38%), and lower faecal egg count (FEC) values (20%).

Slightly higher CT dietary concentrations were recorded in Yorkshire fog swards than in annual ryegrass (0.420 vs 0.365 ± 0.02% on a DM basis). These low CT levels increased clean wool growth (11%), fibre diameter (4%), although differences in carcass measurements were relatively small, and tended to reduce FEC values (15%). The effects of CT on animal performance were greater in Yorkshire fog swards than in perennial ryegrass swards. CT had no significant effects on diet selection, herbage intake, or grazing behaviour patterns. The very small effects of lotus on sward composition, sward structure and on lamb performance were explained by its very low contribution to both swards.

The major conclusions of the first two experiments are as follows: (i) under high fertility conditions and intensive grazing management, perennial ryegrass/white clover swards appeared to have higher feeding value than Yorkshire fog/white clover swards for sheep production; (ii) the results of these experiments confirmed the presence of limited CT concentrations in *Holcus lanatus*, and provided further evidence that low CT concentrations also exist in perennial ryegrass; (iii) these low CT concentrations (≤ 0.2% on a DM basis) present in both swards did not influence sheep performance significantly. Finally, the conclusions of the last experiment were: (i) under low to moderate soil fertility conditions and lax rotational grazing management, Yorkshire fog swards had better composition and structure for lamb production than annual ryegrass, as a consequence of the early reproductive development in annual ryegrass; (ii) low CT concentrations (range 0.36 to 0.42% on a DM basis) consistently increased wool production and liveweight gains, particularly in Yorkshire fog swards.

The findings of these studies are discussed (Chapter 6) in the context of the role of *Holcus lanatus* for grazing systems and of the potential benefits of low dietary CT concentrations in *Holcus lanatus* and *Lolium* spp. for animal production.

Keywords: *Lolium perenne* (perennial ryegrass); *Lolium multiflorum* (annual ryegrass); *Holcus lanatus* (Yorkshire fog); *Trifolium repens* (White clover); *Lotus corniculatus* (Birdsfoot trefoil); Polyethylene glycol (PEG); Condensed tannins (CT); herbage intake; diet selection; grazing behaviour and lamb production.

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