THE EFFECT ON INTAKE, PALATABILITY AND DIGESTIBILITY OF PHENOLIC COMPOUNDS IN TAGASASTE (*CHAMAECYTISUS PROLIFERUS*)

N.J. Edwards[1], J.C. Mailey[1,4], D.M. McNeill[1,5], J.B. Lowry[2], C.S. McSweeney[2], D.A. Henry[3] and C.M. Oldham[1]

[1] Faculty of Agriculture (Animal Science), The University of Western Australia, Nedlands, WA 6907, Australia

[2] CSIRO Division of Tropical Animal Production, Long Pocket Laboratories, Indooroopilly, QLD 4068, Australia

[3] CSIRO Division of Animal Production, Private Bag, P. O. Wembley, W.A. 6014, Australia.

[4] Current Address: Agriculture Western Australia, Three Springs, WA 6519, Australia

[5] Current Address: Department of Agriculture, The University of Queensland, St Lucia, QLD 4072, Australia

ABSTRACT

The major secondary metabolites currently identified in tagasaste (*Chamaecytisus proliferus*) belong to the phenolic group of compounds. The principal phenolic compounds are the flavones, apigenin and luteolin, but low concentrations of condensed tannins, the isoflavonoid daidzein and the alkaloid sparteine have also been detected in some samples. No flavonols have been detected. There is a strong relationship between the concentration of phenolic compounds in tagasaste and its palatability. Furthermore, digestibility of tagasaste is relatively high throughout the year, thereby implicating intake as the major factor influencing the seasonality of liveweight performance of livestock grazing tagasaste. Despite confirmation of the presence of a number of secondary metabolites in tagasaste, there remains an urgent need to screen tagasaste for all possible compounds of this kind in order to fully understand the seasonal constraints to livestock production associated with this important fodder shrub.

KEYWORDS

tagasaste, animal production, secondary metabolites, phenolics, flavones, apigenin, luteolin

INTRODUCTION

Tagasaste (*Chamaecytisus proliferus*) is established as a profitable and sustainable alternative to annual pastures on deep sand in southern Australia (Oldham, 1993; Lefroy *et al.*, 1997). Despite being responsible for a 5-fold increase in livestock carrying capacity from this land (Oldham, 1993), animal productivity from tagasaste is extremely seasonal (Edwards *et al.*, 1997) even though ample feed of apparently excellent quality is available throughout the year (N.J. Edwards, unpublished data). Mirroring the seasonality of animal performance fluctuations in the concentration of phenolic compounds in the edible fraction of tagasaste (Fig. 1). These secondary metabolites are well known for their effects on palatability, intake, diet selection and digestibility as chemical means of defence for plants (Harborne, 1991; Provenza, 1996). Whilst no cause and effect relationship has been established for these compounds in tagasaste, indications are that the seasonal peak in their concentration corresponding to a trough in cattle liveweight gain is more than coincidental.

This paper discusses the identity, occurrence and action of phenolic compounds in tagasaste and their potential link to fluctuating liveweight gains typical for animals grazing this fodder shrub.

Secondary Metabolites in Tagasaste: Total phenolic concentrations in edible leaf and stem material of tagasaste routinely vary from 0.5 to 5% (expressed as tannic acid equivalents) in the cool, wet winter-spring growth period up to 10 to 12% in the hot, dry late summer-autumn. Values as high as 25% have been recorded in response to locust attack, whilst 17% phenolics has been associated with rejection of tagasaste by grazing sheep (Oldham, 1993).

Using HPLC methods, the major components of the phenolic fraction were identified as the flavones apigenin (3', 5, 7-trihydroxyflavone) and luteolin (3', 4', 5, 7-tetrahydroxyflavone), which occur as glycosides of undetermined nature in the plant. Flavones typically have anti-microbial, anti-oxidant and enzyme inhibition effects on biological systems (Harborne, 1991), however the effects of these particular compounds are unknown. Although Borens and Poppi (1990) were unable to detect tannins in tagasaste leaves, we detected low concentrations of condensed tannin (<1.5%) using identical methods to these workers. We could not, however detect any of the common flavonols, nor oestrogenic isoflavones (formononetin, genistein and biochanin A), but the isoflavone daidzein was detected. Similarly the alkaloid sparteine has been identified in a number of tagasaste subspecies grown in Spain (Muzquiz *et al.*, 1996), however alkaloids have not been measured in Australian grown tagasaste.

Palatability of Tagasaste: Under Australian grazing conditions sheep and cattle consume tagasaste with no apparent ill-effects, but an array of palatabilities have been observed between tagasaste plants, probably due to genetic and environmental variation. Mailey (1994) observed that there was no change in preference or potential intake rate (PIR) for fresh tagasaste as phenolic concentration decreased from 6 to 4%. However, preference increased from 18 to 40%† as phenolic concentration decreased from 4 to 2.75% within wilted (overnight at 60°C) treatments, but PIR did not change. Furthermore, both preference (30% v 11%; $P<0.05$) and PIR (50g DM/min v 31g DM/min; $P<0.05$) were greater for wilted than fresh tagasaste.

Whilst these results partly support the hypothesis that palatability of tagasaste increases as phenolic content increases, the situation is unclear, since both preference and PIR were expected to increase as phenolic concentration decreased. One reason for the equivocalness of these results may be the relatively low phenolic concentrations in the test materials. Another factor is that the phenolic concentration was not the only factor which differed between the test materials. For example, crude protein was 19.0% (DM basis) in low phenolic tagasaste and 13.9% in high phenolic tagasaste, dry matter digestibility was 77.8 and 75.7%, respectively and percent of leaf in the sample was 80 and 74%.

Digestibility and Intake of Tagasaste: Intake of tagasaste by livestock appears to be a major factor limiting animal production in the late summer-autumn period. Despite Oldham (1993) observing field intake estimates of around 1,000 g edible tagasaste DM/head/day for young 35kg Merino wethers in summer-autumn, recent pen feeding studies indicate these values are at the high end of the range (A.J. Williams and N.J. Edwards, unpublished data). A field study of intake and digestibility of tagasaste using n-alkane dosed cattle is nearing completion, with initial indications that a 2-fold fluctuation occurs in intake through the year. Preliminary *in sacco* digestibility results from this study (Fig. 2) indicate that digestibility of tagasaste material is seasonally variable, but remains relatively high throughout the year and should not be limiting animal liveweight gain. This is especially evident for hand picked material (Fig. 2), as this represents the 'cream' of tagasaste material available to animals. The relatively low *in sacco* digestibility for the rumen collected material in April 1996 (55.2%) is likely to be a function of the collection animals

having to consume poorly digestible material, since the amount of tagasaste available for grazing at this time may have limited intake, rather than an indication of voluntary consumption of this poor material or excessive leaching of nutrients in the rumen during sample collection.

CONCLUSIONS

The flavones, apigenin and luteolin, or their glycosidic equivalents, are the major phenolic components of tagasaste. Nevertheless, the mechanism of phenolic compounds in general, and apiginen and luteolin in particular, in the chemical defence of tagasaste from grazing is unclear. Current evidence suggests that seasonal productivity of animals grazing tagasaste is largely due to changes in feed intake through the year, mediated by the concentration of phenolic compounds in its edible leaf and stem material. There is an urgent need to identify and quantify the full range of secondary metabolites present in tagasaste under a variety of environmental and management conditions. Investigations are underway to establish roles for these compounds directly on rumen fermentation and function and hence their effect on intake and animal productivity.

We thank The University of Western Australia, Meat Research Corporation and Martindale Pty Ltd for funding this research and Greg Allen for his tireless help.

REFERENCES

Borens, F.M.P. and D.P. Poppi. 1990. The nutritive value for ruminants of tagasaste (*Chamaecytisus palmensis*), a leguminous tree. Anim. Feed Sci. Tech. **28**: 275-292.

Edwards, N.J., G.M. Allen, D.M. McNeill and C.M. Oldham. 1997. Grazing management of tagasaste (*Chamaecytisus proliferus*) for sheep and cattle production in southern Australia. Proc. 18th. Int. Grass. Cong., Canada, (this conference).

Harborne, J.B. 1991. The chemical basis of plant defence. Pages 45-59 *in* R.T. Palo and C.T. Robbins, eds. Plant defences against mammalian herbivory. CRC Press, Boca Raton, Florida.

Lefroy, E.C., A.K. Abadi Ghadim, N.J. Edwards and M.A. Ewing. 1997. The role of tagasaste (*Chamaecytisus proliferus*) in farming systems of southern Australia. Proc. 18th. Int. Grass. Cong., Canada, (this conference).

Lesperance, A.L., V.R. Bowman and D.W. Marble. 1960. Development of techniques for evaluating grazed forage. J. Dairy Sci. **43**: 682.

Mailey, J.C. 1994. Does phenolic content of tagasaste affect its palatability? Honours Thesis, Faculty of Agriculture, University of Western Australia, Nedlands, W.A., Australia.

Muzquiz, M., L.M. Robredo, C. Burbano, C. Cuadrado, G. Ayet and P. Mendez. 1996. Variation in the alkaloid content of different subspecies of *Chamaecytisus proliferus* from the Canary Islands. J. Chromatogr. A **719**: 237-243.

Oldham, C. M. 1993. Tagasaste (*Chamaecytisus palmensis*) - A fodder shrub and alternative forage. Pages 118-138 *in* D.L. Michalk, A.D. Craig and W.J. Collins, eds. Alternative pasture legumes 1993, Primary Industries South Australia, Technical Report 219.

Provenza, F.D. 1996. Familiarity and novelty in animal diets: Implications for management. Proc. Aust. Soc. Anim. Prod. **21**: 12-16.

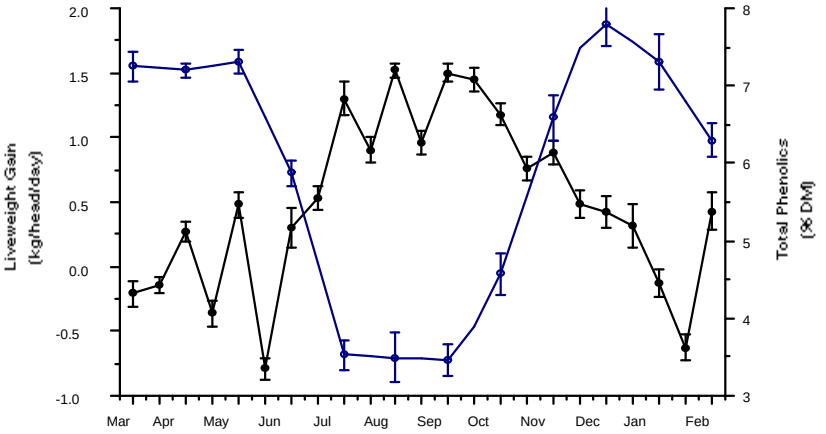

Figure 1
Seasonal fluctuations in the concentration of phenolic compounds in hand picked portions of the edible leaf and stem material of tagasaste (∘) and liveweight performance of cattle grazing that material (•) in 1994/95.

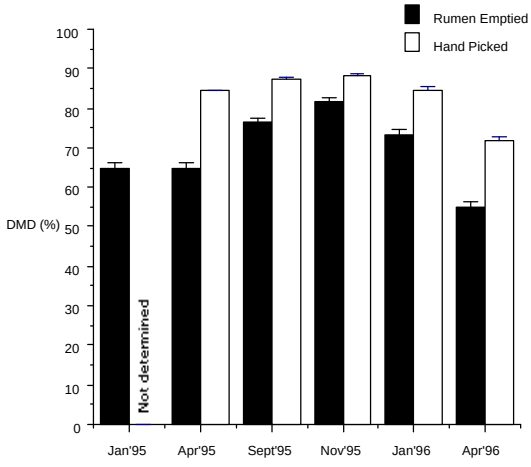

Figure 2
In sacco dry matter digestibility of rumen collected and hand picked tagasaste throughout the year (The former was collected from four fistulated Friesian steers by initially emptying their rumens of their contents as described by Lesperance *et al.* (1960). Freshly grazed material was collected from each rumen after one hour and both this and the hand picked material were freeze dried, ground through a 1 mm sieve and returned in nylon bags of 50µm pore size to the rumen of the fistulated steers for 36 hours; values are the mean ± sem for four animals, with duplicate nylon bags used for each animal).