The effect of ensiling forage legumes on condensed tannins

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Abstract

Condensed tannin (CT) containing legumes are widely known for their beneficial or anti-nutritional effects when fed to ruminants. But what happens to the CTs when these legumes are ensiled? Analyses of birdsfoot trefoil (*Lotus corniculatus*) and sulla (*Hedysarium coronarium*) crops grown at Dexcel, Hamilton, showed that total concentration of CT in dry matter (DM) was similar in fresh herbage (2.86% and 1.95% of DM) as in ensiled herbage (2.90 and 1.87 % of DM). This suggests that total CT concentration is not affected by ensilation. However, the amount of 'free' CTs (CTs not in complex with other molecules) is markedly reduced in the ensiled forages. In fresh birdsfoot trefoil herbage 67% of the CTs were free, but only 11% of the CTs were free in the ensiled birdsfoot trefoil herbage. Likewise for the sulla; 88% of the CTs in fresh sulla were free, while only 8% of CTs were free in ensiled sulla. The remaining CTs are 'bound' to other molecules such as plant proteins or fibre. This alteration in proportions is believed to be due to the process of ensilation, causing cell rupture and release of the CT from the plant cells, allowing them to bind with other molecules. The binding capability of CTs is significant to animal production, because those plant proteins bound to CTs are protected from microbial degradation in the rumen.

Additional Key Words: sulla, birdsfoot trefoil, silage.

Introduction

CTs are a group of polyphenolic compounds occurring in the vacuole of plant cells in a wide range of plant species. Temperate forage legumes that contain CTs are generating increased interest as alternative or supplementary forages for ruminants. Numerous studies have shown these forages to have significant benefits for animal production and health (Waghorn et al., 1998; Woodward et al., 1999). This is in part due to the action of CTs. CTs form complexes with plant proteins when released from plant cells (ruptured by chewing or maceration). Proteins in this complex are protected from microbial degradation in the rumen, resulting in more amino acids being transported to and absorbed by the small intestine (Waghorn et al., 1987). This is significant as up to 70% of dietary protein can be lost to microbial degradation (Barry and Duncan., 1984) which can lead to an insufficient protein supply to meet the demands of high productivity (Wang et al., 1996). Woodward et al., (1999) showed that cows fed birdsfoot trefoil (*Lotus corniculatus)* produced 47% more milk than cows fed ryegrass during summer, and the CTs were directly responsible for 42% of that increase. The remaining increase in production was due to the higher nutritive value associated with legumes (Woodward et al., 2000).

Problems with establishment, management and persistence of these legumes have limited their widespread use on commercial farms in New Zealand. However the potential animal production and health benefits of feeding birdsfoot trefoil and sulla provide good reasons why these legumes should be included in farming systems. This paper discusses the effects and implications of ensiling sulla and birdsfoot trefoil on CTs, and potential advantages of ensiling these legumes.

Materials and Methods

Crops of birdsfoot trefoil and sulla were grown at Dexcel's, No. 5 dairy farm in the Waikato region of New Zealand. The perennial birdsfoot trefoil (cv. Grasslands Goldie) was sown in March (autumn) 1997 at a rate of 15 kg of coated seed per hectare. The first silage crop was cut to 10cm and baled in January 1998. Sulla (cv. Grasslands Aokau) a biannual, was sown in November (spring) 2000 at 16 kg per hectare of uncoated hulled seed, and the first silage crop cut to 15 cm and baled in December 2000.

Samples of fresh forage cut to grazing height and samples from silage bales were collected, freeze-dried for 72 hours then ground. Ground samples were analysed for CT content using the butanol HCl method (Terrill et al., 1992). CT content was compared between samples of fresh forage and ensiled forage collected on similar dates. Herbage CT data was analysed for variance using Genstat 5.3. Adjusted means and SEDs for each forage species are presented in Table 1.

Results and Discussion

Total CT content was not affected by ensiling (Table 1). Total CT concentration was similar between the fresh and ensiled samples for both birdsfoot trefoil and sulla forages. Total CT concentrations in this experiment were low, particularly for the sulla, which typically has CT concentrations of 6 – 8% of DM (Waghorn et al., 1998). Since total CT concentration appeared to be unaffected by ensiling it was assumed that any beneficial effect of the CT in the fresh forage will also be present in the ensiled forage of birdsfoot trefoil and sulla.

The proportion of free CTs was reduced markedly with ensiling (Table 1). The greatest proportion of CTs was free in the fresh forage (67% of total CT concentration in birdsfoot trefoil and 88% in sulla), compared with only 11% and 8%, respectively, in the ensiled forages (Table 1). This change was most likely due to the process of ensiling with associated cell rupture releasing the CTs and allowing them to bind to other molecules. CTs have a stronger affinity for protein, but a small proportion (approximately 9%) will bind to fibre (Waghorn *pers. comm.*). This binding during ensiling means there are less free CTs available to bind to proteins from other plants fed with the silage. This decrease in binding capacity should be taken into consideration when incorporating these ensiled forages into a mixed ration diet.

Table 1. Total, free and bound condensed tannins (CT) concentrations, expressed as a percentage of dry matter, for fresh and ensiled birdsfoot trefoil and sulla herbage.

Forage		Fresh	Ensiled	SED
Birdsfoot trefoil	Total CT	2.89	2.90	0.023
	Free CT	1.92	0.33	0.054
	Bound CT	0.97	2.57	0.063
Sulla	Total CT	1.95	1.87	0.025
	Free CT	1.67	0.15	0.095
	Bound CT	0.28	1.72	0.089

Studies at Dexcel, in Hamilton, have shown the potential advantages of feeding CT containing legumes sulla and birdsfoot trefoil on dairy cow performance. Ensiling these crops may be one way of minimising some of the problems associated with their management and persistence. Harvesting for silage promotes growth by increasing the amount of light reaching the plant crown (Niezen et al., 1998), whereas grazing these legumes, can be risky as they are susceptible to trampling and overgrazing by stock, causing damage to the delicate plant crown, which reduces subsequent yields and crop persistence. CTs also help preserve the silage by reducing proteolysis (Waghorn et al., 1998) and plant protein loss to ammonia (Niezen et al., 1998). A high ammonia level in silage reduces forage palatability and nutritive value.

Conclusion

The CTs found in the forage legumes birdsfoot trefoil and sulla are beneficial to both animal production and health. Ensiling these forages did not appear to affect the total concentration of CT, but appeared to reduce the amount of free CTs available to bind to proteins of other plants fed with the silage.

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