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SHORT NOTE [NOTA CORTA]

CHEMICAL COMPOSITION AND DEGRADATION CHARACTERISTICS OF PUNCTURE VINE (*Tribulus terrestris)*

[COMPOSICION QUIMICA Y DEGRADACION RUMINAL DE *Tribulus terrestris*]

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SUMMARY

The chemical composition and rumen degradability of *Tribulus terrestris* was determined. It was also screened for condensed tannins (proanthocyanidins) and total phenolics. The crude protein content was 156 g/kg of dry matter (DM), the neutral detergent fibre (NDF) 467 g/kg DM, the acid detergent fibre 374 g/kg DM and the ash content 121 g/kg DM. The total phenolics (Ytterbium precipitated) content was 61.9 g/kg DM. The quickly degradable dry matter content was 247 g/kg DM, the potential degradability 716 g/kg DM and the effective degradability (k-value = 0.05) 446 g/kg DM. The quickly degradable nitrogen content was 201 g/kg of nitrogen, the potential degradability 660 g/kg N and the effective nitrogen degradability (k-value = 0.05) was 312 g/kg N. The results show that *T. terrestris* has adequate crude protein levels, low condensed tannins and total phenolics and is moderately degradable in the rumen to be utilized by ruminants as a source of nitrogen for microbial protein synthesis.

Key words: *Tribulus terrestris,* chemical composition, polyphenols, rumen degradation.

RESUMEN

Se evaluó la composición química, contenido de taninos condensados (proantocianidinas), fenoles totales y degradabilidad ruminal de *Tribulus terrestris*. El contenido de proteína cruda fue de 156 g/kg MS, FDN 467 g/kg MS, ADF 374 g/kg MS y cenizas 121 g/kg DM. El contenido fenoles fue 61 g/kg MS. Los valores de degradación ruminal para MS fueron a: 0.247, potencial de degradación (P): 0.716 y una degradabilidad efectiva (DE) (k = 0.05) de 0.446. Para N los valores fueron 0.201, 0.660 y 0.312 para a, P, y DE respectivamente. Los resultados mostraron que *T. terrestris* tiene un contenido adecuado de proteína cruda, bajo contenido de taninos y fenoles y una degradabilidad ruminal moderada, por lo que puede ser empleada como fuente de N para rumiantes.

Palabras clave: Tríbulus terrestres, composición química, fenoles, degradación ruminal.

INTRODUCTION

Nutrition remains one of the major constraints to livestock production in the tropics, particularly the lack of protein during the dry season (Karue, 1974; FAO, 1981; Minson, 1990). In developing countries, conventional protein supplements such as oilseed cakes and animal by-product meals are rarely feed because they are expensive and not readily available (Nyambati *et al.,* 1993). In Zimbabwe adapted tropical forage legumes such as *Stylosanthes guianensis* var intermedia cv. Oxley (Fine stem stylo) and *Cassia rotundifolia* cv. Wynn are currently used in veld re-enforcement in both large scale commercial and smallholder sectors (Mupangwa, 2000). However, their use in the dry areas receiving less than 450 mm rainfall per annum is limited. It is thus important to consider other locally adapted forage plants as alternative protein sources in these areas. *Tribulus terrestris* is one such plant that is widely grazed by cattle, sheep and goats in the dry western parts of Beit Bridge, Zimbabwe during the rain season. Drummond

(1984) notes that it is regarded in some parts of South Africa and Zimbabwe as a life-saving fodder for sheep and goats. Harvesting this plant and drying it during the wet season and then feeding it as a protein supplement during the dry season could improve animal production.

T. terrestris belongs to the family Zygophyllaceae. Its common name is devil's thorn, caltrops or puncture vine. It is a plant with prostrate creeping branches with a semi-perennial underground stem and root system. It is widely distributed in both tropical and warm temperate countries. The foliage of *T. terrestris* can, however, be toxic to livestock, especially sheep, when consumed in large quantities in excess of 80 percent of diet (Sahelian, 2003). Puncture vine has also been used in folk medicine throughout history, as far back as the Greeks, for wide-ranging conditions as headache, nervous disorders, constipation, and sexual dysfunction (Sahelian, 2003). The fruits/berries are the parts most often used in traditional medicine. They contain a number of different substances including saponins (protodioscin, furostanol), flavonoids, alkaloids, resins, tannins, sugars, sterols, and essential oil (Sahelian, 2003). Some of the anti-nutritional substances such as alkaloids could have a direct effect on palatability, intake and digestibility of the plant (Richards *et al.,* 1994; Reed, 1995).

The objective of this study was to carry out a quantitative assessment of usable nutrients as well as to estimate the levels of condensed tannins and total phenolics of *T. terrestris*. The rumen degradability was also determined using the nylon bag technique.

MATERIALS AND METHODS

Chemical composition of *Tribulus terrestris*

Source of *Tribulus terrestris*

The *T. terrestris* was harvested using hand clippers just before flowering in the Lupane district of Matabeleland North province in Zimbabwe, between November and December 2000. Lupane District is in Natural Region IV with an average annual rainfall of 450mm and an altitude of 1080 m above sea level. The soil type is predominantly Kalahari sands. Small stem branches with leaves were hand clipped and air-dried. During air drying the plant material was turned frequently to ensure even drying. The dried material was graded to remove large stems and hardy fruits before being packed pending chemical analysis at Matopos Research Station and rumen degradation study at the University of Zimbabwe Bio-assay laboratory.

Chemical Analysis

The air-dried material was milled through a 2 mm screen. To determine dry matter, samples were dried at 60ºC for 48 hours while the ash content was determined by igniting in a muffle furnace at 600ºC for 4 hours. Crude protein (CP) content was determined using the Kjeldahl procedure (AOAC, 1990), while neutral detergent fibre (NDF) and acid detergent fibre (ADF) were estimated according to the procedures of Goering and Van Soest (1970). Total phenolics and proanthocyanidins were estimated by the ytterbium precipitated phenolics procedure and colorimetrically by the butanol-HCl method respectively (Reed *et al.,* 1985).

Degradability of *Tribulus terrestris*

Animals and Management

Three mature Friesian-Holstein steers weighing 480 ± 20 kg, each fitted with a rubber rumen cannula of 8.5 cm diameter, were used to determine the degradability profile of the plant material using the nylon bag technique (Mehrez and Ørskov, 1977; Bhargava and Ørskov, 1987). The steers were kept in the bio-assay laboratory of the Department of Animal Science, University of Zimbabwe. The steers were fed *ad libitum* a diet of *Chloris gayana* cv. Katambora Rhodes grass hay mixed with the forage legume fine stem stylo (*Stylosanthes guianensis).* They were also feed 800g of crushed maize grain every morning. They were fed for 14 days prior to the ruminal incubation of the nylon bags, to allow animal adaptation. Fresh water was always available from drinking troughs.

Incubation Procedure

Dried and milled (2mm screen) samples, obtained from the same material used for chemical analysis, weighing approximately 3g were placed in nylon bags of 8 x 15cm and pore size of 40 to 45 µm (Polymon, Switzerland). The bags two per incubation period per steer, giving a total of fourteen bags per steer, were tied using cable tiers around a rubber stopper of 5 cm diameter which was hooked onto a flexible vinyl tube 40 cm long and of 10 mm diameter. The bags were suspended in the rumen of each steer by a nylon rope of 4 mm diameter attached to the two ends of the flexible vinyl tube. A weight was attached to one end of the flexible vinyl tube to prevent the bags from floating. Two bags per steer were withdrawn at 6, 12, 24, 48, 72, 96 and 120 hours giving a total of six bags per incubation time for the three steers. At the end of each incubation period, the bags were washed under running tap water and stored frozen until all the bags had been removed. At the end of the 120 hours of incubation all bags were hand washed under running water until the water coming out of the bags was clear. The 0 hour measurement was obtained by soaking six bags in cold water for one hour. The bags were dried

in an oven for 48 hours at 60 °C to constant weight**.** The six samples per period from the three steers were averaged and incubation was carried out once in the three steers simultaneously.

Chemical Analysis

The residues after rumen incubation were analysed for dry matter and Kjeldahl-N according to standard procedures (AOAC, 1990).

Statistical Analysis

The non- linear model ($P = a + b (1- e^{-ct})$) (Ørskov and McDonald, 1979), where P = dry matter or nitrogen degradation at time t, a = quickly degradable and soluble fraction (represented by the 0 hour samples), b = slowly degradable fraction, c = rate of degradation, t = incubation time (hour), was used to describe the pattern of degradation. The constants were fitted by an iterative least squares procedure (SAS, 1998). The effective degradability (ED) was calculated according to the model of Ørskov and McDonald (1979): ED = a + (bc / (c + k)), where k is the rumen fractional outflow rate: a value of 0.05/hr for rumen outflow rate (k) of supplement was assumed as it generally corresponds to the passage rate of low producing ruminant animals.

RESULTS

Chemical composition of *Tribulus terrestris*

The dry matter and organic matter content of the *T. terrestris* were 932 g/kg and 811 g/kg DM respectively. Crude protein (N×6.25) content was 156.25g/ kg DM, neutral detergent fibre content 467 g/kg DM, acid detergent fibre content 374 g/kg DM, acid detergent insoluble nitrogen 14 g/kg nitrogen and ash content 121 g/kg DM, while the condensed tannins (proanthocyanidin) and total phenolics content were 0.039 absorbance units per gram of dry matter and 6.19 percent of the total dry matter respectively.

Degradability of *Tribulus terrestris*

The *in situ* dry matter and nitrogen degradability constants are given in Table 1. The quickly degradable (t = 0 hours) dry matter and nitrogen was 247 g/kg DM and 201 g/kg N respectively. The extent of dry matter and nitrogen degradation was 71.6 per cent and 66.0 per cent respectively. The effective degradability at a passage rate of 5 per cent per hour of dry matter and nitrogen was 44.6 percent and 31.2 percent respectively. The rate of dry matter degradation was 0.017 while that for nitrogen was 0.016.

Table 1. The dry matter and nitrogen degradability of *T. terrestris* (g/kg).

	a	b	c	PD (a + b)	ED
Dry Matter	247	469	0.017	716	446
Nitrogen	201	459	0.016	660	312

a = quickly degradable (t =0 hours), b = insoluble but slowly degradable, c = rate of degradation, PD = potential degradability or extent of degradation, ED = effective degradability at passage rate of 5% per hour)

DISCUSSION

The crude protein content of 156.25 g/kg DM was above the proposed minimum requirement for lactation (120 g/kg DM) and growth (113 g/kg DM) in ruminant animals as reported by ARC (1984). This value also falls within the range reported for tropical legumes by other workers (Topps and Oliver, 1993; Norton and Poppi, 1995; Mupangwa, 2000). This suggests that puncture vine could be used as a source of protein to supplement low quality roughages in ruminant diets. The neutral detergent fibre of 467 g/kg DM and the acid detergent fibre of 374 g/kg DM is comparable to values of 339 to 545 g/kg DM and 374 g/kg DM reported by Topps (1993) for 13 tropical herbaceous legumes respectively and shows that it is moderately degradable in the rumen. The slowly degradable dry matter of 469 g/kg DM was just above the range of 355 to 457 g/kg DM reported for tropical herbaceous legumes (Mgheni *et al.*, 1993), while the potential dry matter degradability of 716 g/kg DM was within the range of 485 to 870 g/kg DM (Kimambo *et al.* 1994) and the range of 532 to 740 g/kg DM reported for tropical herbaceous legumes (Mgheni *et al.,* 1993).

The mean rate of dry matter degradation was comparable to the values of 0.037 per hour and 0.028

/hr for *Desmodium intortum* and *Desmodium uncinatum,* respectively (Mgheni *et al.,* 1993).

The quickly degradable nitrogen (QDN) of 201 g/kg N was just below the range of 214 to 496 g/kg DM reported by Mgheni *et al.,* (1993) for tropical herbaceous legumes. The high QDN content of puncture vine suggests that it could supply sufficient quantities of nitrogen for rumen microbial production. The slowly degradable nitrogen content of 459 g/kg N and is comparable to values of 216 to 423 g/kg N reported by Mgheni *et al.* (1993).

The rate of nitrogen degradation was similar to that reported by Mupangwa (2000) and Balde *et al.* (1993) for tropical herbaceous legumes. The potentially degradable nitrogen value of 660 g/kg N was within the range of 430 to 880 g/kg N reported by Mgheni *et al.* (1993) for *D. intortum* and *D. uncinatum.* The moderate potentially degradable nitrogen content of *T. terrestris* shows that it could be a suitable protein supplement to low quality roughages.

The condensed tannin (proanthocyanidin) content of 0.039 absorbance units per gram of dry matter was lower than for some acacia leaves in Southern Africa which was as high as 2.011 absorbance units per gram of dry matter (Dube *et al.,* 2001). The total (Ytterbium precipitated) phenolics of 6.19 per cent of dry matter was within the range of 4.7 to 29.8 per cent of total dry matter recorded for acacia leaves in Southern Africa (Dube *et al.,* 2001). The comparatively low total phenolics and condensed tannins content of puncture vine suggests that it may be suitable for supplementation of low quality diets in ruminants. However, the reported toxic effects require further analysis of *T. terrestris* to ascertain the type and amount of antinutritional substances.

CONCLUSION

The crude protein content of the *T. terrestris* and the moderate degradability suggests that it could be a suitable protein supplement to low quality roughages. There is however, a need for more detailed analysis to determine the types and levels of antinutritional substances.

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