Mal J Nutr 13(2): 179-187, 2007

In vitro Evaluation of the Nutritive Value of *Trianthema portulacastrum* as a Source of Fodder for Ruminants

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ABSTRACT

Trianthema portulacastrum (common farm weed in tropical countries) contains 21.5 ± 1.2% crude protein, similar to Lucerne with relatively low structural carbohydrate (neutral detergent fibre: 43.6 ± 3.1%). The mineral profile of *T. portulacastrum* was well above the critical level as far as calcium (0.3%), magnesium (0.2%), iron (50 ppm), copper (8 ppm), zinc (30.0 ppm) and manganese (50 ppm), whereas the phosphorus content at 0.13 ± 0.1 % was below the critical level recommended by McDowell *et al.* (1983). Degradability studies in rumen stimulation technique (RUSITEC) revealed that nearly half of the dry matter in *T. portulacastrum* was soluble and degradable, while 69.9% of the nitrogen was insoluble but degradable. The digestible rumen degradable nitrogen and digestible un-degradable nitrogen values were 1.2% and 1.4% respectively, with the total absorbable nitrogen value of 2.5%. This study revealed that supplementation of digestible organic matter to the extent of 14.9% and phosphorus to the extent of 0.2% was suggested as a tool to exploit the full potential nutritive value of *T. portulacastrum*.

INTRODUCTION

Trianthema portulacastrum is a common farm weed and belongs to the Aizoacea family. It is now naturalised throughout India in cultivable fields, riverbeds, waste ground etc. The plant is a diffused prostrate glabrous succulent herb with many angular branched stems and its flowers are pink and white colour.

T. portulacastrum has been reported in many countries having tropical climate. It is considered as a problematic terrestrial weed by virtue of its infestation in various agricultural and vegetable crops such as mustard, maize, pigeon pea, mungbean, potato, onion, cotton, soyabean, pearl millet and sugar cane, especially during rainy season (Balyan & Bhan, 1986; Simmuons, 1986). *T. portulacastrum* is available in abundant quantity at the time of de-weeding operation.

It has been observed that cattle prefers this weed in the midst of other weeds and herbages, and can be fed as sole fodder as cattle prefer to eat to the extent of 1.99 kg dry matter per 100 kg body weight (Singh *et al.*, 1982). Further reports on their medicinal value exist (Sar *et al.*, 2006; Kumar, Banu & Pandian, 2005). Thus, *T. portulacastrum* appears to be a viable unconventional fodder resource wherever fodder shortage exists. Furthermore *T. portulacastrum* constitutes a major

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component in the diet of low productive animals during the de-weeding operation. Though reports on the proximate composition, intake and digestibility of nutrients of *T. portulacastrum* are available, the rate of nutrient delivery and supplementary strategy required to enhance the utility of *T. portulacastrum* is yet to be studied. In this context, a study was carried out to determine the nutritive value, rate of nutrient delivery and supplemental strategy to be adopted to enhance the nutritive value of *T. portulacastrum.*

MATERIALS AND METHODS

About 5 kg of *T. portulacastrum* samples were collected from each of the eight different locations at Tamil Nadu. The sun-dried samples of the whole plant except roots were ground to pass through 2 mm sieve and stored in airtight container for further analysis.

Evaluation of nutritive value of *Trianthema portulacastrum*

Proximate composition of *T. portulacastrum* was determined according to AOAC (1995). Kjeltec (Model No.1002), Soxtec (Model No.1043) and Fibertec (Model No.1030) of Tecator, (Sweden) were used to estimate crude protein, ether extract and crude fibre, respectively. Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) were analysed as per the method described by Goering & Van Soest (1970) using Fibertec (model 1030). The nitrogen bound to acid detergent fibre (ADFN) was determined in ADF residue of the fibre fraction using the Fibertec. The values for these fibre fractions were expressed as per cent of dry matter. The samples were digested with perchloric and nitric acids for mineral analysis. The mineral content of *T. portulacastrum* viz. calcium, magnesium, iron, copper, manganese and zinc were determined using the Atomic Absorption Spectrophotometer (AAS) as per the procedure given in the instrument manual (Perkin Elmer, 1994). Phosphorus was determined colorimeterically using ammonium vanadate (AOAC, 1995).

Degradability study in RUSITEC to determine the rate of nutrient delivery and to evolve supplementary strategy

The *in vitro* dry matter and protein degradability characteristics of *T. portulacastrum* was determined using rumen simulation technique (RUSITEC) described by Czerkawski & Breckenridge (1977). Each of the eight samples of *T. portulacastrum* was randomly allotted to one of the eight reaction vessels. The study was carried out in duplicate in two sequential runs.

The rumen liquor used in RUSITEC was collected from three cattle maintained on grazing and the liquor was strained through four layered muslin cloth. All the operations were carried out under continuous carbon dioxide flushing. About 500 ml of this strained rumen liquor was immediately transferred into each one of reaction vessel and 200 ml of artificial saliva that was prepared as per McDougall (1948) was also added. The solid inoculum of about 80 g rumen cud was placed in a nylon bag. The feed was taken in another bag and both these bags were placed inside the perforated cage. The remaining space in the reaction vessel was filled with distilled water. On the subsequent day the solid content was removed and in its place a bag with feed was placed. The space between the lid and the liquor was around 50 – 70 ml and this was filled with carbon dioxide through a gas valve to maintain an anaerobic environment. About 800 ml of artificial saliva per 24 hours was infused through the inlet at the bottom of the reaction vessel. The dilution rate was adjusted at 0.55 ml/min.

The collection period started from the 10th day of initiation of experiment. Accurately weighed quantities of 10 g of *T.*

portulacastrum were placed in nylon bags. These bags were incubated for 6, 12, 24, 48 and 72 hours in the reaction vessel of the RUSITEC. After removal, the incubated bags were washed twice with 40 ml of artificial saliva, the washed saliva being poured back into the appropriate reaction vessel.

The bags collected after the incubation periods were washed in a washing machine for about 15 minutes and then dried in a hot air oven at 60°C for 48 hours. The bags were cooled in desiccators and weighed.

Calculations

The *in vitro* degradability values (per cent) of the samples were calculated using the following formula:

In vitro degradability

$$= \frac{\text{Weight of nylon bag with sample before incubation} - \text{weight of the nylon bag with sample after incubation}}{\text{Weight of the sample}} \times 100$$

The results of dry matter degraded at various time intervals were fitted to exponential equation of (McDonald, 1981). The equation is:

$$P = a + b\,(1 - e^{-ct})$$

Where, P = efficiency degradability
t = time
a + b = Potential degradability
c = rate of degradability

a, b and c are constants in exponential equation

The residual dry matter in the nylon bag is generally contaminated with a significant amount of microbial nitrogen (Nocek, Cummins & Polan, 1979). This contaminated nitrogen was estimated by incubation of nitrogen free cellulosic materials in a nylon bag under similar conditions and making appropriate correction prior to calculating effective degradability (Negi, Singh & Makkar, 1988). The effective rumen degradable nitrogen was thus calculated based on effective degradability. The acid detergent fibre nitrogen (ADFN) was estimated by determination of nitrogen (AOAC, 1995) in the acid detergent fibre (Goering & Van Soest, 1970) residue.

Neway Software program (Rowette Research Institute, Aberdeen, UK) was used to assess the fitted values for the degradability measurements made. The effective dry matter degradability and effective nitrogen degradability were calculated at rumen outflow rate of 0.05/hour. The effective rumen degradable nitrogen was calculated from the effective nitrogen degradability multiplied by the total nitrogen. The organic matter apparently digested was derived by multiplying organic matter with effective dry matter degradability. The digestible rumen degradable nitrogen was derived by multiplying effective rumen degradable nitrogen with 0.75 followed by 0.85 to account for microbial true protein and its digestibility (Alderman & Cottrill, 1993). The potential microbial nitrogen production was derived by dividing organic matter apparently digested by 3.33 and divided by 100 (AFRC, 1992). The difference between effective rumen degradable nitrogen and potential microbial nitrogen production reveals the scope for either non protein nitrogen supplementation or digestible organic matter supplementation to fully exploit the nutritive value of substrate.

The un-degradable nitrogen value was obtained by subtracting effective rumen degradable nitrogen from total nitrogen and digestible un-degradable nitrogen by subtracting ADFN. The total absorbed nitrogen is the sum of digestible rumen degradable nitrogen as per cent of total nitrogen and digestible un-degradable degradable nitrogen as per cent of total nitrogen.

Statistical analysis

The data obtained in different parameter was subjected to statistical analysis (Mean and SEM) as per the procedure of Snedecor & Cochran (1994).

RESULTS

The chemical composition, per cent degradability of dry matter as well as nitrogen and the degradability character of *T. portulacastrum* are presented in Tables 1, 2 and 3 respectively.

The chemical composition indicates that *T. portulacastrum* contains a good source of crude protein content with 19.6% soluble ash (total ash –acid insoluble ash) having wide ratio of calcium : phosphorus of 8.88:1 and 56.4% of cell sap (100 – Neutral detergent fibre). The mineral profile of *T. portulacastrum* was well above critical level for calcium (0.3%), magnesium (0.2%), iron (50 ppm), copper (8 ppm), zinc (30.0 ppm) and manganese (50 ppm). Acid detergent bound nitrogen constitutes only a very small proportion (2.3%) of the total nitrogen, suggestive of scope for effective utilization of the rest of the nitrogen content of *T. portulacastrum*. *T. portulacastrum* has low structural carbohydrate (crude fibre, Neutral detergent fibre).

The dry matter as well as nitrogen in *T. portulacastrum* degraded at more or less at same pace. Nearly 64% of dry matter and 68% of nitrogen were degraded at 24 hours of incubation (Table 2).

Though the degradability pattern remained similar between dry matter and nitrogen, the rate of degradation differed between them (Table 3). On the other hand the effective degradability was almost similar between dry matter and nitrogen. Lag time to initiate incubation was not observed in *T. portulacastrum.* The degradability characters revealed that a larger proportion of soluble dry matter is likely to be of non nitrogenous nutrient, whereas the insoluble and degradable dry matter is largely nitrogenous. *T. portulacastrum* has 53.2% of rumen degradable protein (per cent effective rumen degradable nitrogen to total nitrogen), which is lower than potential microbial nitrogen production and thus providing scope for digestible organic matter supplementation to exploit its nutritive value. The total absorbable nitrogen in *T. portulacastrum,* constituted 73.8% of the total nitrogen which in turn reveals that the nitrogen in the *T. portulacastrum* is efficiently utilised.

DISCUSSION

The proximate composition of *T. portulacastrum* reported in this study (Table 1) were in general agreement with the reports (Singh *et al.,* 1982; Banerjee & Mukherjee, 2000; Bharathi & Umamaheswari, 2001). The crude protein content of 21.53 ± 1.2% in *T. portulacastrum* was almost similar to leguminous fodder. The crude protein content of Lucerne for example is on an average 20-89% organic matter (McDonald *et al.,* 1999) in pre-budding stage. *T. portulacastrum* had similar crude protein but lower organic matter particularly crude fibre of 17.09 ± 0.9% on dry matter basis.

T. portulacastrum contained less structural carbohydrate than lucerne. The cell sap content (Neutral Detergent Soluble) was reported to be 49.3% in lucerne (Banerjee, 1998) compared to 56.43 per cent in *T. portulacastrum*. The hemicellulose and lignin value of *T. portulacastrum* were similar to lucerne but the cellulose content was comparatively less. The lower content of cell wall is one of the indications of better digestibility.

The total ash content of *T. portulacastrum* was 26.63 ± 1.6% out of which 7.00 ± 0.6% was acid insoluble ash, presenting a fairly high mineral content. The mineral profile of *T. portulacastrum* is well above critical level of the respective minerals as suggested by McDowell *et al* (1983) except

Table 1. Chemical composition of *Trianthema portulacastrum* (mean±SE) on dry matter basis*

Nutrient proximate composition (%)	*Composition*
Crude protein	21.53 ± 1.2
Ether extract	2.3 ± 0.4
Crude fibre	17.09 ± 0.9
Total ash	26.63 ± 1.6
Acid insoluble ash	7.00 ± 0.64
Nitrogen free extract	32.045 ± 4.3
Fibre fractions (%)	
Neutral detergent fibre	43.57 ± 3.11
Acid detergent fibre	30.93 ± 2.41
Hemicellulose	12.64 ± 0.9
Cellulose	18.23 ± 1.08
Lignin	6.23 ± 0.16
Acid detergent fibre bound nitrogen	0.08 ± 0.01
Macro minerals (%)	
Calcium	1.11 ± 0.02
Phosphorus	0.13 ± 0.1
Magnesium	0.24 ± 0.1
Trace minerals (PPM)	
Copper	33.73 ± 0.7
Iron	456.69 ± 13.05
Zinc	48.06 ± 3.24
Manganese	118.81 ± 5.08

*Mean of eight observations

Table 2. Per cent dry matter and nitrogen degradability (mean±SE) of *Trianthema portulacastrum* at different incubation periods (hours)*

Incubation period	*Dry matter degradability*	*Nitrogen degradability***
6	42.94 ± 6.0	40.05 ± 3.6
12	53.36 ± 5.2	60.03 ± 4.2
24	64.00 ± 7.1	67.95 ± 5.4
48	73.2 ± 6.6	74.80 ± 4.4
72	77.00 ± 7.0	75.61 ± 5.8

*Mean of eight observations
** Corrected for microbial nitrogen contribution

Table 3. Degradability characteristics and partitioning of nitrogen of *Trianthema portulacastrum* along with the scope for nutrient supplementation for effective utilisation (mean±SE) on dry matter basis*

Row No.	*Degradability characteristics (%)*		*Calculation*
	Dry matter		
1	Degradation rate	0.0522± 0.01	
2	Soluble fraction	30.77 ± 2.89	
3	Insoluble degradable fraction	46.86 ± 3.27	
4	Un-degradable fraction	22.37 ± 1.54	
5	Effective degradability	54.70 ± 4.26	
	Nitrogen		
6	Degradation rate	0.1206± 0.01	
7	Soluble fraction	4.69 ± 0.31	
8	Insoluble degradable fraction	69.93 ± 5.22	
9	Un-degradable fraction	25.42 ± 2.14	
10	Effective degradability	53.15 ± 4.72	
	Scope for nutrient supplementation		
11	Effective rumen degradable nitrogen	1.83 ± 0.11	Total nitrogen x Row 10
12	Digestible rumen degradable nitrogen	1.17 ± 0.07	Row 11 x 0.75 x 0.85
13	Organic matter apparently digested in the rumen	40.14 ± 3.61	((100 – Total ash) x Row 5) /100
14	Potential microbial nitrogen production	1.34 ± 0.05	(Row 14 x 3.33) /100
15	Scope for digestible organic matter supplementation	14.85 ± 1.05	(Row 11 – Row 14) x100/3.33
16	Un-degradable nitrogen	1.61 ± 0.08	Total nitrogen – Row 11
17	Digestible un-degradable nitrogen	1.37 ± 0.06	(0.9 x Row 17) - ADFN
18	Total absorbable nitrogen	2.54 ± 0.18	Row 17 + Row 12

*Mean of eight observations

for phosphorus which is lower by 0.2% than the critical level. Further a wide ratio of calcium: phosphorus (8.88:1) is suggestive of phosphorus supplementation whenever *T. portulacastrum* are fed. Thus this study suggests supplementation of 0.2% of phosphorus to low milk yielding (<6 liters of milk/day) cow to rectify mineral imbalance as well as to provide adequate level of phosphorus.

Studies on degradability and rumen characteristics

Dry matter degradability

The % dry matter degradability values of *T. portulacastrum* at 6 hours of incubation was 42.9 ± 6.0 and at 72 hours of incubation, it was 77.00 ± 7.0% (Table 2). These values were comparable to fodder verity [VG (F) 9873 of Indian Grassland Research Institute] of groundnut haulms (Sokkalingam, 2002). Dry matter degradability characteristics (Table 3) revealed a fair amount of soluble dry matter with 50% higher insoluble but degradable dry matter in *T. portulacastrum.* Absence of lag time to initiate incubation in fodder indicates the susceptibility of fodder to rumen microbial invasion and thus efficient nutrient delivery which is reflected in dry matter effective degradability of 54.7 ± 4.3%.

Nitrogen degradability

The per cent nitrogen degradability values of *T. portulacastrum* (Table 2) were comparable to fodder verity of groundnut haulms (Sokkalingam, 2002). As against the results observed in dry matter degradability, the soluble degradable nitrogen in *T. portulacastrum* was lower with higher level of insoluble but degradable nitrogen having effective degradability of 53.2 ± 4.7% resulting in steady supply of nitrogen in the rumen for microbes to utilise them effectively.

The assessment for the need of supplemental nutrients to *T. portulacastrum* indicates that the availability of digestible rumen degradable nitrogen was lower than potential microbial nitrogen, which reveals scope for further improvement in the microbial production through digestible organic matter supplementation to the extent of 14.9 ± 1.1%. Similar observations on the need to supplement digestible organic matter to enhance the nitrogen utilization were made for Tapioca leaves (Murugeswari, 2002). The total absorbable nitrogen of 2.5 ± 0.2% in *T. portulacastrum,* constituting 73.8% of the total nitrogen, reveals that the nitrogen in the *T. portulacastrum* is efficiently utilised. These observations gain significance due its highly palatable nature (1.99 kg DM per 100kg body weight) and good digestibility of 68.9% dry matter, 72.9% organic matter, 79.6% crude protein and 71.0% crude fibre (Singh *et al.,* 1982).

It is concluded that *Trianthema portulacastrum* contained 21.5 ± 1.2% crude protein content that is almost similar to Lucerne with relatively low structural carbohydrate of 43.6 ± 3.1%. The mineral profile of *T. portulacastrum* is well above critical level as far as calcium, magnesium, iron, copper, zinc and cobalt where as the phosphorus content of 0.13 ± 0.1% was below the critical level. Further a wide ratio of calcium: phosphorus (8.88:1) is suggestive of phosphorus supplementation of 0.2% whenever *T. portulacastrum* are fed as sole diet to low milk yielding (< 6 liters of milk/ day) cow. Cows yielding more than six liters cannot be maintained by sole feeding of fodders and requires concentrate supplementation that contains minerals and therefore specific supplementation of phosphorus may not be required. Degradability studies on *T. portulacastrum* conducted in RUSITEC revealed that to exploit the full potential nutritive value of *T. portulacastrum* supplementation of digestible organic matter to the extent of 14.9% is recommended.

ACKNOWLEDGEMENT

The author gratefully acknowledges the Tamil Nadu Veterinary and Animal Sciences University authorities for facilities rendered to conduct this study.

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