The effect of drying on the intake and rate of digestion of the shrub legume Calliandra calothyrsus

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Abstract

Although Calliandra calothyrsus is a productive tropical shrub legume with high crude protein content, it has not been well accepted in tropical countries as a feed source. To investigate the reputed poor acceptance of calliandra we studied the voluntary intake and in sacco digestibility of fresh and dried leaf material in experiments at Townsville.

Using Merino wethers, there was a large and significant difference (P<0.01) between the voluntary intake related to body weight (W) of fresh (59 g DM/kg W0.75) and low temperature dried (25°C) calliandra (37 g DM/kg W0.75). The higher level of voluntary intake was associated with a higher in sacco digestibility (using Droughtmaster steers) of fresh material than oven dried at 25°C or 65°C or freeze dried leaf material. Low temperature drying for quite short times (3–6 hours) depressed rate of digestion and could also depress voluntary intake.

It is recommended that only fresh material be used to evaluate calliandra. It is suggested that the same principle may well apply to other forages, especially shrub legumes.

Resumen

A pesar que Calliandra calothyrsus es un arbusto tropical productivo con alto contenido de proteína, aún no es bien aceptado en los países tropicales como fuente alimenticia. Con el fin de investigar la baja aceptación de calliandra, condujimos un estudio del consumo voluntario y de la digestibilidad in sacco de hojas frescas y secas, en Townsville.

Se encontró una diferencia significativa (P<0.01) entre el consumo voluntario relacionado con el peso corporal (W) entre el material fresco (59 g DM/kg W0.75) y el material secado a baja temperatura (25°C) (37 g DM/kg W0.75). El alto consumo voluntario fue asociado con la mayor digestibilidad in sacco (utilizando novillos Droughtmaster) del material fresco comparado con el material secado en la estufa a 25 o a 65°C y con el material congelado. Las temperaturas de secado por corto tiempo (3–6 horas) redujeron la tasa de digestión y posiblemente redujeron también el consumo voluntario.

Se recomienda utilizar únicamente material fresco para evaluar calliandra. Se sugiere que el mismo principio pudiera ser aplicado a otros forrajes, particularmente a leguminosas arbustivas.

Introduction

Calliandra calothyrsus Meissn. (calliandra) is a leguminous tree native in (sub)humid Central America between 8–16°N. From these areas it has been introduced to many of the tropical regions of the world where it has been used largely for amenity purposes. It is grown widely in Indonesia for fuel and it produces abundant leaf material, outyielding other shrub legumes, especially when grown on acid soils (Anon. 1983; Palmer et al. 1989). Although the foliage has a high crude protein content it has not been well accepted in tropical countries as a feed source either for cut and carry feeding or for direct grazing. The reason for this has not been elucidated but it appears that the cut forage is not readily accepted by stock. This paper describes a study of the voluntary intake of fresh and low temperature (25°C) dried, hereafter described as wilted
calliandra, and of the possible reason for the observed differences in voluntary intake.

Materials and methods

Experiment 1. Voluntary intake

Calliandra was grown at Lansdown (19°13' S, 146°48' E) near Townsville on an alluvial soil in rows 2 m apart with 0.5 m between plants. At the time of the experiment the plants were 12 months old and had been cut at 3-monthly intervals to a height of 1 m. Superphosphate was applied at transplanting at a rate of 20 kg/ha P.

Fresh calliandra leaf from 3-month regrowth was harvested twice daily at approximately 0900 and 1800 h. During an acclimatisation period of 10 days, six merino wethers (18 months old, average weight 27 kg) were fed a 50:50 mixture of fresh calliandra and a poor quality Chloris gayana hay.

Voluntary intake of fresh and wilted calliandra (as sole diets) was determined during an 8-day measurement period in which animals were offered approximately 80 g of excess dry matter (DM) each day. The fresh calliandra was offered to three sheep within 30 mins of collecting, whereas the other 3 sheep were offered calliandra that had been wilted for 24 h in a forced draft oven at 25°C. Feed residues were collected twice daily and dried at 65°C for 72 h to determine DM content. Voluntary intake was expressed as DM intake per unit of metabolic weight of the animal (W^{0.75}, where W is the liveweight of the animal in kilograms).

Experiment 2. Rate of digestion

Rate of digestion of fresh, wilted and dried calliandra was determined using the in sacco technique (Ørskov 1984) in each of four mature Droughtmaster steers fitted with rumen cannulae.

The 4 treatments imposed on the leaf material were as follows:
1. Fresh material (harvested immediately prior to insertion).
2. Wilted at 25°C for 24 h in a forced draft oven.
3. Dried at 65°C in a forced draft oven.
4. Freeze dried.

The animals were fed a 20:80 mixture of fresh calliandra and Chloris gayana hay at 3-hourly intervals using an automatic feeder to minimise diurnal variation (Minson and Cowper 1966). The in sacco bags used were 150 x 80 mm, made from dacron cloth with a pore size of 50 μm. Bags were filled with 10 g of fresh leaf chopped to a mean size of 2.5 mm before the appropriate drying treatment. Harvesting times were organised so that the 14 bags of each treatment were placed into the rumen at the same time; two bags of each treatment were removed after 3, 5, 9, 12, 24, 48 and 96 hours. The freeze drying treatment had only two bags in each animal which were removed after 48 hours. Bags were suspended on semi-rigid tubes (Ørskov 1984) to hold samples in the ventral sac of the rumen.

Bags were removed from the rumen and, together with those not subjected to any rumen fermentation (representing zero time), were washed under running water for 20 mins and lightly squeezed to assist in removal of rumen fluid. They were then dried at 65°C in a forced-draft oven for 72 h and weighed to determine DM loss.

Experiment 3. Duration of wilting

As for experiment 2, digestibility of leaf was measured on samples inserted inside dacron bags into the rumen of Droughtmaster steers. Samples were wilted for 3, 6, 9, 12, 18, 24 and 48 h at 25°C in an oven with forced draft prior to insertion in the rumen. Simultaneous placement of these samples into the rumen necessitated their harvest at different times of the day, with the 24 h, 48 h and fresh samples being taken at 1100. Duplicate samples were placed in the rumen of each of 3 animals for 48 h.

Results

Experiment 1

The calliandra was eaten by all 6 sheep with little change in intake within treatments over the 8-day feeding period (Figure 1). There was however a large and significant difference (P<0.01) between the voluntary intake of the fresh (59 g DM/kg W^{0.75}) and wilted calliandra (37 g DM/kg W^{0.75}). The level of excess feed offered was 10 and 19% for the fresh and wilted treatments respectively. The DM contents of the fresh and wilted calliandra were 35 and 95% respectively.
Experiment 2

The results are presented in Figure 2. In the first few hours of incubation, DM loss with oven dried samples was significantly greater than with fresh or wilted samples but did not exceed the 15% loss observed by merely washing oven dried samples. After 12 h the loss of dried material was almost identical with that of the wilted material. The net loss after 96 h was only about half that of the fresh material. A freeze dried sample showed the same DM loss after 48 h in the rumen as the wilted and oven dried samples. There was little loss of fresh material from the bags on washing (2.5%). Fermentation of fresh forage proceeded exponentially with a net loss of about 17% in 12 h, 37% in 24 h, 57% in 48 h and 75% in 96 h.

Figure 2. The relationship between in sacco digestibility of Calliandra calothyrsus and the length of time in the rumen of steers.
Experiment 3

There was a dramatic decrease in DM digestibility during the first 6 h of wilting from about 60% to around 30%, with no further decrease thereafter (Figure 3).

Discussion

It has been stated that drying has no effect on voluntary intake of forages provided the DM content of the fresh forage exceeds 22% (Minson 1990). This conclusion was based on published results from a wide range of temperate and tropical forages. The work reported in this paper shows that this generality does not apply to calliandra. This has important implications for the use of calliandra in animal production systems and may explain why calliandra has not been used in the past. In many Asian countries ruminants are housed, and forage is cut and carried to the animals. This system has proved satisfactory for most forages (Remenyi and McWilliam 1986) and no doubt the same system would have been tried with calliandra in these regions. The failure of calliandra to be accepted could possibly be due to its having been fed in a wilted or semi-wilted state, making it less attractive to the animals.

Experiment 1 showed that drying for 24 h reduced voluntary intake by 37%, but in farm practice the reduction would probably have been less and dependent on the length of delay and prevailing meteorological conditions. Wherever possible calliandra should be grazed to maximise voluntary intake, but if this is not feasible then the forage must be fed with minimum delay after harvesting.

The voluntary intake of forages is positively correlated with the rate of digestion of the forage (Donefer et al. 1960, Minson and Milford 1967). This study showed that the fresh calliandra was more rapidly digested than the wilted, dried or freeze dried material and that this difference is probably the cause of the 37% difference observed in the intake of fresh and wilted calliandra. The cause of this large reduction in digestion rate is at present unknown and warrants further work. It may be associated with the presence of tannins which are known to occur in calliandra (Ahn et al. 1990).

The results for oven dried samples in this experiment are similar to others reported in the literature (Mahyuddin et al. 1988; Bamualim 1981; Ahn et al. 1989), but the high digestibility of fresh material (60–80%) shows the true potential of calliandra as a feed for browsing animals.

The wilting treatment imposed in this study was fairly severe, being of 24 h duration and leading to a DM content of about 95%. Less drastic treatments might have had a smaller effect on both voluntary intake and rate of digestion. The

![Graph](LSD (P <0.05)

**Figure 3.** The relationship between *in sacco* DM digestibility of *Calliandra calothyrsus* in the rumen of steers and the duration of wilting.
results in experiment 3 show that wilting for quite short times (3–6 h) had a major impact on rate of digestion and would possibly have a comparable effect on voluntary intake. This indicates that post-harvest delays in feeding must be kept to the absolute minimum if maximum intake from calliandra is to be achieved.

Acknowledgements

The work reported here is part of a larger study on “Production and utilization of shrub legumes for infertile soils in the tropics”, funded partly by the Australian Centre for International Agricultural Research. The technical assistance of Mr A. Day and Mr M.G. Fulloon is gratefully acknowledged.

References


(Received for publication November 15, 1991; accepted May 18, 1992)