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Evaluation of Browse Legume Diets (*Acacia angustissima*, *Leucaena trichandra* and *Calliandra calothyrsus)* on Feed Intake and Growth of Goats

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Abstract A 56-day feeding trial was conducted to evaluate the effect of supplementing goats with browse legumes on growth and feed intake. Castrated kids (n = 12) with an average initial age of 135 days and live weight of 14 ± 2kg were used to study the effects of the browse legumes *Acacia angustissima*, *Leucaena trichandra* and *Calliandra calothyrsus* on live weight gain. Three diets made up of wheat straw and maize supplemented with one of the browse legumes at an inclusion level of 30% were randomly assigned to the goats. The diets were made isonitrogenous by adding cottonseed meal from a commercial feed manufacturing company. A commercial goat meal was used as the control while the goats were housed in individual pens. A completely randomized block design was used with the initial weight being the blocking factor. The results indicated that goats fed *A. angustissima* consumed 2.2kg per week of the supplement which was significantly higher ($P<0.05$) than for *L. trichandra* (2kg) and *C. calothyrsus* (1.9kg) but significantly lower than the control diet (2.9kg). Final live weights showed that goats fed the *A. angustissima* supplement had live weight gains (23.12kg) that were significantly higher ($P<0.05$) than those fed *L. trichandra* (19.37kg) and *C. calothyrsus* (18.87kg) but not different from the control diet (23.75kg). It is concluded that *A. angustissima* was the best supplement and that browse legumes have positive effects on the feed intake and growth of goats at an inclusion level of 30%.

Keywords Goats, Feeding Trials, Browse Legumes, Feed Intake, Growth

1. Introduction

The primary constraint to ruminant production in many tropical regions such as Southern Africa is poor nutrition. Most of the native grasses and crop residues that form the basis of the diets in these regions are low in nitrogen (6.2 – 10%) and high in fibre (67 – 74%) (Seyoum and Zinash, 1989). One of the biggest challenges when feeding these low-quality forages to ruminants is how to increase their intakes (Ndlovu, 1992). Chemical treatments, while successful, present several practical problems for smallholder farmers. Among the challenges is the cost of the chemicals used and how to administer them to the forages.

The use of leguminous fodder trees to alleviate nutrient deficiencies is a promising method since fodder trees provide supplementary nutrients to livestock in addition to their other uses such as medicine, fuel wood and nitrogen fixation. The extent of substitution of the basal diet depends upon the level of inclusion of the supplement. Since commercial supplements are expensive and limited in terms of supply, this calls for the use of legumes as alternative sources of protein.

Browse legumes are a potential supplement due to their positive traits that include fast growth adaptation to free draining acid soils, drought tolerance and retaining green leafy material during long dry seasons (Gutteridge, 1994) and have high nitrogen (33.2 – 40.8 g/kg DM). Leaf yields of up to 5t per hectare DM per year have been reported (Dzowela, Hove, Maarsdorp and Mafongoya, 1997). Proper use of these plants would make them important protein supplements for resource poor farmers in developing countries.

L. leucocephala is able to supply high amounts of biomass during the dry season reaching a total production of 2.78t DM/ha of which 1.92t DM is edible (Hernandez, Benavides, and Simon, 2000). Studies have been conducted on the effects of legumes in the diet on animal production and have noted significant increases in animal production (Lazier, 1994). The objectives of this study were to determine voluntary feed intake and weekly live

weight gains of goats fed diets made from *A. angustissima*, *L. trichandra* and *C. calothyrsus*.

2. Materials and Methods

2.1. Animals and Management

Twelve goats with an average weight of 14 ± 2kg were given diets containing *A. angustissima*, *L. trichandra* and *C. calothyrsus* as protein sources at an inclusion level of 30%. A bought commercial goat feed from a manufacturing company was used as the control and the diets were made isonitrogenous (16% crude protein) by adding cotton seed meal. The goats were blocked by initial weight and within each block were randomly allocated to four treatments giving four animals per treatment.

The supplements were ground through a 3mm screen and then homogenously mixed. Animals were offered wheat straw as a source of roughage at 12 noon. The wheat straw was obtained from the University of Zimbabwe farm and had an average CP content of 4% and NDF of 60%. The wheat straw was chopped and offered to the animals based on their live weights and with an allowance of 10% more than the previous day's measured intake. Animals had free access to water at all times.

2.2. Procedure and Design of the Experiment

The leaves for the animal feeding trials were collected from Domboshawa, Zimbabwe and air-dried for one week before use. Each goat was weighed and placed in a pen and underwent a 14-day adaptation period on the experimental diets before recordings began. The goats were randomly allocated to the four diets in a completely randomized block design with three replicates. Wheat straw and maize grain were used as the basal diet while cotton seed meal was used to make diets isonitrogenous. The diets were formulated as follows and the chemical composition of the diets is shown in Table 1 below:

Treatment 1: maize, wheat straw and 30% *A. angustissima* and 1% cotton seed meal

Treatment 2: maize, wheat straw and 30% *L. trichandra* and 2% cotton seed meal

Treatment 3: maize, wheat straw and 30% *C. calothyrsus* and 3% cotton seed meal

Control: commercial goat feed, wheat straw 10%, maize 75%, 11% cotton seed meal, vitamin mineral mix 4%

Table 1. Chemical composition of the browse legumes

Browse legume	DM	OM	CP	ASH	NDF
A. angustissima	88.95	89.95	20.80	8.95	36.85
L. trichandra	88.20	93.70	19.85	5.60	48.10
C. calothyrsus	88.90	91.80	16.85	7.30	46.85
Control	89.20	93.30	16.00	6.72	24.1

2.3. Measurement of Dry Matter Intake

The goats were weighed before recording commenced. Dry matter intake was measured for 56 days at 0800hrs. At the end of the trial period, the goats were weighed and released. Dry matter intake was determined as the difference between feed offered and feed refused. Refusals were collected every morning before the next feeding and weighed. The weekly weight gains were determined as the difference between two consecutive week weights.

2.4. Statistical Analysis

The data for voluntary feed intake and weekly live weight gains were analysed using GLM procedures (SAS, 1996) accounting for the effects of browse legume and initial weight of the animals.

3. Results

Figure 1 and Figure 2 show the results for weekly supplement intake and weight gain respectively. *A. angustissima* fed goats compared favourably to the control diet and performed better than those on *L. trichandra* and *C. calothyrsus*.

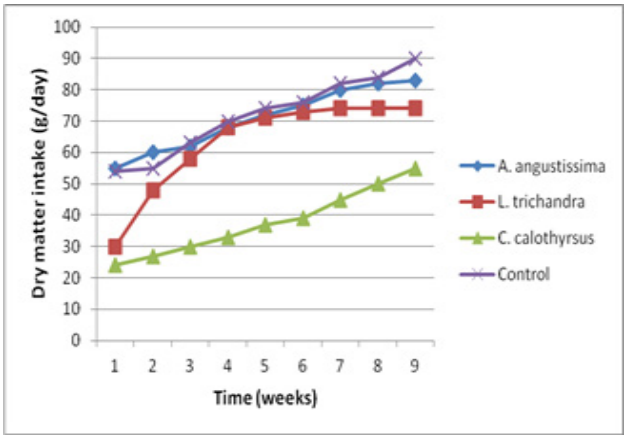

Figure 1. Effect of browse legume diets on dry matter intake (g/day) of goats

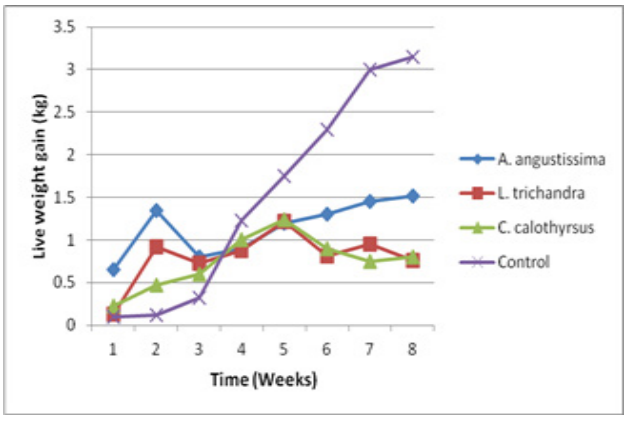

Figure 2. Effect of browse legume diets on the live weight gain (kg) of growing goats

Goats fed control diet had the highest weekly intakes followed by those on the diet that contained *A. angustissima* which recorded a significantly ($P<0.05$) high intake (0.9kg) compared to those on *L. trichandra* (0.82kg) and *C. calothyrsus* (0.55kg) diets. *C. calothyrsus* diet had the least overall intake due to condensed tannins found in the browse legume. The results also show that intake and weight gain of the growing goats increased significantly with time.

4. Discussion

The animals remained healthy throughout the entire period of the experiment. Dry matter intake is an important factor in the utilization of roughage by ruminants and is a critical determinant of energy intake and performance in small ruminants (Devendra and Burns, 1983). The use of browse trees as fodder for ruminant is increasingly becoming important in many parts of the tropics (Njidda and Ikhimioya, 2010). Furthermore, it is important that feed supplements should not adversely affect intake of basal roughage diet. The best live weight gain was recorded in goats fed the *A. angustissima* and this supplement provided energy and protein which are critical for growth of goats. *A. angustissima* is more palatable and digestible. The value of tree legumes as protein supplements has been demonstrated in various studies (Ebong, 1995; Ondiek, Tuitoek, Abdulrazak, Bareeba and Fujihara, 2000). Brown, N'gambi and Norris (2016) noted that indigenous legume species were considered as invasive and needed to be eradicated from rangelands but there has now been a paradigm shift in thinking to accept them as a valuable ruminant feed resource, particularly goats.

However, the tree legumes contain antinutritional compounds, chief among them condensed tannins. The presence of condensed tannins in browse species is detrimental to the intake and digestibility of these feed resources especially during the dry season when animals require supplementary feeds. Knowledge about these secondary plant metabolites is critical if efficient and effective use of tree legumes can be achieved. Condensed tannins (CTs), also known as proanthocyanidins, are phenolic plant secondary compounds that are found in plants, leaves, bark, fruit, wood and roots (Hassanpour et al., 2011). Condensed tannins are the most common type of tannins found in forage legumes, trees and shrubs such as Lotus corniculatus and in several Acacia species (Min et al., 2003). They are more copious in the parts of the plants which are more likely to be consumed by herbivores (Alvarez del Pino et al., 2001). There have been several notions regarding the basis for CTs synthesis which include protection against herbivory, plant defence against pathogens, nitrogen conservation, etc. (Waghorn, 2008). Tannins bind with the proteins making them unavailable to the animal although this negative effect can be alleviated if the proteins can be released in post ruminal sites. *L. trichandra, L. pallida* and *L. diversifolia* are among tree legumes with high tannin content (Dalzell, Stewart, Tolera, and McNeill, 1998). In this study the dry matter intake of *L. Trichandra* diet did not seem to be affected by the presence of the legume. However, the liveweight gain of goats on this diet was significantly lower than those on *A. angustissima* diet. *C. calothyrsus* also has high tannin content which could have affected both dry matter intake and liveweight gains.

The presence of secondary metabolites should not limit their use since many strategies have been devised to mitigate the effects of the antinutritional factors. Removal of tannins has been achieved through the use of alkalis (e.g. sodium hydroxide (0.05M), sodium carbonate (0.1M), urea, ammonia: Makkar, 2003; Vitti et al., 2005), oxidising agents (e.g. potassium permanganate (0.03M), potassium dichromate (0.02M), ferrous sulphate (0.015M), hydrogen peroxide: Deshpande et al., 1986; Makkar and Singh, 1992c; Makkar and Becker, 1996b), extraction with organic solvents (e.g. acetone, methanol, ethanol: Makkar and Singh, 1992c), use of tannin binding compounds such as polyvinylpyrrolidone (PVP) and polyethylene glycol (PEG) (Getachew et al., 1998; Barry et al., 2001; Makkar, 2003). However, smallholder farmers' adoption of these technologies can be limited by lack of capital, equipment and expertise.

Tree legumes have proven to be of excellent nutritional value during the dry season in many countries such as India (Mitra and Mitra, 2000), Cuba (Mendez, 1999), Nigeria (Cobbina, 1994) and Ethiopia (Haque, 1991). The feeding value of forages depends on the balance between the nutritive components of the plants, the digestibility of such nutrients, the metabolism of absorbed nutrients and the quantity of nutrients ingested by the animal (Adesogan et al., 2006). Performance of animals depend on the amount of nutrients ingested especially the nitrogen containing nutrients such as proteins and amino acids. Tree legumes also boost intake of low quality forages (Kennedy, Lowry, Coates and Oerlemans, 2002), have antihelmintic qualities (Poppi, MacRae, Brewer, Dewey and Walker, 1986) and can produce forage in the dry season (Barker and Caradus, 2001).

5. Conclusions

Browse legume diets have been shown to have a positive effect and have a great potential as protein supplements. The inclusion of browse legumes at a level of 30% of the DM intake was shown to be effective since no negative effects were observed during the 56-day trial. *A. angustissima* is the browse legume recommended to farmers due to the high dry matter intake as well as the live weight gains of goats recorded in this study.

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