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Full Length Research Paper

Performance of Dorper lambs fed buffel grass and browse as basal diet and sorghum bran as supplement

Dr Keitirele Patricia Walker

Malotwana Silvopastoral Farm P. O.Box 2386 Mochudi. Botswana. Principal Research Scientist, National Food Technology Research Centre.E-mail: keitirelewalker@yhoo.co.uk.

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Sixteen weaned lambs (10 castrates and 6 females) were used in a feeding trial at Malotwana Silvopastoral Farm in an on-farm investigation lasting 134 days. The study was undertaken to investigate the growth rates of lambs fed cultivated *Leucaena spp.* browse in comparison with those fed sorghum bran as supplements. The main basal diet was buffel grass (*Cenchrus ciliaris*), which is a common grass that the animals in Botswana graze on the range. Feed and water were provided *ad. lib*. Animals were supplemented with idiosed salt and dicalcium phosphate. The average daily mass gain of bran-supplemented lambs was lower than that for browse-supplemented lambs (83.95 ± 9.49 g/day/head compared to 103.33 ± 2.72 g/day/head). The metabolic rate was also higher for the browse-fed group: 12.19 ± 0.19 g/day/head compared to 11.90 ± 0.52 g/day/head for bran-fed lambs (P = 0.1538). Throughout the study the browse-fed lambs performed better, and by day 49 had a significantly greater mean mass (P = 0.0245) than the bran-fed group. Unseasonally cold weather in November affected both groups, leading to loss of weight, with the bran-fed lambs recording a significantly lower mean mass by day 98 of the trial (P = 0.0174). The results showed that crude protein requirements of lambs can be met through the use of *Leucaena* browse.

Key words: *Leucaena* browse, *Cenchrus ciliaris,* growth rates, body weight, sorghum bran, Botswana.

INTRODUCTION

Ruminant production in Botswana is largely dependent upon the communal range and is constrained by fodder scarcity, especially during the dry season. As in much of Africa, livestock graze on poor quality forage, mainly grass which is high in fibre but too low in crude protein to meet animal nutritional requirements (Rubabza et al., 2003). The crude protein also declines in the dry season (Aganga et al., 2011). Consequently, annual lamb mortality of 30 to 36% results GoB, (2002). When farmers can afford to, they source sorghum bran from milling companies at high prices to provide nutrients for livestock, which improves survival during the dry season. Through tree planting farmers can diversify sources of feed as well as increase self-reliance. In the absence of tree-related research in Botswana to demonstrate the potential of planted browse, a study was conducted at Malotwana Silvopastoral Farm during which the harvested leaves and pods of planted *Leucaena* were fed to weaned lambs and their growth rates were compared to those of lambs fed sorghum bran.

About species used in study

Cenchrus ciliaris, often called foxtail buffalo grass grows in Eastern Botswana along with *Panicum maxima*, and other grass species of similar nutrition (Field, 1978). *C. ciliaris* in the wet season has a crude protein (CP) of 10.2 % but declines during the dry season to as low as 4.2% (Aganga et. al., 2011), raw data Department of Agricultural Research (DAR, 2012). *C. ciliaris* was used because it has been planted at Botswana College of Agriculture and at DAR and bales were readily available at the College. It is a good grazing grass and is palatable though this drastically decreases as the plant matures (Van Oudtshoorn, 1999).

Leucaena spp.

The two species are widely researched in the tropics as recognized fodder trees that are known to contribute to animal feed (Stewart and Dunsdon, 1998). *L. leucocephala*

is more widely used, being a moreproductive and drought resistant species than *L. diversifolia*. It is considered to be weedy while *L. diversifolia* is less weedy. *L. diversifolia* was also selected because of its better tolerance to both frost and acidic soils. Both species are highly nutritious with crude protein ranging from 12 to up to 31% (Nyambati et al.,1996; Aregheore 2002). While both species have been grown and researched as fodder in the wetter tropics, research has been limited in arid-areas such as Botswana. However, more significantly recent research has focused on the study of the attack of *L. leucocephala* by the aphid Heteropsylla cubana (Walker, 2007). Consequently research in the late 1990s mainly explored the cross breeding of *L*. *leucocephala* with *L. diversifolia L. pallid* and *L. trichandra* in an attempt to develop greater resistance to the aphid. In Botswana, however, research on the potential contribution of grown tree fodder, especially *Leucaena spp*. remains limited which informed the initiative for this study.

Sorghum Bran

Sorghum bran was used in this study because sorghum bran is the product most commonly purchased by farmers to supplement animals during the dry season. It is traditionally the most planted cereal in Botswana and constitutes the staple food. The crude protein of sorghum bran variety segaolane is report by Macala et. al. (1995) to be 11.5%, dry matter 90%, Calcium 0.38% and Phosphorous 0.31%.

Objective of the study

The objective of this study was to determine the potential role of planted *Leucaena* as a feed supplement for lambs.

MATERIALS AND METHODS

The study was conducted at Malotwana Silvopastoral Farm in the Kgatleng District of Botswana. Malotwana Village is located at latitude 24o 20' S, longitude 26o 05' E; altitude between 940 and 950 m.a.s.l. The browse fed to the experimental animals was cultivated and harvested for lamb feeding. The browse feed was made up of a 2:1 ratio of pods to leaves of *Leucaena leucocephala* K28 in equal part to those of *Leucaena diversifolia*.

SAMPLING

Samples for analysis were collected from the four most central plants in each plot and were separated into pods and leaves for each tree. Subsequently leaf and pod material from each tree per plot was mixed thoroughly and 250 g was taken for drying for 48 hours in an air-forced oven at 70□C. The dried samples were ground to pass through a 1 mm sieve and were stored in air-tight jars for analysis. The material was analysed at the Botswana College of Agriculture laboratory using the procedures of AOAC (1996). Neutral Detergent Fibre, Acid Detergent Fibre and Acid Detergent Lignin contents were determined according to the modified (Van Soest et al., 1991) procedure in the ANKOM220 fibre analyzer. The procedure followed for condensed tannin analysis was that of Makkar (1999). In vitro dry matter digestibility was measured following the modified technique of (Tilley and Terry, 1963). Sodium and potassium were measured using a flame photometer (Ciba-Corning Flame Photometer 410) and phosphorus using a UV1601PC UV visible spectrometer (ILSA Pty Ltd.) Organic matter and ash were determined by ashing samples in a Gallenkamp muffle furnace at 550□C for four hours. The results of the nutritional content of *L. leucocephala* and *L. diversifolia* are published in the International Journal of Agricultural Research (Walker, 2012).

The nutritional values for leaves and pods were used to calculate the nutritional composition of the feed given to lambs during the study.

Selection of Experimental Lambs

The 53 weaner lambs from which selection was made were from a well-bred Dorper flock.

The lambs were balanced for body mass and sex between the control group and the browse group. The lambs were penned in adjoining shelters with dwarf walls, a concrete floor and a corrugated roof with similar environmental conditions. The shelters measured 20 m2 each, giving an area of 2.5 m2 per lamb.

The lambs were intravenously vaccinated against pasteurella at 2 ml per animal and against pulpy kidney using Pulvax at 1 ml per animal. This was followed by de-worming with Zenfen (Albendzole 2.5%) at a dose of 5 ml administered orally. The lambs were all given vitamins A, D and E anti-stress at 1 ml per animal intramuscular prior to the trial.

Processing of feed

Buffel grass feed for the trial was obtained from Content Farm (Botswana College of Agriculture, Sebele) and was purchased at P12.00 (US$2.05) per bale, including the cost of processing. The grass was processed using a chaffing machine with a sieve of 15 mm. Pods were also processed using the same size sieve. Sorghum bran was obtained from the local milling company, TOM (Pty) Ltd.

The control group was fed 30% sorghum bran, 69% *Cenchrus ciliaris* (buffel grass), while the treatment group was fed a complete feed made up of 30% bran, 39% buffel grass, 30% browse. Both groups were supplemented with 0.5% iodiosed salt and 0.5% dicalcium phosphate. The animals were fed *ad lib.* With the trough Being refilled each time there was 10% of the feed remaining. Potable water was provided *ad lib* (Table 1 &2). Lambs were weighed individually at weekly intervals for

Table 1. Availble nutrition of C. ciliaris grass (DAR, 2013).

	Period	CP%	P%	Ca%
C. ciliaris	January early	10.88	0.196	0.241
	January	6.33	0.38	_
	August	5.81	0.009	0.544

Table 2. shows the composition of feeds given to the experimental lambs.
Table 2. Chemical composition of the experimental feeds (g/100g DM)

Parameter	Bran+grass (control group) (30% : 69%)	Browse +bran+grass(treatment) 30% : 30% : 39%
ADF	32.58	30.40
ADL	4.73	5.80
Ash	8.62	6.48
CP	7.69	11.25
IVDMD	47.37	55.29
NDF	57.66	47.47
OM	91.38	93.52
Tannin	-	0.67
Ca	1.06	1.29
K	0.73	1.04
Mg	0.17	0.14
P	0.31	0.32
Na	0.004	0.033

*ADF = acid detergent fibre, NDF=neutral detergent fibre, ADL=acid detergent lignin, IVDMD *in vitro* dry matter digestibility, OM=organic matter content, CP = crude protein.
Crude protein feed content for the browse group was 11.25 g/100g that of the control was 7.69g/100g.

Lambs were weighed individually at weekly intervals for the first five weeks and thereafter fortnightly. This led to final mass at 6-7 months, i.e. the age at which lambs are mature for sale. Data were entered in Microsoft Excel and were analysed using SAS (2000). The analysis was based on the two feeds, hence a paired t-Test based on the model below:

$Y_{ij} = \mu + T_j + E_{ij}$ Y_{ij} = mass of lambs

μ = expected overall mean

T_i = feed effect i = 1, 2 E_{ij} = random error

j = number of lambs j = 1, 2, 3, 4, 5, 6, 7, 8

H_o: No difference between mean mass of browse-fed lambs and that of control group

i.e $H_o = \mu_1 - \mu_2 = 0$ vs H_1: $\mu_1 - \mu_2 \neq 0$

RESULTS

The results (Table 3) show that growth rates of both treatments were the same at end of the experiment. However, the browse supplemented lambs tended to have numerically higher mean mass, ADGs and metabolic mass. As shown in Fig. 1 the browse supplimented lambs maintained numerically higher mass throughout the study. During the period between day 77 to 120, there were significant differences in mass (P= 00174) during a cold spell.

DISCUSSION

During the first four weeks the mass gains of the the browse-fed group and the control group were similar (Fig. 1). This may have been influenced by the fact that previously all the lambs had experienced a very low feed supply from the veldt. However, throughout the feeding trial the browse-fed lambs performed better than the control group, and by the 49th day browse-fed lambs had a significantly higher mean mass than the control group (P = 0.0245).

During the unseasonally cold weather, energy was mobilized to provide heat and maintain body temperature. Thus the browse supplemented lambs were able to deal

Table 3. Growth rate of Dorper lambs fed buffel grass and browse as basal diet.

	Control / Bran+grass	Browse + Grass	t-value
Initial mass (kg)	16.00 ± 0.79	16.04 ± 0.53	0.9691
Final mass (kg)	27.72 ± 1.58	29.75 ± 0.59	0.1601n.s. *
Metabolic mass (kg $^{0.75}$)	11.90 ± 0.52	12.74 ± 0.19	0.1538n.s.
Body mass gain (kg)	11.25 ± 1.27	13.71 ± 0.36	0.0836n.s.
ADG (g/day)	83.95 ± 9.49	102.33 ± 2.70	0.0836n.s.

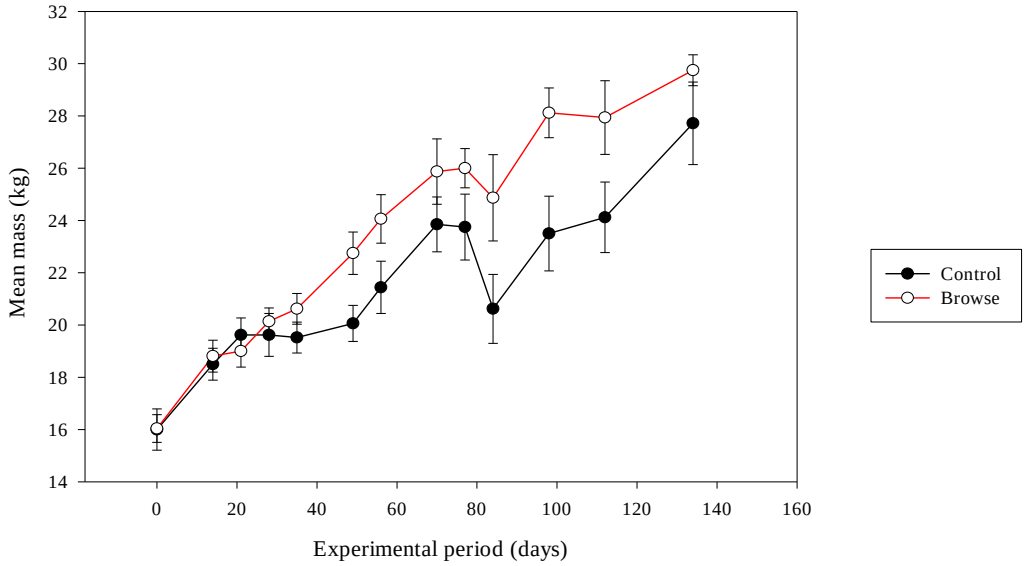

Fig. 1 Mean mass of dorper lambs fed browse and control groups

with cold much better since the tree fodder provided more protein and hence energy for body heat as well as provide for growth. The control lambs could not generate enough energy for both body heat due to the limiting supply from bran and the grass which are not easily digestible and as such the lambs mobilized their body tissues and thus lost body mass (Figure. 1). This was observed between days 77 and 112 when the cold conditions caused declines in the mean masses of the two groups. This also led to greater difference in mean masses (with low P-value, P = 0.0645), starting at the measurements on day 84. The passage of further cold fronts led to an increased difference between the mean masses of the two groups on day 98 (P = 0.0174). Once the temperatures returned to normal levels the recovery was at different rates, as shown on day 112 when the P-value comparing mean mass was 0.0712. As shown in Table 2, the crude protein of the browse-fed group was 11.25 g/100 compared to 7.69 g/100 for the control group. These results indicate that the control group had sufficient crude protein for basic maintenance, but a somewhat lower value than the 8 g/100 required to sustain growth when part of the energy is needed to maintain body temperature McDonald et al. (1973).

The contribution of browse, as demonstrated in these results, compares favourably with the findings of Aganga and Monyatsiwa (1999) whose goat trial was based on the use of *Terminalia sericea*, *Uclea schimperi* and *Combretum apiculatum,* and demonstrated considerable potential in contributing to livestock mass gain. In their study, goats given branches of these species, as supplements, gained 64, 67 and 77 g/head/day respectively, compared to the 103g/head/day that was recorded in this study (Table 3) when *L. diversifolia* and *L. leucocephala* were used to feed lambs.

In Tanzania, (Karachi and Zengo 1998) studied the growth of goats fed browse of *L. leucocephala, Sesbania sesban* and *Cajanus cajan* as supplements. In their study

Table 4. Cost-benefit analysis of the feeding regime of lambs in Botswana Pula.

Item	Browse Group	Control Group
Sales Revenue	4 760.00	4 435.00
Variable Costs		
Initial cost of sheep	720.00	720.00
Sales value at the end of the feeding trial	4 760.00	4 435.00
Price/kg for fattened sheep	20.00	20.00
Vet remedies:		
Pasturella	3.80	3.80
Pulpivax	12.00	12.0
Dewormer	9.60	9.60
Water	36.00	36.00
Grass hay at P12.00/20kg bale	350.00	620.00
Supplement Browse	120.40	
Supplement Bran	130.00	130.00
Total variable costs	1381.80	1 531.40
Gross margin	3378.20	2 903.80
Gross margin/sheep	422.28	362.98
Fixed Costs		
Rent	15.00	15.00
Labour	275.00	275.00
Total fixed costs	290.00	290.00
Net farm income	3088.20	2 613.80
Net income/ sheep	386.03	326.73

Botswana Pula (P1 = $0.171)

the groups fed *L. leucocephala* and *C. cajan* showed a significantly greater (p□ 0.05) mass gain than the control group. The researchers also reported that goats fed any of the three browses when afflicted with trypanosomiasis (animal sleeping sickness) at the height of the wet season were more resilient than the control group. In their study the effects of trypanosomiasis were more severe and prolonged in the control group than among the browse-supplemented goats, a situation which seems to match the responses of the two groups of lambs in this study to the period of unusually cold conditions (Figure. 1).

In the study of (Shenkoru and Mekonnen 1994) in Debre Zeit, Ethiopia, the increase in mass gain was related to increases in the proportion of browse fed to the different groups. Over the 90 days of their trial, three groups of penned-sheep, fed *Leucaena* as a crude protein supplement at proportions 8, 18 and 24% to *Cicer arietinum* L. (chick pea haulm), experienced mass gains of 72, 73 and 87 g/head/day. These results show superior performance to those reported in other feed trials and with the results of this study, with the 30% *Leucaena* leading to a mean mass gain of 103 g/head/day for the browse group.

The potential contribution of the fodder at 30% is very promising and browse feed could be increased to up to 50% of the total leading to greater protein being availed to the lambs. It is possible to explore this in future as animals are known to adjust to the use of tree products by producing stomach enzymes once they get used to a feed and the crude protein content can then be increased to facilitate greater performance.

Financial analysis of the two feeding regimes

An analysis of the costs and benefits of the two feed systems is presented in Table 4; it is based on the assumption that lambs were purchased at P90 each, which is the market value for lambs of the same age. (However, the Botswana Unified Revenue Service allows lambs to be priced at either P10 for subsistence and P45 for commercial farmers due to high mortality among lambs). The sale of sheep is based on their live mass.

It is evident that an increase of more than 18.5% in net income per animal can be realised through browse-feeding. This can make an important contribution to farmer income.

Through tree growing on-farm, farmers could make available to themselves a reliable source of protein. On the other hand, sorghum bran is susceptible to frequent price increases, rising by 56% between 2004 and 2006.

M. sativa, which is popular and commonly used as a commercial feed, has also risen considerably in price, by approximately 65% between 2004 and 2006, the price largely depending on the availability of grazing. Fodder tree planting on-farm will bring more effective management to farmers and reduce the costs of production. Also they will have an available and reliable source of good quality feed which is rich in protein.

Because of its low crude protein content in the dry season, buffel grass can be substituted in part by browse to good effect. Its cost, like that of bran and *M. sativa,* tends to increase substantially during the dry season. Increases of between 100 and 150% in the cost of a 20 kg bale occur depending on the condition of the range in any one year. Its price is often comparable with that of the more protein-rich *M. sativa*, with which it shares a lack of standardisation with respect to bale weight.

CONCLUSIONS

Comparison of the growth rates of lambs fed a composite feed of browse, bran and buffel grass and those fed buffel grass and bran from weaning to sale, demonstrates a greater growth rates and mass gain by those fed browse and the former were more resilient during cold periods.

Greater performance due to browse could be achieved if a higher percentage of browse is included in the diet since at 30% lambs deplayed no adverse effects so that a greater profit marging might be achieved.

Growing trees on-farm can contribute to sustainable agriculture through the provision of protein, which is a

major limiting factor to animal production. Through such a practice purchased supplements such as *Medicago sativa* (lucerne/alfalfa) can be reduced, while limiting livestock losses and alleviating poverty by improving nutrition and reducing livestock mortality among resource-poor farmers.

Farmers can be encouraged to plant *L. Leucocephala and L. diversifolia* on their land to diversify sources of supplementary feed and increase self-sufficiency.

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