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NITROGEN BALANCE AND RUMEN MICROBIAL PROTEIN SYNTHESIS IN GOATS FED DIETS CONTAINING SOAKED AND ROASTED MUCUNA BEAN (*Mucuna Pruriens*)

M. R. MBEWE, V. R. HAMANDISHE*, V. E. IMBAYARWO-CHIKOSI and B. MASUNDA

Department of Animal Science, Faculty of Agriculture, University of Zimbabwe, P. O. Box MP 167 Mt Pleasant, Harare, Zimbabwe

*E-mail: vhamandishe@gmail.com

ABSTRACT: *The effect of soaking and roasting velvet beans (Mucuna pruriens) on nitrogen utilization and rumen microbial protein synthesis in goats was investigated. Sixteen goats were randomly assigned to four diets in a completely randomized design. Goats were fed a basal diet of Cynodon dactylon hay plus 30% soaked (treatment 1), 30% roasted (treatment 2) and 30% untreated velvet bean (treatment 3). The control diet had 100% hay (treatment 4). Animals were given experimental diets over 14 days following a 7-day adjustment period. Feed, refusals, urine and faecal samples were collected daily from individual goats for determination of nitrogen, nitrogen intake, utilization and allantoin in faeces and urine. Microbial protein yield was estimated from the allantoin. Data were analysed using PROC General Linear Model of Statistical Analysis Software. Goats fed a diet with soaked beans had significantly higher (P<0.05) nitrogen balance than those fed diets with roasted beans although nitrogen balance for the latter was non-significantly different (P>0.05) from that of goats fed untreated beans. Microbial protein synthesis was highest for diets with soaked beans although this was non-significantly different (P>0.05) from diets with roasted and untreated beans. All diets containing velvet beans, processed or not, contributed to significantly higher (P<0.05) microbial protein yield than diets with hay only. In terms of nitrogen balance, soaking can be recommended as an appropriate processing method for velvet beans for goat feeding. However, for microbial protein yield, processing method was not statistically important and the bean could be used untreated producing the same results.*

Key words: *Velvet Beans, Goats, Nitrogen Balance, Microbial Protein*

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INTRODUCTION

In Southern Africa, the seasonality of rainfall results in marked seasonal variation in the quantity and quality of feed. Available feeds are of very poor quality during the dry season and there is usually an acute shortage of feed resources characterized by low protein content and high fibre. This leads to slow rates of ruminal degradation, a high rumen load, low rumen fractional outflow rates, poor growth in young stock, loss of body weight and consequent sub-optimal productive and reproductive performance (Mupangwa et al., 2002). Poor quality pastures and crop residues alone are not able to sustain effective animal production and maintenance so there is need to find alternative protein supplements which enhance productivity. Forage legumes such as velvet beans can be used as supplementary feeds during the dry season. Supplementation increases rate of fibre digestion which increases forage intake thereby improving nutrient absorption for enhanced animal production (Tolera et al., 2000).

Velvet bean (*Mucuna pruriens* var *utilis*) is a high yielding herbaceous legume that has been put to various uses worldwide. Because of its high crude protein content of about 27.7% (Belewu et al., 2008), it is potentially a good source of crude protein for use in animals supplementation during the dry and drought season. The legume, however, contains anti-nutritional factors like L-dopa which deter feed intake and hence growth rate. L-dopa levels can be reduced through various processing methods including roasting and soaking (Nyirenda et al., 2003). These processing methods are easy and affordable rendering them appropriate for communal farmers who depend on small ruminant production for a number of benefits. The extent to which these processing methods influence the utilisation of nitrogen in velvet bean and rumen microbial protein production in goats is not known. Such knowledge, when available, will enable communal farmers to make informed decisions on appropriate processing methods for velvet bean before use as a protein supplement for goats, the majority of which are within this group. In Zimbabwe, goats are primarily owned by resource poor smallholder farmers who hold 97% of total national goat population (CSO 2000). Optimization of goat production in this group of farmers, therefore, has the potential to significantly reduce levels of malnutrition and improve livelihoods through income generation. The objective of this

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study was to determine the effects of roasting and soaking velvet beans on nitrogen utilisation and rumen microbial protein production in goats.

MATERIALS AND METHODS

Animals and management

The study was carried out in the University of Zimbabwe Animal Science Bioassay Laboratory with 16 Mashona does weighing on average of 18.5±4 kg. The feeding trial was conducted over a period of 21 days comprising of seven days adaptation period and the remaining fourteen days for sample collection. Animals were housed in individual metabolism cages that allowed separate collection of urine and faeces. Goats were initially offered feed at a rate of 3% of their body weight on dry matter basis. The amount of feed offered was then adjusted accordingly depending on their stable daily intake during the adaptation phase. Weighed amounts of the experimental diets were then offered *ad lib* every morning and water provided through drinking nipples. Feed offered, refusals, faeces and urine were measured and recorded every morning. The goats were offered fresh feed every morning and the metabolism crates were cleaned on a daily basis.

Preparation of treatment diets

The first treatment comprised of velvet beans soaked in water for 24 hours, dried overnight in an oven at 30^{0}C, ground and mixed with hay at a ratio of 3:7. The second treatment had velvet beans roasted in an oven at 90^{0}C for 30 minutes, ground and mixed with hay at a ratio of 3:7. The third treatment was 10kg of velvet beans ground raw and mixed with hay at the ratio of 3:7. 100% hay was the negative control treatment. Four goats were randomly assigned to each of these treatments in a completely randomized design.

Refusal, faeces, urine collection and sampling

Feed refusals and faeces were collected and weighed every day. Small samples of the refusals and faeces were stored in a cold room at 3^{0}C for nitrogen determination. Urine samples were measured, preserved with 25% sulphuric acid and stored in a cold room at 3^{0}C for nitrogen and allantoin determination.

Proximate analysis

Five replicates of the treatment diets were evaluated for dry matter, crude protein, crude fibre and ash using the A.O.A.C (1990) methodologies for proximate analysis.

Rumen microbial protein synthesis

Urine samples were diluted and analysed for the presence of purine derivatives using the Allantoin technique by Young and Conway (1942). Microbial protein yield (MPY) was calculated using the formula:-

MPY = (G x 70) / (0.83 x 0.116 x 1000)

Where $G = \frac{D}{0.84}$

D is the amount of allantoin excreted in urine

Nitrogen balance

Feed, urine, faecal and refusal samples were analysed for nitrogen content using the Kjeldhal method (AOAC, 1990). Nitrogen balance was calculated using the formula:-

Nitrogen Balance = Nitrogen Intake - (Faecal nitrogen + Urinary Nitrogen)

Statistical analysis

Results from proximate analysis were analysed using the general linear models procedure of SAS Version 9.3 (SAS, 2010). Nitrogen balance and rumen microbial protein production were also analysed with PROC GLM of SAS. Adjusted Tukey's method was used for multiple comparison of means.

The model was:

$Y_{ij} = \mu + T_i + e_{ij}$

where

Y_{ij} was the nutrient composition, nitrogen balance or rumen microbial protein production;

μ was the overall mean due to conditions common to all observations;

T_i was the effect of the i^{th} treatment diets (i=1, 2, 3 and 4); and

E_{ij} were the random residuals.

RESULTS AND DISCUSSION

The nutritional composition of the treatment diets and the effects of the four diets on nitrogen balance and microbial protein yield are summarized in Table 1 and Table 2 respectively. The method of velvet bean treatment did not significantly ($P<0.05$) influence crude fibre content, crude protein content, ash content, and rumen microbial protein yield of the treatment diets.

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Table 1 - Mean percent dry matter, crude fibre crude protein and ash in soaked, roasted and untreated velvet beans and hay diets

Diet	Dry Matter	Crude protein	Crude fibre	Ash
30% Soaked beans + 70% hay	91.63(0.099)[a]	14.08(0.368)[a]	27.74(0.513)[b]	6.94(0.058)[b]
30% Roasted beans + 70% hay	91.67(0.099)[a]	14.70(0.368)[a]	27.47(0.513)[b]	6.98(0.058)[b]
30% Untreated beans + 70% hay	90.96(0.099)[b]	14.08(0.368)[a]	26.97(0.513)[b]	7.04(0.058)[b]
100% Hay	91.27(0.099)[b]	11.27(0.368)[b]	34.72(0.513)[a]	8.09(0.058)[a]

[ab]Means in same column with different superscripts differ significantly

Table 2 - Mean intake, nitrogen balance and rumen microbial protein yield in goats fed roasted, soaked and untreated velvet beans and hay diets

Treatment Diets	Nitrogen intake (g/day)	Nitrogen balance (g/day)	Microbial Protein Yield (ml)
30% Soaked beans + 70% hay	1 767.36[a]	358.00[a]	56.69[a]
30% Roasted beans + 70% hay	1 133.97[b]	-243.94[b]	37.65[ab]
30% Untreated beans + 70% hay	1 193.97[b]	41.18[ab]	40.89[ab]
100% Hay	549.94[c]	-221.45[b]	28.13[b]

[abc]Means in same column with different superscripts differ significantly

The inclusion of velvet beans in the diets increased nitrogen intake and more importantly, soaking velvet beans significantly increased intake compared to roasted and untreated velvet beans. Goats fed diets with soaked velvet beans had significantly higher (P>0.05) nitrogen balance (P<0.05) than those fed roasted, untreatred velvet beans and 100% hay (Figure 1). This was probably because the nitrogen intake of soaked beans was higher than any other treatment. Matenga et al. (2003) reported lower levels of intake when goats were fed untreated velvet beans. This low intake of nitrogen in diets with untreated and roasted velvet beans could be attributed to presence of anti-nutritional factors which lower the nutritional value of grain legumes and subsequently reduce nutrient utilisation by animals (Mugendi et al., 2010). The positive nitrogen balance observed in goats fed diets with soaked beans probably implied that significant amounts of nitrogen were being absorbed and utilised for tissue growth.

The negative nitrogen balance obtained in goats fed diets with roasted velvet beans could be attributed to the low availability of nutrients following the heating process. Roasting and hence heating denatures proteins. Emenalom et al. (2005) concluded that roasting was a less efficient method of processing velvet beans when compared to methods such as boiling. As a treatment procedure, roasting does not reduce L-dopa but reduces the protein quality of velvet beans (Mugendi et al., 2010). From this study, soaking velvet beans before feeding to the goats led to relatively higher nitrogen balance than roasting and feeding untreated. Soaking is easy and less laborious method of processing the beans. This concurs with the observation that soaking is a better method in terms of nitrogen retention than other methods like boiling and leaching (Nyirenda et al., 2003).

There was no significant difference (P>0.05) in the microbial protein yield of goats fed diets with soaked, roasted and untreated velvet beans (Table 1). However, the microbial protein yield in goats fed diets with soaked beans was significantly higher (P<0.05) than that of goats fed diets with 100% hay as a negative control. Contrary to Matenga et al. (2003)'s assertion that velvet beans contain anti-nutritional factors capable of producing derivatives which suppress microbial activity in the rumen, this study showed that conservative inclusion of untreated velvet beans in goat diets produce comparable amounts of microbial protein to soaked and roasted velvet beans. However, Mugendi et al. (2010) reported that roasting had no significant effect on levels of L-dopa in velvet beans. This could explain the similarity in microbial protein production of roasted diet with untreated beans. Clearly, inclusion of velvet bean, treated or untreated, in goat diets increases rumen microbial protein synthesis.

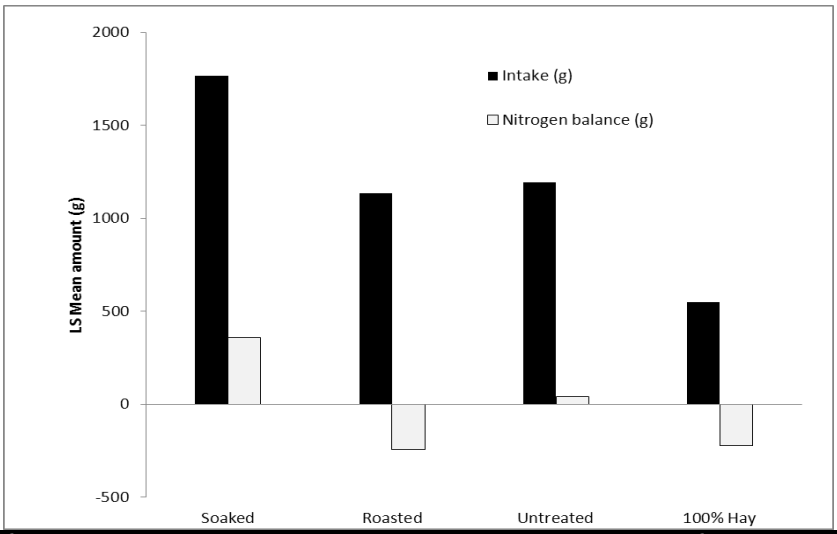

Figure 1 - Effect of treatment method on nitrogen balance and intake in goats fed roasted, soaked and untreated velvet beans and hays diets

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CONCLUSIONS

Soaking velvet beans in water increased nitrogen balance and rumen microbial protein production compared to roasting which had a negative balance and a lower microbial protein yield. Although this study indicated that the velvet beans can be used unprocessed, more studies are required to reinforce this notion.

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