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Growth Performance and Feed Utilization by Intact Male Mubende Goats Fed Various Supplements with Elephant Grass (*Pennisetum purpureum*) as Basal Diet in Uganda

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Abstract: The objective of this study was to determine, the intake and nutritive values of supplements and the response of Mubende goats to these feeds using elephant grass as basal diet. Thirty young intact male Mubende goats aged between 4 and 6 months with a mean live weight of 14.7±2.8 kg were studied for growth performance and feed utilization. The goats were stratified by live body weight and each goat was randomly allocated to any of the 5 treatment groups resulting in 6 goats per group. All the animals were individually fed elephant grass, used as basal diet *ad libitum*. The control group was fed elephant alone. However, the other four treatment groups were supplemented with 4,100 g of fresh banana peels, 680 g maize bran, 272 g cottonseed cake and 722 g fresh leucaena leaves, respectively to provide each goat with approximately 10 g N day^{-1}. Water and mineral blocks were offered *ad libitum*. The feeding trials lasted 26 weeks. Chemical composition of the feeds showed that low protein content in banana peels is a major constraint in its use for ruminant feeding. Goats fed on control diet consumed the highest amount of roughage (349 g day^{-1}), while supplements depressed intakes of roughage in the other groups. Dry matter and organic matter digestibility values differed significantly ($p<0.01$) between groups with the latter reflecting energy, which is highest in diet supplemented with maize bran. The best growth rates of 13.5 and 31.7 g day^{-1} were recorded in goats fed on maize bran and cottonseed cake supplements, respectively. These feed supplements provided adequate energy and protein, which are critical for growth of goats. However, negative growth rates of -3.1 g day^{-1} were recorded in goats fed on elephant grass alone and leucaena leaves supplement despite adequate availability of nitrogen. The critical factor here seems to be the balance between energy and protein input, which must be correct for proper growth of goats.

Key words: Supplements, basal diet, feed intake, digestibility, nitrogen retention, daily gains

INTRODUCTION

Tethering and limited free range grazing are the traditional methods of goat husbandry in Uganda (Okello and Obwolo, 1984). The feed resource base is unimproved pastures and browse trees, which mature early during the wet season and whose nutritive value decline rapidly in the dry season. The dry and highly lignified pastures alone can not meet the maintenance requirements of the goats for energy (Luo *et al*., 2004) and digestible protein (Abate, 1988). Such deficiencies are reflected in seasonal fluctuations in weight gains, high incidence of diseases and death rates (Kasali *et al*., 1989).

Elsewhere in Africa, attempts have been made to improve the productivity of goats by improving nutrition. In this respect rational use of crop residues and agro-industrial by-products have been empirically validated and extensively documented (Kayongo-Male and Said, 1986). In Uganda banana peels, cottonseed cake and maize bran are candidate items in the feed resource inventory. While, the values of cottonseed cake and maize bran are known and commonly used, the nutritional value of banana peels for goats has received little attention. Low nitrogen content in banana peels is a critical constraint. However, this limitation can be compensated for, by high digestible energy in banana peels believed to be costly (Luo *et al*., 2004) and critical (Aregheore, 1995) nutrient in goat production. Although, these feed resources are potentially useful supplements in goat nutrition (Okello and Obwolo, 1984), there are no guidelines for rational utilization due to lack of data on animal response. Of particular concern, is the fact that resource poor farmers often do not provide the necessary balance between energy and protein.

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This study was conducted to determine the intake and the nutritive values of cottonseed cake, maize bran, banana peels and leucaena leaves and the response of the Mubende goats to these feeds using elephant grass as the basal diet.

MATERIALS AND METHODS

Animals and dietary treatments: Thirty young intact male Mubende goats aged between 4 and 6 months and with a mean live weight of 14.7±2.8 kg were purchased from a market in Kampala for this study. The goats were stratified by live body weight and each goat was randomly allocated to any of the 5 treatment groups resulting in 6 goats per group. Elephant grass (*Pennisetum purpureum*) was used as the basal diet and fed *ad libitum* to all animals. Goats from four treatment groups were supplemented with 4,100 g of fresh banana peels, 680 g maize bran, 272 g cottonseed cake and 722 g fresh leucaena leaves (*Leucaena leucocephala*), respectively to provide each goat with approximately 10 g N day^{-1}. The fifth group, used as control was fed only elephant grass because it is the dominant feed used in zero-grazing management in Uganda. Water was available *ad libitum* and each animal had access to a mineral block.

Each animal was identified with numbered ear tag and individually confined in a metabolic cage with slated floor measuring 120×70 and 120 cm high. The base of the slated floor was 30 cm from the ground. All the goats were given prophylactic treatments using a broad spectrum anthelmintic (Oxibendazole, Bayer Germany); for endo-parasites and acaricide pour-on Baytical (1% Flumethrin, Bayer Germany); for ecto-parasites, dosage given according to body weight. The goats were given 14 days for adaptation to respective diets, examined and found free from respiratory diseases, contagious pustular dermatitis and mange infection before commencement of data collection.

Feeding trials: Feeding of basal diet commenced at 08.30 and 2 h later, supplementary feeds were given. Collection of feed refusals was done 24 h later. Feed offers and refusals from each animal were weighed. Samples of each diet were taken for dry matter determination and for subsequent analysis. Intake was calculated as the difference between feed offer and refusal corrected to dry matter content. The feeding trials lasted 26 weeks.

Chemical analysis: All dried feeds were ground to pass through a 2 mm screen using a grinder (Jenker and Kunkei, IKA, Germany). Chemical components of the feeds, were determined by standard methods (AOAC, 1990). Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) were determined by Goering and Van Soest methods (1970).

Digestibility trials: In the digestibility trials, which were carried from the 23rd week of feeding, each goat was fitted with a funnel (at the penis), connected to a bottle by a 1 m. Teflon tubing for urine samples. This allowed urine and faeces to be collected separately. Faecal samples were collected by spreading polythene sheet under the slated floor of the cages. Total faeces and urine were collected over a period of 7 days of feeding. At each collection, total amount of faeces voided and urine excreted by each goat was measured. Samples of faeces and urine (5%), respectively were each bulked across the 7 days of collection. These were stored at 20°C for chemical analysis by standard methods (AOAC, 1990).

Digestibility components involving Dry Matter (DM) and Organic Matter intakes (OM) and protein were calculated as proportions of respective components of nitrogen not recovered in the faeces. Nitrogen retention was calculated as the amount of nitrogen not recovered in faeces and urine and therefore, assumed to have been retained in the body for growth.

Growth: Each goat was weighed at the beginning of the experiment and every successive 7 days subsequently for 183 days. Average daily gains (g day^{-1}) were calculated as the difference between final and initial body weights divided by the number of feeding days.

Statistical analyses: The difference in feed intake, digestibility, nitrogen retention, average daily gain were examined by analysis of variance (Morshed *et al*., 2008) using SPSS statistical package. Differences between treatment means were compared by Multiple Range Test (Thigpen and Paulson, 1974) using STATGRAPHICS statistical package.

RESULTS AND DISCUSSION

Chemical composition results of the feeds used are shown in Table 1 and similar to other published data

Table 1: Chemical composition (g kg^{-1} dry matter) of feed supplements offered to male intact Mubende goats fed elephant grass (*Pennisetum purpereum*) *ad libitum* as basal diet

Feed	DM	N	NDF	ADF	EE	Ash
Elephant grass	288	20.2	650.2	423.9	10.8	100.0
Banana peels	151	9.9	414.1	132.5	45.0	79.0
Maize bran	862	16.5	189.1	103.9	82.0	50.8
Cottonseed cake	930	50.1	168.4	133.1	66.7	81.2
Leucaena leaves	329	50.0	319.0	328.8	14.1	91.3

DM = Dry Matter; N = Nitrogen; NDF = Neutral Detergent Fibre; ADF = Acid Detergent Fibre, EE = Ether Extract

Table 2: Intake (g day^{-1}) components in male intact Mubende goats fed on (*ad libitum*) elephant grass (*Pennisetum purpereum*) with or without supplement of leucaena leaves, maize bran, banana peelings and cottonseed cake

	Diet						
Parameters	Leucaena leaves	Maize bran	Banana peels	Cottonseed cake	Elephant grass	SEM	Sig
Basal feed	308±56.5^{b}	285±74.9^{b}	307±59.1^{b}	334±71.9^{a}	349±66.7^{a}	50.27	**
Sup. intake	103±4.6^{c}	366±133.0^{a}	349±127.0^{a}	251±28.5^{b}	-	67.63	*
TDM intake	411±56.7^{c}	651±181.4^{a}	655±160.0^{a}	585±84.4^{b}	349±66.7^{d}	87.15	**
TOM intake	372±51.1^{c}	604±169.4^{a}	592±152.8^{a}	514±89.1^{b}	313±60.3^{d}	107.10	**
DOM intake	261±61.6^{c}	551±189.0^{a}	515±163.8^{a}	411±122.9^{a}	206±88.0^{c}	123.91	**

*(p<0.05); **(p<0.01), $^{a-d}$: Values with the same superscript in a row do not differ significantly. Sup. = Supplementary; TDM = Total Dry Matter; TOM = Total Organic Matter; DOM = Digestible Organic Matter

Table 3: Digestible (g kg^{-1}) components in male intact Mubende goats fed on (*ad libitum*) elephant grass (*Pennisetum purpereum*) with or without supplement of leucaena leaves, maize bran, banana peelings and cottonseed cake

	Diet						
Parameters	Leucaena leaves	Maize bran	Banana peels	Cottonseed cake	Elephant grass	SEM	Sig
FDM output	123±59.8^{a}	55±40.5	81±42.7^{b}	108±63.9^{a}	118±55.9^{a}	47.39	**
FOM output	111±53.3^{a}	53±39.1^{c}	77±40.6^{b}	103±61.0^{a}	107±50.6^{a}	44.33	**
FNDF output	72±36.0^{a}	27±19.6^{c}	44±24.0^{b}	56±33.0^{b}	69±33.2^{a}	26.18	**
DMD	701±133.5^{d}	893±138.9^{a}	867±79.4^{b}	807±124.3^{c}	651±167.0^{a}	11.44	**
OMD	701±133.9^{d}	889±145.2^{a}	855±94.9^{b}	787±144.4^{c}	638±208.7^{a}	13.02	**
NDFD	649±165.6^{a}	829±221.4^{a}	795±115.2^{b}	741±165.5^{b}	695±148.0^{d}	14.82	**

**(p<0.01), $^{a-d}$: Values with the same superscript in a row do not differ significantly. FDM = Faecal Dry Matter; NDFD = Neutral Detergent Fibre Digestibility, FOM = Faecal Organic Matter, OMD = Organic Matter Digestibility, FNDF = Faecal Neutral Detergent, DMD = Dry Matter Digestibility

(Larbi *et al*., 1991; Hango *et al*., 2007). It indicates that low protein content is a major constraint in the use of banana peels for ruminants making it unlikely to meet the nitrogen requirements for goats. In ruminants, the digestibility of fibre is enhanced by the increase in concentration of ammonia ruminal fluid, the critical level being 50-250 mg ammonia per liter of ruminal fluid (Preston and Leng, 1987). In this respect, banana peels is marginally below the above critical level ammonia ruminal fluid required for proper rumen function.

Dry matter intake is an important factor in utilization of roughage by ruminants and is a critical factor reflected in energy intake and performance in small ruminants (Devendra and Burns, 1983). Hence, a food supplement should not reduce intake of basal roughage. Table 2 shows that the goats fed on control diet consumed the highest amount of roughage. While, supplements depressed intakes of roughage in the other groups in terms of total forage intake, goats fed on banana peels consumed more than the control group. Maize bran depressed intake of basal feed more than cottonseed cake, but did not differ significantly with leucaena leaves and banana peels. The intakes of maize bran and banana peels were similar (Table 2). This suggests that banana peels have a lower rate of substitution than maize bran. This attribute can be associated with influence of the diet in the rumen pH. Maize bran is a high-energy diet and has a high rate of fermentation in the rumen, producing large quantity of volatile fatty acids, which can not be absorbed fast enough in the rumen, which lowered the pH. Low pH in such diets like maize bran reduces the activities of cellulolytic bacteria and hence, low rate of fibre digestion in the rumen (Preston and Leng, 1987).

Dry matter and organic matter digestibility values differed significantly (p<0.01) between groups with the latter reflecting energy, which is highest in diet supplemented with maize (Table 3). However, despite high energy intake, average daily gains in goats fed on banana peels and maize bran supplements was lower than in goats fed on cottonseed cake supplement (Table 4). The critical factor seems to be deficiency in the banana peels and maize bran supplements (Table 1).

Assuming protein requirement for growing goats to be 0.27 g DCP/g live weight gain per day (Devendra and Burns, 1983), Table 4 indicates that nitrogen in the control goats and in goats fed on banana peels was inadequate. It was adequate in goats fed on leucaena leaves, maize bran and cottonseed cake.

Nitrogen excretion pattern in urine and faeces often reflects microbial activity in the rumen as influenced by energy availability. The amounts excreted by the two routes tend to be negatively correlated (Kadzere and Gambodete, 1997). However, lack of clear association in this experiment suggests the amount excreted in urine and faeces are influenced by differences in digestibility and efficiency of tissue nitrogen utilization. Goats fed on banana peels supplement voided the largest volume of urine (1103 mL day^{-1}). The reason for this was not clear. High moisture content in the peels is intimated.

One of the major limiting factors in meat production from goats is their inherently low growth rate, which

Table 4: Nitrogen utilization and body weight gain (kg) of male intact Mubende goats fed on (*ad libitum*) elephant grass (*Pennisetum purpereum*) with or without supplement of leucaena leaves, maize bran, banana peelings and cottonseed cake

	Diet						
Parameters	Leucaena leaves	Maize bran	Banana peels	Cottonseed cake	Elephant grass	SEM	Sig
N intake (g day^{-1})	11.4±1.2^{b}	11.8±3.2^{b}	9.6±2.0^{c}	19.5±2.3	7.0±1.3^{d}	1.98	**
Urine vol. (mL)	573±332.3^{b}	307±129.4^{c}	1103±308.2^{a}	610±256.0^{b}	669±334^{b}	47.73	**
Uninary N Conc. (mg/100 mL)	0.30±0.13^{b}	0.37±0.04^{a}	0.24±0.09^{c}	0.29±0.07^{b}	0.39±0.02^{a}	0.07	**
Uninary N (g day^{-1})	1.7±1.3^{b}	1.2±0.5^{b}	2.6±1.2^{a}	1.7±1.07^{b}	1.7±0.7^{b}	0.99	**
Faecal N (g day^{-1})	3.4±1.3^{c}	4.6±0.9^{b}	3.5±2.5^{c}	8.1±2.2^{a}	2.9±0.6^{c}	1.22	**
N. retention	6.3±2.2^{b}	6.1±3.0^{b}	3.5±2.5^{c}	9.7±3.0^{a}	2.4±2.1^{d}	2.10	**
Body gain (g day^{-1})	-3.1±1.6^{d}	13.5±3.1^{b}	7.2±2.1^{c}	31.7±2.1^{a}	-3.1±1.2^{d}	1.35	**

**($p<0.01$), $^{a-d}$: Values with the same superscript in a row do not differ significantly

affects feed conversion unfavourably (Naude and Hofmeyr, 1981). This could be due to poor nutritional conditions as well as to a limited genetic potential for growth. In this experiment goats fed on leucaena leaves supplement and elephant grass alone lost weight despite adequate nitrogen consumed (Table 4). The critical constraint seems to be inadequate energy supply evidenced by low digestible organic matter intake by these animals (Table 2). Anti-nutrient factors like mimosine in leucaena could have interfered with nitrogen utilization although, no signs of toxicity (alopecia, excessive salivation, anorexia and enlargement of the thyroid) were observed (Monoj and Samiran, 2007). These symptoms of toxicity are normally seen when leucaena component of the diet is >30% (Monoj and Samiran, 2007). However, in this experiment, leucaena supplement comprised only 25% of the diet.

This result, however, is inconsistent with growth rates of goats on leucaena supplementation recorded by Aregheore (1995). He obtained growth rates of 23, 29 and 30 g day^{-1} with levels, 100 g, 200 g and *ad libitum* sun-dried leucaena (normally has less mimosine) supplementation per day, respectively. The positive growth rates recorded by these researchers could have been influenced by consumption of sun-dried leucaena and pasture, which provided the goats with free options to obtain their requirements, whereas in this experiment, elephant grass was the only basal diet and selection of feed was limiting. Meanwhile, goats fed on banana peels supplement virtually maintained weight indicating that they did not receive adequate protein to balance the sufficient amount of energy in goats fed on maize bran and cottonseed cake, respectively (Table 4). These feed supplementation provided adequate energy and protein, which are critical for growth of goats (Morand-Fehr, 1981).

CONCLUSION

It can be concluded that banana peels meet energy requirement for maintenance and growth of goats, however low nitrogen contents is the most critical and limiting factor. Elephant grass alone is not ideal for goat feeding and it should be supplemented with other browses and or concentrates rich in energy and nitrogen. Maize bran as feed supplement can meet both energy and nitrogen requirement for moderate growth in goats, however the ideal supplement is cottonseed cake, which provides both energy and nitrogen to enhance growth rate.

This study calls for a field type investigation where goats are left to free range, but get the above feeds as supplements, now that basic information on the various feeds as they influence growth performance has been availed in this study.

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