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Effect of Feed Supplements on Weight Gain and Carcass Characteristics of Intact Male Mubende Goats Fed Elephant Grass (*Pennisetum purpureum*) *ad libitum* in Uganda

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Abstract: The objective of the study was to determine the effect of supplement on weight gain and carcass characteristics of Mubende goats fed elephant grass as basal diet. Twenty intact male Mubende goats were randomly divided into five groups of four goats each. Each group was randomly assigned one of the five dietary treatments resulting into a complete randomized design. All the animals were individually fed Elephant (E) grass, used as basal diet *ad libitum*. Treatments were isonitrogenous amount (10 g N day^{-1}) of Banana Peels (BP), Maize Bran (MB), Cotton Seed Cake (CSC) and fresh Leucaena Leaves (LL) offered as supplements. The control treatment was fed elephant grass alone without any supplement. Water and mineral blocks were offered *ad libitum* to all groups. At the end of the feeding trials (186 days), the goats were sacrificed for carcass analysis and the various body parts and organs were measured. Final live weights did not differ significantly between treatment groups ($p>0.05$) although, goats fed on CSC were heavier than the rest. Empty body and dressed carcass weights differed significantly ($p<0.05$) in goats fed on different diets. Dressing percentage in goats fed LL, MB and CSC were similar and significantly higher ($p<0.01$) than in goats fed on BP and E alone. The pH of the carcass was similar across all treatments. Weights of the head, full gut, empty gut, blood, kidney and omentum fat did not differ significantly ($p>0.01$) however, weights of skin, pluck and feet differed significantly ($p<0.01$). Various carcass components were highly correlated with live weight across all diets suggesting that all the diets did not severely alter allometry of growth. The critical nutrients for enhancing growth of goats seem to be sufficient amounts and the right combination of energy and protein. In this respect, maize bran and cottonseed cake seem to be better feed supplements in providing these nutrients.

Key words: Supplements, basal diet, randomized design, carcass characteristics, sacrificed, omentum fat, critical nutrients

INTRODUCTION

The economic importance of goats in the provision of animal proteins in developing countries has been extensively reviewed elsewhere (Devendra and Burns, 1983). Meat from small ruminants accounts for almost 30% of the meat consumed in Africa (Atti *et al*., 2003). In Uganda, goats provide about 23% of the total red meat produced and goat meat ranks second to beef in sales. However, in terms of palatability and delicacy, it is preferred to beef. It is possible that goats could play a leading role in the provision of animal protein to supplement other sources such as from beef, chicken, pork and fish.

Goats are produced in Uganda using traditional practices, where goats are either tethered or left to roam, browsing and grazing on whatever, they can find (Okello and Obwolo, 1984). The main feed resources for goats are natural pastures consisting of legumes and browse tree species. During the dry season, grazing land is scarce and pastures are deficient in energy, proteins and minerals. This is aggravated by lack of alternative feed during this critical period (Okello and Obwolo, 1984).

In Uganda Banana Peels (BP) crop residues, Cottonseed Cake (CSC) and Maize Bran (MB) (agro-industrial by-products) can supply readily fermentable carbohydrate and energy needed for increasing growth rate in goats. Due to their low fibre

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contents, they can be consumed in adequate quantities to also meet the nitrogen requirement for growing goats without need for additional supplementation.

A study was initiated to evaluate BP, MB, CSC and Leucaena (LL) as supplements to Elephant (E) grass in goat production. The evaluation included chemical analysis of feeds and carcass study.

MATERIALS AND METHODS

Twenty young intact male Mubende goats (4-6 months of age) purchased from a market in Kampala were used. Each goat was identified with a numbered ear tag and individually confined in a metabolic cage with a slated floor. All animals were given prophylactic treatments for endo and ectoparasites. They were given 14 days for adaptation to respective diets before the beginning of data collection. The goats were randomly divided into five groups of four goats each. Each group was randomly assigned one of the five dietary treatments resulting into a complete randomized design. Treatments were isonitrogenous amounts (10 g N day^{-1}) of BP, MB, CSC and LL offered as supplements to E, which was used as basal diet fed *ad libitum* to all animals. The control group had no supplement. Water was available *ad libitum* and each animal had access to mineral block.

Proximate analysis: Samples of feeds were dried at 60°C for 48 h in an oven. The dry samples were grounded to pass through a 2 mm screen. A 0.5 g portion of each sample in duplicate was analyzed according to AOAC (1990). Neutral-Detergent Fibre (NDF) and ash were determined according to Goering and Van Soest (1970).

Intake and growth: Feeding commenced at 800 h and collection of feed refusal was done 24 h later. Feed offered and refusals from each animal were weighed. Samples of each diet were taken for subsequent dry matter determination and chemical analysis. Intake was calculated as the difference between feed offered and refused corrected for dry-matter content.

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

Carcass analysis: At the end of the feeding trials (186 days), the goats were sacrificed. Before slaughter, live weight and skin thickness were measured; body condition score was assessed according to Pettit *et al.* (1988). The animals were decapitated and the blood was drained into a bucket and the weight of blood was measured.

The decapitated animals were flayed by gentle tearing of skin from the carcass to ensure that fat and muscle tissues did not adhere onto the skin. The legs were cut at the fetlock joints. Weights of the skin, head and legs were measured and carcass value was assessed on the scale 0-3 as follows:

0 = Emaciated carcass
1 = Lean carcass
2 = Moderate fatty carcass
3 = Full fatty carcass

The carcasses were eviscerated and the gut and pluck were removed and weighed. The gut content was removed by flushing the gut with running water. The empty gut and dressed carcass were weighed separately. Kidney fat with capsule was removed and weighed. Thickness of brisket fat and longismus dorsi muscle and pH of the carcass were measured.

Statistical analysis: The differences in feed intake, average daily gain and carcass composition were examined by analysis of variance for a complete randomized design using the STATGRAPHICS statistical package. Differences between means were compared using Multiple Range Test (Thigpen and Paulson, 1974). Body and carcass cutting relationship with live weight were by simple linear regression analysis of variance.

RESULTS AND DISCUSSION

The chemical composition of the feeds in Table 1 indicate that high moisture and low protein content rank banana peels as the least favourable diet for ruminants. Low dietary protein content inhibits rumen microbial activity with resultant low intake of roughage and sub-optimal supply of protein to the animal. In this respect, elephant grass and maize bran are marginally below the critical level (150 mg L^{-1}) of rumen ammonia required for proper rumen function (Preston and Leng, 1987).

Intake: Table 2 summarizes the voluntary feed intake of animals in the different treatment groups. Dry-matter

Table 1: Chemical composition of feed ingredients offered to intact male Mubende goats fed elephant grass *ad libitum* as basal diet

	Dry matter (g kg^{-1})				
Feed	Dry matter	Nitrogen	NDF*	Ether extract	Ash
Elephant	288.0	15.6	551.1	35.0	90
Banana Peels (BP)	133.2	11.0	449.1	42.5	69
Maize Bran (MB)	856.7	15.6	393.0	45.0	44
Cottonseed Cake (CSC)	885.5	34.4	462.1	78.0	140
Leucaena Leaves (LL)	314.0	30.4	479.3	29.0	79

NDF: Neutral Detergent Fibre

Table 2: Intake (g day^{-1}) in male intact Mubende goats fed on *ad libitum* elephant grass with or without supplements of Leucaena leucocephala leaves, maize bran, banana peels and cotton seed cake

	Diet						
Parameters	Leucaena leaves	Maize bran	Banana peels	Cottonseed cake	Elephant grass	SEM	Sig.
Elephant grass (DM)	335±21.0^{bc}	311±17.5^{c}	356±11.0^{b}	336±12.5^{bc}	404±16.0^{a}	7.1	**
Supplement intake (DM)	119±14.5^{b}	222±44.9^{a}	127±41.8^{b}	175±25.9^{ab}	-	13.6	***
Total dry-matter intake	454±33.8	533±57.7	483±50.0	511±270.0	404± 16.0	017.6	NS
Total organic-matter intake	353±31.4	439±44.6	445±46.5	370±25.0	370±14.8	15.3	NS

NS: p>0.05, * p<0.05, ** p<0.01, *** p<0.001, values in the same superscript in a row do not differ significantly

intake is an important factor in the utilization of roughage by ruminant livestock and is a critical determinant of energy intake and performance in small ruminants (Devendra and Burns, 1983). Further more, it is important that feed supplements should not adversely affect intake of basal roughage diet. Goats fed the control diet consumed the highest amounts of the basal diet. The lack of significant differences in total dry-matter intake indicates strong substitution of the basal diet by the supplements.

Growth: Low growth rate is acknowledged to be the major limiting factor in goat production and the plane of nutrition can markedly improve weight gain; the degree of response varies with breed or type (Devendra and Burns, 1983). In this experiment, goats fed on leucaena leaves supplement and elephant grass alone lost weight with negative growth rates of -3.8 and -3.2 g day^{-1}, respectively. Digestible organic matter intake indicates that energy was limiting growth of these animals (Table 2). The negative growth rates recorded by goats fed on elephant grass alone was attributed to the insufficient amount of energy and protein in the grass. Meanwhile, goats fed on maize bran supplement virtually maintained weight indicating that they received only adequate nutrient for maintenance. The best growth rate of 30.1 g day^{-1} was recorded in goats fed the cottonseed cake supplement. This feed supplement provided energy and protein, which are critical for the growth of goats. The growth rate however is lower than values obtained (91 g day^{-1}) in Uganda by Wilson (2009), but similar to values obtained in West African Dwarf goats Jabbar *et al*., 1997). Ademosun *et al*. (1985) also recorded growth rates that were higher than values obtained in this experiment.

Carcass characteristics: Body condition score and carcass were value were subjective assessment. Condition score reflects subcutaneous fat deposits, which is lower in goats than in sheep (Naude and Hofmeyr, 1981). It also reflects muscular development and coverage of the ribs. Similarly, carcass value was assessed according to visible subcutaneous fat coverage and leanness of the meat. Body condition score and carcass value were better in goats fed on maize bran and cottonseed cake. These findings were reflected in the objective measurements of fat deposits in the omentum, kidney and brisket, as well as in the thickness of the longismus dorsi muscle.

Table 3: Regression coefficients (y = a + bx) of body part and carcass component in intact male Mubende goats

	Regression coefficient			
Body part	a	b	r^2	Sig. level
Empty body weight	-2.02	0.86000	0.905	***
Head weight	0.40	0.04000	0.586	***
Skin thickness	0.20	0.00125	0.066	NS
Feet weight	0.20	0.02000	0.638	***
Pluck weight	-9.50	0.04000	0.716	***
Dressed carcass	2.20	0.55000	0.891	**
Full gut weight	2.00	0.18000	0.283	**
Empty gut weight	-0.02	0.18000	0.282	**
Longismus dorsi thickness	0.70	0.04000	0.209	*
Testicular circumference	12.25	0.05000	0.475	**
Gut content	2.03	0.17000	0.283	*

NS: p>0.05, *: p<0.05, **: p<0.01, ***: p<0.001

Empty body weight and dressed carcass weight are function of live weight (Fehr *et al*., 1976). Table 3 shows that various carcass components and body parts (except skin thickness) were highly correlated with live weight across all diets, suggesting that all the diets did not severely alter the allometry of growth. Goats fed on cottonseed cake and maize bran produced dressed carcasses which were significantly heavier (p<0.01) than carcasses from goats fed on the other three diets (Table 4). These differences were associated with differences in fat deposits in the omentum, kidney and brisket.

Table 5 shows that gut contents in goats fed on elephant grass with Leucaena leaves were higher than those of goats fed the other diets. The least gut contents were those of goats fed maize bran. Goats fed maize bran and cottonseed cake were heavier than the rest and they also had the heaviest legs and skin, suggesting that the two components were function of final body weight. It was observed that goats fed on cottonseed cake and maize bran had more omentum and kidney fats. pH normally indicates the keeping quality of the meat. Lack of

Table 4: Body weight, carcass characteristics and meat pH of intact male Mubende goats fed elephant grass with or without supplements

	Diets						
Parameters	E	LL+E	MB+E	BP+E	CSC+E	SEM	Sig.
Body weight gain (kg)	-0.6±0.9^{b}	-0.7±0.7^{b}	1.2±1.7^{b}	2.2±1.8^{b}	5.62±1.5^{a}	0.60	*
Body condition score	1.3±0.3^{b}	1.0±0.0^{b}	1.5±0.3^{b}	1.3±0.7^{b}	2.50±0.3^{a}	0.14	*
Carcass value	1.0±0.0^{b}	1.0±0.0^{b}	1.5±0.3^{b}	1.3±0.7^{b}	2.50±0.3^{a}	0.13	*
Empty body weight (kg)	10.4±0.7^{b}	11.6±0.4^{b}	14.3±1.3^{a}	11.5±0.9^{b}	16.80±1.9^{a}	0.53	*
Dressed carcass weigh	t5.6±0.4^{b}	6.6±0.3^{b}	8.4±0.9^{a}	6.1±0.6^{b}	9.50±1.1^{a}	0.33	**
Dressing percentage	53.5±1.2^{b}	56.7±0.6^{a}	58.5±1.4^{a}	53.0±0.2^{b}	57.00±0.7^{a}	0.53	**
Carcass pH	6.0±0.2	6.6±0.2	6.0±0.2	6.4±0.1	5.90±0.3	0.11	NS

Table 5: Weights of organs, body parts, omentum and kidney fat, gut content and blood of intact male Mubende goats fed on elephant grass with or without supplements

	Diets						
Parameters	E	LL+E	MB+E	BP+E	CSC+E	SEM	Sig.
Head weight (kg)	1.01±0.04	1.20±0.04	1.24±0.09	1.00±0.05	1.33±0.15	0.04	NS
Skin weight (kg)	0.94±0.07^{c}	0.93±0.03^{c}	1.25±0.12^{b}	0.92±0.09^{c}	1.51±0.13^{a}	0.04	**
Feet weight (kg)	0.48±0.03^{bc}	0.53±0.03^{b}	0.63±0.01^{a}	0.45±0.03^{c}	0.60±0.05^{a}	0.01	**
Pluck weight (kg)	0.55±0.06^{c}	0.58±0.03^{c}	0.74±0.06^{c}	0.60±0.03^{c}	0.88±0.08^{a}	0.03	**
Full gut weight (kg)	5.01±0.24	6.04±0.46	4.33±0.55	5.05±0.10	4.84±0.91	0.25	NS
Empty gut weight (kg)	1.24±0.11	1.23±0.04	1.54±0.15	1.58±0.12	1.79±0.27	0.07	NS
Gut content weight (kg)	3.78±2.00^{b}	4.81±0.43^{a}	2.79±0.42^{c}	3.47±0.07^{bc}	3.05±0.66^{bc}	0.19	*
Blood weight (kg)	0.60±0.09	0.64±0.02	0.75±0.05	0.65±0.03	0.86±0.130	0.04	NS
Kidney fat weight (g)	21.40±7.80	23.80±7.50	167.50±44.4	90.30±30.5	237.50±123.3	28.30	NS
Omentum fat weight (g)	36.10±17.2	37.00±7.00	342.80±103.5	146.30±65.2	405.00±196.2	48.30	NS

Table 6: Skin, brisket fat and longismus dorsi muscle thickness (cm) and testicular circumference (cm) of intact male Mubende goats fed on elephant grass with or without supplements

	Diets						
Parameters	E	LL+E	MB+E	BP+E	CSC+E	SEM	Sig
Skin	0.22±0.01	0.22±0.01	0.23±0.01	0.23±0.01	0.21±0.01	0.00	NS
Brisket fat	0.71±0.22^{bc}	1.39±0.29^{a}	1.20±0.10^{ab}	1.64±0.21^{a}	0.66±0.04^{c}	0.10	*
Long dorsi muscle	1.23±0.16^{b}	1.44±0.09^{ab}	1.33±0.18^{b}	1.64±0.04^{a}	0.99±0.01^{c}	0.05	**
Testicular circ.	19.25±0.75^{bc}	20.50±0.79^{b}	19.67±1.20^{bc}	23.88±0.43^{a}	18.38±0.38^{a}	0.32	***

NS: p>0.05, *: p<0.05, ** : p<0.01, values with the same superscript in a row are not significantly different; E: Elephant grass; LL: Leucaena Leaves; MB: Maize Bran; BP: Banana Peels; CSC: Cottonseed Cakel; SEM: Standard Error of Mean

significant differences between groups suggests that keeping quality was not affected by the different feeds. Testicular circumference was bigger in goats that were fed on cottonseed cake and maize bran (Table 6). Regression analysis of measurements of body parts on the live weight were highly correlated, suggesting that the apparent dietary effect on testicular circumference was associated with difference in live weight of the goats fed on the different diets.

CONCLUSION

The critical nutrient for enhancing growth of goats seem to be sufficient amounts and the right combination of energy and protein. In this respect, maize bran and cottonseed cake seem to be better feed supplements in providing these nutrients. These agro-industrial by-products are abundant in Uganda and their use will greatly increase meat production from goats.

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