INFLUENCE OF DIFFERENTLY PROCESSED MANGO SEED KERNEL MEAL ON PERFORMANCE RESPONSE OF WEST AFRICAN DWARF GOATS FED SPEAR GRASS BASED DIET

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Abstract
Twenty four growing goats balanced for weight 8.00 ± 0.45kg were fed spear grass based diet with differently processed mango seed kernel meal supplement to assess growth, nutrient digestibility and nitrogen utilization. Goats were assigned to four dietary treatments with six goats per treatment in a completely randomised design. The four compared experimental diets were; T_A (contained 65% spear grass with 35% concentrate diet that served as the control group) T_B (comprised spear grass and raw mango seed kernel meal with concentrate diet in a ratio of 35:30:35), T_C (constituted spear grass and soaked mango seed kernel meal with concentrate diet in a ratio of 35:30:35) and T_D(consisted spear grass and parboiled mango seed kernel meal with concentrate diet in a ratio of 35:30:35). Results obtained showed that T_A was significantly ($P < 0.05$) best in digestibility of ash (62.01%) compared with other treatment diets. Feed conversion ratio (3.35), digestibility of ether extract (67.03%) and nitrogen in faeces (4.97g/day) were significantly ($P < 0.05$) higher in T_B, while T_C was significantly ($P<0.05$) higher in crude fibre digestibility (71.23kg). Final body weight gain (14.06kg), total weight gain (5.46kg), average weight gain (65.00g), total feed intake (10.97kg), average daily feed intake (130.60g), digestibility in dry matter (70.41%) with crude protein (81.07%), nitrogen intake (14.00g/day), nitrogen absorb (11.35g/day), nitrogen retain (10.36g/day), nitrogen absorb and retain as percentage of nitrogen intake (8.07 and 94.00g/day) were higher in T_D and significantly ($P<0.05$) different from other treatment diets. Significant difference ($P > 0.05$) did not occur in initial body weight and nitrogen in urine among treatment diets. It was concluded that the combination of spear grass and parboiled mango seed kernel meal with concentrate diet in a ratio of 35:30:35(T_D) has the potential to improve growth, nutrient digestibility and nitrogen utilization for goats.

Keywords: Mango seed kernel, spear grass, performance and goats

Introduction

Ruminant animal production in Nigeria is hampered by poor quality and seasonal native pastures. This inadequacy in quality and quantity of pastures affect the nutritional status of ruminants, thereby leading to weight loss and poor performance. The effect of this challenge has led to increase in animal protein demand for human consumption (Yousuf and Adeloye, 2010). Though efforts have been made by farmers to explore the possibilities of incorporating conventional feedstuffs into ruminant feeds in order to reduce scarcity of feeds and maximize returns (Ogunbajo *et al.,* 2009*)*. High cost of these feeds and competition between livestock and human further compounded the problem of feed shortage that led to the sub-optional utilization of the available ruminant products in the tropics (Odeyinka and Okunade, 2005). Thus, this has necessitate the need to search for alternative source of feed materials that are locally sourced, cheap and nutritional adequacy all year round to augment the nutrient requirement of ruminant animals. Hence, the use of differently processed mango seed kernel meals could go a long way in circumventing the problem of feed scarcity and cost in goat production.

Mango (*Mangifera indica*) seed kernels could be considered as valuable feedstuffs that have a great potential for ruminant animal production. Though they are low in protein content (Sanon *et al.,* 2013) their hard fibrous shell contain kernel that are rich in starch (40 – 50%) and oil (6 – 16%) (Medina *et al*., *2010),* hence their uses have been successful investigated in several animal spices. However, one of the major constraints militating against their uses in animal production includes tannin cyanogenic glucoside with rancidity that reduces their utilization in livestock (Moor, 2004). Thus, harnessing of mango seed kernel as meal is important to improve the utilization as feeds for livestock (Olabanji *et al*., 2010). Therefore, the current study was designed to assess the influence of differently processed *mango* seed kernel meal on growth performance, nutrient digestibility and nitrogen utilization of goats fed spear grass based diet.

Materials and Methods

Experimental site: The experiment was conducted at the Sheep and Goat Unit of the Teaching and Research Farm, Ambrose Alli University, Ekpoma, Nigeria. The area lies on longitude 6.09^0E and latitude 6.42^0N. The mean annual rainfall of the location is about 1556mm while the temperature ranges between 26^0C and 34^0C. The climate is characterised by a defined wet season that normally begins in April and ends in October, while the dry season last from October to March.

Preparation of experimental diets: Spear grass (*Imperata cylindrical)* was harvested at pre-anthesis stage within the Teaching and Research Farm of the Ambrose Alli University Ekpoma. It was allowed to wilt overnight, chopped into small bits of about 5 to 6cm before fed to the animals in the morning. Mango seeds were collected from mango waste around Ekpoma, washed, cut opened and chopped out the kernels. Thereafter, they were differently processed in the following ways; raw sun dried mango seed kernel meal (RMSKM), soaked (one hour) before sun dried the mango seed kernel meal (SMSKM) and parboiled (at 30^0C for 10minutes) the mango seed kernel meal before sun dried (PMSKM). Concentrate that comprised 80% dried brewery grain, 18% rice bran, 0.75% limestone, 0.5% bone meal, 0.5% salt and 0.25% vitamin premix was also used in the treatment diets. However, the combination of *spear* grass and differently processed mango seed kernel meals with concentrate diet were used as the treatment diets. The four compared treatment diets prepared were; A (65% spear grass with 35% concentrate diet that serves as control group), B (comprised spear grass and RMSKM with concentrate diet in a ratio of 35:30:35), C (constituted spear grass and SMSKM with concentrate diet in a ratio of 30:30:35) and D (consisted spear grass and PMSKM with concentrate diet in a ratio of 30:30:35). However, the prepared experimental diets were offered to the animals at the rate of 5% (dry matter basis) of their body weight.

Experimental animals and design: Twenty four growing West African Dwarf (WAD) goats aged between 8 – 9 months with a mean body weight of 8.45kg (ranged 8.00 – 8.90kg) were purchased from an open livestock market at Ekpoma. They were balanced for weight and randomly allotted to the four (4) dietary treatments (A, B, C, & D) with six (6) animals per treatment; hence each treatment was replicated six (6) times. The experimental design for this study was completely randomised design.

Feeding and management of the experimental animals: The experimental pens were cleaned and disinfected before the arrival of animals. On arrival, the animals were given anti – stress and prophylactic treatments against the common viral and bacterial diseases. They were dewormed and bathed to eliminated endo-parasites and ecto-parasites respectively. The animals were housed individually in an open-sided that was well-ventilated pen. Feeding of animals that lasted for 12 weeks was preceded by 2 weeks of acclimatization. The weighted experimental diets were offered once daily in the morning at about 8:30am. The animals also had free access to fresh water and salt lick daily.

Performance studies

Growth study: The quantity of experimental diets offered to the animals and leftovers were weighed daily every morning prior to feeding to determine daily feed intake. Subsequently, live weight measurement were carried out prior to feeding by using handing scale on weekly basis to determine body weight gain. Data derived from the daily feed intake and daily weight gain was computed and feed conversion ratio was calculated as the ratio of feed intake and body weight again.

Digestibility with nitrogen metabolism study: Four growing goats randomly selected from each treatment were used to carry out the digestibility and nitrogen metabolism trials at the end of growth study. Goats (totalling 16) were then housed in individual metabolic cages with slated floors adapted for faecal and urinary collection. Goats were fed with their weighed treatment diets for the last 7-days after a 7-day adjustment period of metabolic cages. The quantity of feeds offered which represented the fraction of quantity of feeds offered to each goat per day and the leftover which represented the one that was not consumed were weighed daily. The weight difference between them were recorded and taken as the feed intake. Daily faecal sub-samples were weighed, bulked together and stored in airtight containers. Sub-samples of daily urine samples from each goat were collected in sample bottles and frozen until they were required for analysis. Thus, the apparent nutrient digestibility of the goats were calculated as the difference between nutrient intakes and excreted in faeces expressed as a percentage of nutrient intakes. Nitrogen balance by the goats were calculated as the difference between nitrogen intake and nitrogen excreted from faeces and urine, while nitrogen retention percentage were computed from nitrogen balance expressed as a percentage of nitrogen intake.

Chemical and statistical analyses: Samples of the experimental diets, faecal output as well as nitrogen content in urine samples were analysed for proximate composition using the procedures of AOAC (2002). Data obtained on growth, digestibility and nitrogen metabolism were subjected to analysis of variance (ANOVA) to determine the significant of treatment effects following the methods described by SAS (2001). Significant difference between means were separated using the Duncan's multiple range test.

Results and Discussion

The proximate composition of differently processed mango seed kernel meal, spear grass, and concentrate diet are presented in Table 1. Results obtained showed that PMSKM (92.06%) had the highest dry matter content compared with other feedstuffs. Crude protein content that ranged between 5.00 and 20.00% was highest in concentrate and lowest in spear grass. The low values of crude fibre obtained from RMSKM (0.89%), SMSKM (1.00%) and PMSKM (1.04%) compared with spear grass (37.00%) and concentrate (13.00%) could be due to complete removal of the testa (the translucent covering) of the mango seed kernels at de-hulling. The higher values of ether extract in RMSKM (5.46%), SMSKM (5.00%) and PMSKM (4.60%) compared to spear grass (1.40%) and concentrate (1.09%) could probably due to the concentration of some chemical component and their processing methods which they have undergone. The low ash values observed in RMSKM (2.25%), SMSKM (2.30%), and PMSKM (2.69%) compared with spear grass (8.80%) and concentrate (7.99%) could be as a result of flushing of soluble fraction of the kernel in the treatment they have undergone. The nitrogen free extract that ranged from 47.80% to 85.65% was higher in differently processed mango seed kernel meals compared with spear grass and concentrate. This indicates that mango seed kernel was good starchy meal with high energy content than spear grass.

Table 1: Chemical composition (%DM) of differently processed mango seed kernel meal, spear grass and concentrate diet

Parameters	Feedstuffs				
	RMSKM	SMSKM	PMSKM	Spear grass	Concentrate Diet
Dry Matter	90.56	89.76	92.06	50.36	86.31
Crude Protein	5.90	6.15	7.20	5.00	20.00
Crude Fibre	0.89	1.00	1.04	37.00	13.00
Ether Extract	5.46	5.00	4.60	1.40	1.09
Ash	2.25	2.30	2.69	8.80	7.99
Nitrogen free extract	85.50	85.65	84.47	47.80	57.92

RMSKM = Raw sun dried mango seed kernel meal
SMSKM = Soaked sun dried mango seed kernel meal
PMSKM = Parboiled sun dried mango seed kernel meal

Table 2: Growth performance of goats fed diet supplemented with differently processed mango seed kernel meal

Parameters	Treatments				
	T_A	T_B	T_C	T_D	SEM ±
Initial body weight (kg)	8.12	8.90	8.73	8.60	0.01
Final body weight (kg)	11.15^{c}	10.99^{c}	13.01^{b}	14.06^{a}	0.70
Total body weight gain (kg)	3.03^{c}	2.90^{c}	4.28^{b}	5.46^{a}	0.34
Average daily weight gain (g)	36.07^{c}	24.88^{c}	50.95^{b}	65.00^{a}	0.92
Total feed intake (kg)	8.06^{b}	6.99^{c}	9.89^{a}	10.97^{a}	0.78
Average daily feed intake (g)	95.95^{b}	83.21^{b}	117.74^{a}	130.60^{a}	0.42
Feed conversion ratio	2.70^{a}	3.35^{a}	1.87^{b}	1.48^{b}	0.13

$^{a, b, c,}$ means within the same row with different superscripts differ significantly (P<0.05).
SEM = standard error of means

Table 2, presents the growth performance of goats fed diet supplemented with differently processed mango seed kernel meal. Initial body weight of growing goats that ranged between 8.12kg and 8.90kg were similar across the treatment diets. Final body weight that ranged from 10.99 to 14.06kg was significantly highest ($P < 0.05$) in goats on T_D and lowest in goats on T_A and T_B. This difference observed could probably be explained as the low efficiency in nutrient utilization of the diets caused by residual anti-nutritional factors. The total body weight gain was significantly ($P < 0.05$) highest in T_D (5.46kg), followed by T_C (4.28kg) before T_A (3.03kg) and T_B (2.09kg). Average daily weight gain for goats that ranged between 24.88 and 65.00g showed similar trend as observed in total body weight gain. However, the higher total body and average daily weight gain was observed in goats on T_D compared with other treatment diets might be attributed to efficient utilization of the dietary treatment (T_D) by the goats which reflected in the higher final body weight gain. Several reports by Yusuf *et al.* (2013); Ososanya (2010) indicated that feed intake is an important factor in the utilization of feeds by livestock and is a critical determinant of energy and protein availability as well as performance in ruminants. Total feed intake values were similar and significantly higher ($P < 0.05$) in goats on T_D (10.97kg) and T_C (9.89kg) compared with those on T_A (8.06kg) and T_B (6.99kg). The low total feed intake observed in T_A and T_B could be as a result of low acceptability, fibre combination of the diets and other factors such as particles size, chewing frequency and effectiveness, particle fragility, indigestible fraction, rate of fermentation of the potentially digestible diet and characteristics of reticular contractions. This finding is in consonance with the earlier studies of Yousuf and Aeloye (2010), who reported that decrease in total feed intake of goats is due to the problem of acceptability and rate of feed fermentation in the rumen. The average daily feed intake almost followed the same pattern of variation as observed in total feed intake. The average daily feed intake for goats on T_D (130.60g) and T_C (117.74g) were somewhat higher than T_A (95.95g) and T_B (83.21g). This suggests that parboiled and soaked mango seed kernel meals had good acceptability with better balanced nutrient components than others. This observation was similar

to the report of Jokthan *et al*. (2010) who reported that the nature of feeds and acceptability play important role in regulating feed intake in ruminant livestock. Feed conversion ratio was significantly ($P < 0.05$) highest in T_B (3.35) and lowest in T_D (1.48). The lowest feed conversion ratio obtained in T_D explains the ability of the goats to convert less feed intake to produce a unit weight gain.

Table 3: Nutrient digestibility (%DM) of goats fed experimental diets

	Treatments				
Parameters	**T_A**	**T_B**	**T_C**	**T_D**	**SEM ±**
Dry matter	45.99[c]	61.02[a]	58.96[b]	70.41[a]	0.66
Crude protein	58.00[b]	50.30[b]	78.55[a]	81.07[a]	0.52
Crude fibre	55.72[b]	54.73[b]	71.23[a]	69.23[a]	0.36
Ether extract	36.78[c]	67.03[a]	59.00[b]	55.03[b]	0.70
Ash	62.01[a]	36.42[c]	48.20[b]	30.11[c]	0.21

[a, b, c,] means within the same row with different superscripts differ significantly ($P<0.05$)
SEM = standard error of means

Apparent nutrient digestibility of goats fed experimental diets is shown in Table 3. Nutrient digestibility in animals is the classical direct method for estimating feed digestion by ruminants. Hence, the study on the digestibility of ruminant feeds is very important as they allow for the estimation of nutrients actually available for ruminant animals. Sanon and Kanwe (2010) reported that factors involve in variation of digestibility of feeds among ruminant animals include; the concentration of nitrogen and cell wall content especially lignin. Significant differences were observed for all parameters measured for nutrient digestibility. Dry matter digestibility was highest ($P < 0.05$) for goats on T_D (70.41%) and T_B (61.02%) followed by T_C (58.96%) and T_A (45.99%). This observation explains the extent of nutrient accumulation in the treatment diets. The crude protein digestibility values of 58.00, 50.30, 78.55 and 81.07% were obtained for T_A, T_B, T_C and T_D respectively. The values appeared to be significantly ($P < 0.05$) lower in T_A or T_B that contained no or raw mango seed kernel meals compared with T_C or T_D that contained soaked or parboiled mango seed kernel meals. This observed difference could be as a result of higher effect of fibre content in T_A or T_B than T_D or T_C. Several studies (Olabanji *et al*., 2010; Sonon and Kanwe, 2010) have reported a negative correlation between crude protein digestibility and lignin concentration in tannin rich feeds. Crude fibre digestibility showed almost the same trend as observed in crude protein digestibility. The recorded values were significantly ($P<0.05$) higher in T_C (71.23%) and T_D(69.23%) and lowest in T_B (54.73%) and T_A (55.72%). The lowest values obtained in T_A and T_B could be probably due to higher lignifications of the spear grass and the anti-nutritive effect of the raw dried mango seed kernel meal. Nevertheless, some researchers (Wampana *et al*., 2008; Asaolu and Odeyinka, 2006) have demonstrated how lignifications of plant cell wall and tannin – rich feeds decreases crude fibre digestibility in ruminant animals. Ether extract was significantly ($P < 0.05$) best digested in goats on T_B (67.03%) while ash was optimally digested in goats on T_A (62.01%) compared with other treatment diets. This observed difference in their respective digestibility could be a true reflection of their nutrient component in their respective treatment diets. Since nutrient digestibility among other factors would depend on the proximate composition of a ration (Okoruwa *et al*. 2012)

Table 4: Nitrogen utilization (g/day) of goats fed experimental diets

	Treatment				
Parameters	**T_A**	**T_B**	**T_C**	**T_D**	**SEM ±**
Nitrogen (N) intake	8.78[b]	10.00[a]	13.47[a]	14.00[a]	0.06
N – In Faeces	3.68[b]	4.97[a]	2.81[b]	2.65[b]	0.04
N – In Urine	0.20	0.15	0.62	0.99	0.03
N – Absorb	5.10[b]	5.03[b]	10.58[a]	11.35[a]	0.05
N – Retain	4.90[b]	4.08[b]	9.96[a]	10.36[a]	0.02
N – Absorb as % N intake	58.09[b]	50.30[b]	78.55[a]	81.07[a]	0.72
N – Retain as % N intake	55.81[b]	48.80[c]	73.94[a]	94.00[a]	0.58

[a, b, c,] means within the same row with different superscripts differ significantly ($P<0.05$).
SEM = standard error of means

Nitrogen utilization of goats fed experimental diets is presented in Table 4. Nitrogen (N) intake (g/day) for growing goats on T_B (10.00), T_C (13.47) and T_D (14.00) were higher and differed significantly ($P < 0.05$) from those goats on T_A (8.78). The low N – intake observed in T_A could probably due to low crude protein content and high fibre characteristics of spear grass. This is in

conformity with the report of Wampana *et al*. (2008) that the degree of crude protein and fibre contents of a feed is a very important factor that determine nitrogen intake rate in ruminant animals. Nitrogen (N) in faeces was significantly higher in T_B (4.97g/day) compared with other treatment groups. This difference observed could be connected with the degree of crude protein utilization which could have reduced by residual anti – nutritive factors in raw dried mango seed kernel meal. Odunsi (2005); Okoruwa *et al*., (2013) reported that feed materials may contain anti – nutritive factors which may not only inhibit degradation of feeds in which they are contained but also affect the degradation of accompanying feed which changes the pattern of nitrogen excretion towards increasing nitrogen excretion in faeces. Nitrogen (N) in urine values that ranged from 0.15 to 0.99 g/day were not varied significantly ($P < 0.05$) among treatment diets. This observation could be a reflection of ammonia nitrogen concentration in the rumen that depend on the quantity and solubility of the diets fed to the goats. This is in line with the findings of Lindela and Lewis 1995) who reported that nitrogen excreted in urine would depend on urea recycling and the efficiency of utilization of ammonia produced in the rumen by microbes for microbial protein synthesis. Nitrogen (N) – absorb and N – absorb as percentage of Nitrogen (N) intake were significantly ($P < 0.05$) higher in T_D (11.35 and 81.07g/day) and T_C (10.58 and 78.55g/day) compared with T_B (5.03 and 50.30g/day) and T_A (5.10 and 58.09g/day). Methods of mango seed kernel processed into meals in T_D and T_C which were parboiled and soaked respectively might have reduced the anti nutritive factors and allowed the fermentable products for rumen micro-organisms which result in synthesis of microbial protein, hence the amount of nitrogen absorbed available to the growing goats. This corroborates the earlier report of Ahamefule and Udo (2010) who observed that reduction in anti – nutritive factors of mango seed kernels by processing methods may cause changes in the process of rumen fermentation and nitrogen absorbed by ruminant animals.

Nitrogen (N) retain and N – retain as percentage of nitrogen intake which were function of nitrogen ingested, digested and retained were significantly ($P < 0.05$) highest in T_D (10.36 and 94.00g/day) and T_C (9.96 and 73.94g/day) and lowest in T_A (4.90 and 55.81g/day) and T_B (4.08 and 48.80g/day). The low N – retain as percentage of nitrogen intake in T_B might be a reflection of the residual anti – nutritional factors in the raw dried mango seed kernel meal. However, the better performance response of growing goats on T_D in terms of nitrogen utilization further ascribed the best growth performance and nutrient digestibility observed in goats on T_D. Thus, study on nitrogen utilization and nutrient digestibility are said to be important as they allow the estimation of nutrient really available for growth performance of animals (Okoruwa *et al*., 2014).

Conclusion

Based on the results obtained in this study, it was concluded that the feeding of differently processed mango seed kernel meal could be used as supplement to spear grass based diet for growing goats in small ruminant nutrition to improve their performance, most especially during the dry season. However, goats on T_D (spear grass and parboiled mango seed kernel meal with concentrate diet in a ratio of 35:30:35) have the best potential to promote growth rate, nutrient digestibility and enhance nitrogen utilization without any negative effect on goats performance.

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