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Full Length Research Paper

Nutrient utilization and growth performance of West African Dwarf goats fed with elephant grass or different proportions of plantain and mango peels

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Eighteen West African dwarf goats balanced for weight (6.00±0.57 kg) were fed with elephant grass and different proportions of dried plantain with mango peels to evaluate their intake, growth rate, nitrogen and energy utilization. Goats were assigned to three dietary treatments in a completely randomized design with six goats per treatment. The compared dietary treatments were as follows; T_A (elephant grass and concentrate in a ratio of 63:32), T_B and T_C (combination of dried plantain with mango peels and concentrates in a ratio of 55:13:32 and 50:18:32 respectively). The results showed that T_A was significantly (P<0.05) best in crude fibre intake (67.51 g/day), neutral and acid detergent fibre intake (49.01 and 29.58 g/day), urinary nitrogen output 3.62 g/day), faecal and total energy output (185.25 and 220.45 Kcal/g/day). Ether extract intake (9.92g/day) was significantly (P<0.05) highest in T_B compared to T_A and T_C. The total (23970 g) and daily (285.36 g/day) feed intake, average daily feed intake (15.83 g/day), final body weight (9384.00 g), daily weight gain (33.67 g and 13.98 $BW^{0.75}$), nitrogen intake (21.75g/day), faecal nitrogen output (10.09 g/day), nitrogen balance (9.37 g/day and 5.36 $BW^{0.75}$), nitrogen retention (0.43 g/day and 43.08%), gross energy intake (1896.02 Kcal/g/day), digestible energy intake (90.59 Kcal/g/day) and metabolizable energy intake (82.21 Kcal/g/day and 27.30 $BW^{0.75}$) were highest in T_C and significantly differed from the other treatments. Significant differences (P>0.05) did not occur in organic matter intake, feed conversion ratio, metabolizability and ME:DE ratio among the treatment groups. It is concluded that dried plantain with mango peels and concentrate in a ratio of 50:18:32 has the potential to enhance nutrient utilization and growth performance of West African dwarf goats.

Key words: Plantain peels, mango peels, nutrient utilization, dwarf goats.

INTRODUCTION

Ruminant livestock plays an important role in the economic development of Nigeria in terms of feeding the steadily growing population and providing the investible resources for national development. Goats are classified as an important small ruminant on account of their unique ability to adapt and maintain themselves in harsh environment. Their small size relative to cattle contributes to their wide distribution and easy management among

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farmers. They are considered superior to other ruminant species in their utilization of poor quality and high fibre feeds (Oyeyemi and Akusu, 2005). They are mostly kept for sources of meat, milk and skin production. Other purposes of keeping goats include household income, festival season and special occasions (Odeyinka and Okunade, 2005).

Despite the various efforts made by the government, returns to the economy from small ruminant livestock sector have been very much below the potential (Sanni et al., 2003). The major factors contributing to this problem include inadequate feeding and low productivity. The combined weight of these draw back factors has led to the sub-optimal utilization of the available ruminant products. Goats in Nigeria suffer several nutritional stresses in the dry season as a result of seasonal variability that affects the availability and nutritive quality of pastures which in turn marked decrease in nutrient intake and utilization. Small ruminant feeds requirement in the tropics is aggravated by high cost of conventional feeds and lack of alternative source of feed particularly during the dry season when forages are scarce (Okoruwa and Adewumi, 2010). This has necessitated the need to search for alternative sources that are cheaper and readily available.

Mango is the most important fruit crop in the tropics after bananas and plantains (FAO, 2011). The processing yields about 40 to 50% of by-products left behind after the edible portion has been processed into various food items (Sruamsiri and Silman, 2009). Plantain (*Musa paradisiaca*) and Mango (*Mangifera indica*) are believed to have originated in Asia and India respectively. Their peels are always discarded as waste which constitute nuisance in waste disposal of processing industries in Nigeria. This at present is posing a problem to health hazard to humans particularly in the vicinity of the processing points. The use of plantain with mango peels as an alternative source of feed has been identified to play an important role in livestock nutrition (Omole et al., 2004). These peels are classified among other agro-industrial by-products that can be utilized to a great advantage for ruminants in Nigeria. Dried plantain and mango peels have been reported in literatures (Sanon and Kanwe, 2010; Ogunsipe and Agbede, 2010) as energy feed for livestock but low in protein content and the addition of a source of nitrogen or protein is necessary to allow an efficient utilization of these peels in the diet.

Though the utilization of these peels by ruminants are available in literature (Azevedo et al., 2011), there is still a paucity of information on the combination of these peels as replacement for elephant grass by West African Dwarf (WAD) goats. Hence the objective of this present study is to compare the feed intake, nutrient utilization and growth performance of WAD goats fed with elephant grass against different plantain and mango peels combinations.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the sheep and goats unit of the Teaching and Research Farm, Ambrose Alli University, Ekpoma, Edo State, Nigeria. Ekpoma is located in the Northern-east of Edo State (Longitude 6.09°E and Latitude 6.42°N) with a unimodal rainfall pattern which starts from April to October and average of 1556mm per annum. The average ambient temperature was about 30°C per annum.

Experimental diets and design

The elephant grass was harvested at the pre-anthesis stage from the Teaching and Research Farm and manually chopped into small sizes of 4 cm. Plantain and mango peels were collected fresh from their processing centre located within Ekpoma metropolis. They were chopped and immediately dried under shade for several days before milled. The composition of the purchased concentrate diet were as followed: 78% what offal, 20% brewery dried grain, 0.75% limestone, 0.5% dicalcium phosphate, 0.5% salt and 0.25% vitamin premix respectively. Elephant grass and dried plantain with mango peels constituted the basal diets. The experimental diets consisted of basal and concentrate supplement which were offered at the rate of 5% (DM basis) of their body weight in a proportion of 68:32 respectively. Three comparative experimental diets were formulated and designated A, B and C. Diet A which was the control group constituted elephant grass and concentrate in a ratio of 63:32. Diets B and C comprised combination of dried plantain with mango peels and concentrate in ratios of 55:13:32 and 50:18:32 respectively. The experimental animals were weighed before the commencement of the study and randomly allocated to the three dietary treatments in a completely randomized design. Each treatment was replicated with six animals.

Experimental animals and management

Eighteen (18) growing WAD goats (bucks), aged between 6 and 7 months with average initial body weight of 6.00±0.57 kg were used for the experiment. The experimental animals were purchased at a local market within Ekpoma. On arrival, the WAD goats were given prophylactic treatments against ecto and endo parasites and drenched with Albendazole which lasted for 21 days before they were later allotted to demarcated individual pens. The goats were housed in open sided, well-lighted and adequately ventilated building with slightly sloppy concrete floor. The concrete floor was covered with 5 cm

Table 1. Proximate chemical (%DM) and gross energy (Kcal/g) composition of the basal and supplementary diets.

Parameters	Basal diets			Concentrate supplement (CS)
	EG	PL	MP	
Dry matter	86.75	88.90	87.52	85.24
Crude protein	8.12	7.92	9.14	19.98
Ether extract	1.15	1.24	0.42	1.06
Crude fibre	29.55	5.81	5.24	12.06
Ash	10.95	6.52	3.34	7.95
Nitrogen free extract	50.23	78.51	81.86	58.95
Neutral detergent fibre	68.02	24.04	22.15	66.00
Acid detergent fibre	32.10	18.32	16.25	23.11
Gross energy	3.85	4.04	4.16	4.15

EG = Elephant grass, PL = Plantain peel, MP = Mango peel, CS = Concentrate supplement.

layers of wood shavings to absorb urine and for easy removal of faeces. The pens were cleaned daily and wood shavings were changed fortnightly. Basal and concentrate feeds were fed to goats at 8.00am in the morning with concentrate first followed by basal diet. Mineral salt lick and water were provided *ad libitum* to the animals throughout the experimental period. The daily feed intake was determined by the difference in weight in the quantity of feed provided and the residue of the previous day's feed or leftovers. Sub-samples of feeds offered were oven dried at 105°C to constant weight or dry matter determination. They were milled using the Christy Norris hammer mill fitted with a 2 mm sieve. Dried samples were stored in air-tight bottles for analysis. Weighing of the goats were carried out by using hanging scale on weekly basis before the morning feeds were offered to determine weight gain. Data derived from daily feed intake and daily weight gain was computed and feed conversion ratio was calculated as the ratio of feed intake over the body weight gain.

Energy and nitrogen utilization studies

Five (5) WAD goats per treatment (totalling 15) were selected and balanced for weight and randomly allocated to the three dietary treatments in metabolic crates fitted with facilities for separate collection of urine and faeces. The quantity of feed offered and leftover as well as faeces and urine were determined by weighing daily for seven (7) days after 7 day adjustment period. Ten percent of faecal and urinary samples were stored in a refrigerator at 4^{0}C until required for nutrient determination in the laboratory.

Heat combustion of feeds, faeces and urine were determined using an adiabatic bomb calorimeter. Digestible Energy (DE) and Metabolizable Energy (ME) intake per animal were determined from the energy content of the feeds intake and the amount of energy in faeces, urine and methane. The amount of energy loss through methane was set at 5% of the gross energy intake (CSIRO, 2001). Nitrogen balance by the animals was calculated as the difference between nitrogen intake and nitrogen excreted from faeces and urine while nitrogen retention percentage was computed from nitrogen balance expressed as a percentage of nitrogen intakes.

Chemical analysis

Samples of the experimental diets offered and faecal outputs were analysed for proximate composition using the procedures of AOAC (1990). Neutral detergent fibre and acid detergent fibre of the samples were determined as prescribed by Van Soest et al. (1991). Urine samples were analyzed for nitrogen using AOAC (1990).

Statistical analysis

Data obtained on intake, growth rate, energy and nitrogen utilization parameters were subjected to analysis of variance (ANOVA) to determine the significance of treatment effects following the methods described by SAS (1999).

RESULTS

Chemical and gross energy composition of the basal and supplementary diets

The chemical and gross energy composition of basal and concentrate supplement diets used in this study is presented in Table 1. The basal and concentrate supplement diets showed similarities in dry matter (DM) values that ranged from 85.24% in concentrate supplement (CS) to 88.90% in plantain peels (PL). Crude protein values of 8.12, 7.92, 9.14 and 19.98% were

Table 2. Performance characteristics of dwarf goats fed elephant grass and different proportion of dried plantain with mango peels.

Parameters	Treatments			SEM ±
	T_A	T_B	T_C	
Total feed intake (g/day)	19390.00^{c}	21960.00^{b}	23970.00^{a}	3.01
Daily feed intake (g/day)	230.83^{c}	261.43^{b}	285.36^{a}	0.99
Average daily feed intake (g/day/goat)	12.82^{c}	14.52^{b}	15.83^{a}	1.24
Nutrient intake (g/day)				
Crude fibre intake	67.51^{a}	48.98^{b}	45.89^{b}	0.63
Ether extract intake	7.02^{a}	9.92^{a}	5.95^{b}	0.78
Organic matter intake	8.17	8.51	7.92	1.05
Neutral detergent fibre intake	49.91^{a}	41.92^{b}	38.90^{b}	1.86
Acid detergent fibre intake	29.58^{a}	21.95^{b}	20.58^{b}	0.98
Growth indices				
Initial body weight (g)	6557.01	6555.00	6556.00	2.04
Final body weight (g)	8999.00^{c}	9159.00^{b}	9384.00^{a}	1.07
Daily weight gain (g)	29.07^{c}	31.00^{b}	33.67^{a}	2.31
Daily weight gain $BW^{0.75}$	12.52^{c}	13.14^{b}	13.98^{a}	0.81
Feed conversion ratio	7.94	8.43	8.43	0.32

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

obtained for elephant grass (EG), plantain peel (PL), mango peel (MP) and concentrate supplement (CS) respectively, with CS being the highest and PL the lowest. The percentage of ether extract had similar low values that ranged form 0.45 to 1.24% with PL recorded the highest and MP the lowest. Crude fibre and total ash contents which ranged from 5.24 to 29.55% and 3.34 to 10.95% respectively, were considerably differed in values, being highest in EG (29.55 and 10.95%) and lowest in MP (5.24 and 3.34%). Variation also existed in values obtained for nitrogen free extract, with MP (81.86%) being the highest, followed by PL (78.51%), CS (58.95%) before EG (50.23%) which was the lowest. The highest values of neutral and acid detergent fibre were obtained in EG (68.02 and 32.10%) while MP had the lowest values of 22.15 and 16.25% respectively. Gross energy values that ranged from 3.85 to 4.16 Kcal/g were highest in MP and lowest in EG.

Performance characteristics

The performance characteristics of dwarf goats fed elephant grass and different proportion of dried plantain with mango peels are shown in Table 2. Feed intake observed in this study differed significantly (P<0.05) across the treatment groups. Total feed intake (TFI) values of 19390.00, 21960.00 and 23970.00 g/day for T_A, T_B and T_C respectively were significantly higher in goats on T_C compared to T_B and T_A. The daily feed intake (DFI) and average daily feed intake (ADFI) values were significantly (P<0.05) higher in T_C (285.36 and 15.83 g/day) compared to T_B (261.43 and 14.52 g/day) and T_C (230.83 and 12.82 g/day).

Significant differences (P<0.05) were observed in all parameters measured in nutrient intake except organic matter. Crude fibre intake values of 67.51, 48.98 and 45.89 g/day were obtained for T_A, T_B and T_C respectively. No significant difference (P>0.05) was observed between T_B and T_C but T_A was significantly (P<0.05) different from T_B and T_C. Ether extract intake that ranged from 5.95 to 9.92 g/day was not significant different (P>0.05) between T_B and T_A but T_C was significantly (P<0.05) lower than T_B and T_A. Organic matter intake was not significantly (P>0.05) differed between treatment groups, but intake was considerably lower in T_C (7.92 g/day) compared to T_B (8.51 g/day) and T_A (8.17 g/day). Neutral and acid detergent fibre intakes followed a similar pattern of variation as observed in crude fibre intake. The highest value was recorded in T_A (49.01 and 29.58 g/day), followed by T_B (41.92 and 21.95 g/day) before T_C (38.90 and 20.58 g/day) which was the least.

Final bodyweight was significantly (P<0.05) differed between treatments with goats on T_C (938.4 g) being the heaviest, followed by those on T_B (9159g) and T_A (8999g) was the least. Daily weight gain values of 29.07, 31.06 and 33.67 g were obtained for goats on T_A, T_B and T_C respectively. Significant differences (P<0.05) were observed among treatment effects with animals on T_C recording the highest and T_A the lowest. Daily weight gain in $BW^{0.75}$ also differed significantly (P<0.05) between treatment groups with values ranging from 12.52 in T_A to 13. 98 in T_C. Feed

Table 3. Nitrogen utilization of dwarf goats fed experimental diets.

Parameters	Treatments			SEM ±
	T_A	T_B	T_C	
Nitrogen (N) intake (g/day)	18.67[c]	19.86[b]	21.75[a]	1.45
Faecal N output (g/day)	8.53[c]	9.01[b]	10.09[a]	0.92
Urinary N output (g/day)	3.62[a]	3.23[a]	2.29[a]	0.56
N – balance (g/day)	6.52[c]	7.62[b]	9.37[a]	0.79
N – balance $BW^{0.75}$	4.08[b]	4.59[b]	5.36[a]	0.84
N – retention (g/day)	0.35[b]	0.38[b]	0.43[a]	0.04
N – retention (%)	34.92[c]	38.37[b]	43.08[a]	1.93

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

Table 4. Energy utilization of dwarf goats fed experimental diets (Kcal/g/day).

Parameters	Treatments			SEM ±
	T_A	T_B	T_C	
Gross energy (GE) intake	1698.99[c]	1789.75[b]	1896.02[a]	3.62
Faecal energy (FE) output	185.25[a]	182.09[b]	178.34[c]	2.07
Total energy (TE) output	220.45[a]	214.01[b]	207.36[c]	1.95
Digestible energy (DE) intake	89.10[b]	89.85[b]	90.59[a]	0.96
Metabolizable energy (ME) intake	79.96[c]	81.51[b]	82.21[a]	0.98
ME in $BW^{0.75}$	26.74[b]	27.13[a]	27.30[a]	0.42
Metabolizability	0.05	0.05	0.04	0.02
ME:DE ratio	0.90	0.91	0.92	0.05

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

conversion ratio (FCR) that ranged from 7.94 to 8.48 was not significantly different (P>0.05) between treatment groups but the least value was observed in goats on T_A compared to T_B and T_C.

Nitrogen utilization

The results obtained for nitrogen utilization are presented in Table 3. The nitrogen utilization trial showed a significant (P<0.05) effects among dietary treatments. Nitrogen (N) intake and faecal N output of goats on T_C (21.75 and 10.09 g/day) were significantly (P>0.05) higher than those on T_B (19.86 and 9.01 g/day) and T_A (18.67 and 8.53 g/day) respectively. The urinary N output was significantly (P<0.05) influenced by the dietary treatment groups, with goat on T_A (3.62 g/day) being the highest output and T_C (2.29 g/day) the lowest. Nitrogen balance (g/day) was significant (P<0.05) among the three dietary treatments. Goats on T_C (9.37 g/day) gave higher nitrogen balance than those on T_B (7.62 g/day) and T_A (6.52 g/day). Nitrogen balance in $BW^{0.75}$ was not significantly (P>0.05) affected between the values in T_B (4.59 g/day) and T_A= (4.08 g/day) but T_C (5.36 g/day) was significant (P<0.05) higher, leading to a higher positive nitrogen balance compared to T_B and T_A. Similarly, nitrogen retention (g/day) in goats followed the same pattern with nitrogen balance ($BW^{0.75}$); goats on T_C (0.43 g/day) recorded the highest and T_A (0.35 g/day) the lowest. The percentage of nitrogen retention in goats was significantly (P<0.05) highest on T_C (43.08%), followed by T_B (38.37%) before T_A (34.92% which was the least.

Energy utilization

The results for energy utilization of dwarf goats fed experimental diets are shown in Table 4. Significant (P<0.05) difference was observed in gross energy intake with goats on T_C (1896.02 Kcal/g/day) recorded the highest intake, followed by T_B (1789.75 Kcal/g/day) and T_A (1698.99 Kcal/g/day) was the least. The estimated faecal energy output values were 185.25, 182.09 and 178.34 Kcal/g/day for T_A, T_B and T_C respectively, with goats on T_A being the highest followed similar pattern as the faecal energy output assessed. Goats on T_A (220.45 Kcal/g/day) had the highest and T_C (207.36 Kcal/g/day) the lowest. The estimated digestible and metabolizable energy among treatment effects were significantly (P<0.05) different, with T_C (90.59 and 82.21 Kcal/g/day) being the highest, followed by T_B (89.85 and 81.51 Kcal/g/day) and T_A (89.10 and 79.96 Kcal/g/day) was the least. Metabolizable energy in $BW^{0.75}$ indices measured was not significantly (P>0.05) affected between values in T_C (27.30) and T_B (27.13) but T_A (26.74) was significantly different (P>0.05) from T_C and T_B. The metabolizability that ranged from 0.04 to 0.05 (ME/GE) did not significantly (P>0.05) different among treatment groups, though the least was recorded in T_A. ME:DE ratio whose values ranged from 0.90 to 0.92 was also not significant among the three dietary treatment groups.

DISCUSSION

The results revealed that basal and concentrate supplement diets had relatively high dry matter content. This could probably due to the fact that they were prepared from dried ingredients which were characteristically high in dry matter. The values of proximate composition obtained in mango peels, plantain peels and elephant grass in this study were slightly different from those reported by Omole et al. (2004); Ajasin et al. (2004); Widiati and Thalib (2009) respectively. The marked differences between the values reported in this study and that obtained in literature might have been caused by difference in genetic origin, soil fertility and time of harvest. The low crude protein and ether extract values obtained in basal diets confirm that they are not a good source of protein and oil. The concentrate supplement was above the 10 to 12% crude protein moderate level required by ruminants for minimum growth performance (Gatemby, 2002). Thus concentrate supplement was included in basal diets to provide fermentable carbohydrate and nitrogen to augment the supplement of nutrients in the basal diets and encourage rumen degradation (Yousuf and Adeloye, 2011). The low total ash content values obtained in mango peels confirm that the total mineral content in the peels is low. The experimental feed ingredients can be ranked as carbohydrates rich diets due to its relatively high in nitrogen free extract content. The variation in the values of neutral and acid detergent fibre in the study was a reflection of the crude fibre contents in the diets, hence crude fibre was moderately higher in elephant grass and concentrate supplement than dried plantain and mango peels. The low gross energy value obtained in elephant grass further buttressed the fact that energy is lower in elephant grass compared to other (dried plantain and mango peels with concentrate supplement) feeds.

Several reports by Ajayi et al. (2005) and Ososanya (2010) indicated that feed intake is an important factor in the utilization of feed by livestock and is a critical determinant of energy and protein as well as performance in small ruminant. The different mechanisms involved in determining feed intake allow the understanding of differences observed in intake of feed in this study. The total feed intake increased as the inclusion levels of plantain peels decreased with increasing level of mango peels in the diets. This decreasing trend from T_C to T_A could be attributed to the palatability and fibre content of the diets. This observation agrees with the report of Yousuf and Adeloye (2010) who observed that decreased intake of feeds by goats depend on palatability and fibre content of the diets. The total feed intake values obtained in this study were similar to the range of values (19390 to 24970 g/day) reported by Ahamefule and Udo (2010) for dwarf goats. There was an improvement in daily feed intake and average daily feed intake with goats on T_C than T_B and T_A. This suggested that mango peels were probably more palatable and acceptable to goats than elephants grass and plantain peels. Sanon and Kanwe (2010) reported that mixture of mango peels and seed kernels gave a higher intake in sheep than mango peels and seed kernels separately. The generally low feeding values observed in T_A could be attributed to its relatively high fibre content and acceptability level of the diet. This is in consonance with the report of Jokthan et al. (2010) that the nature of feeds with acceptability plays an important role in regulating feed intake in small ruminant livestock.

The crude fibre intake observed in goats on T_A might be regarded as higher compared to T_B and T_C. The decreasing trend of the intake and decreasing level of plantain peels in the diets might have partly contributed to the decreasing crude fibre intake observed. The intake of neutral and acid detergent fibre for treatment groups followed a similar pattern of variation as observed in crude fibre intake suggesting that it could be as a result of the availability of crude fibre content in the diets. The crude fibre values recorded in this study varied with the reported range values (89.10 to 117.00 g/day) for dwarf goats (Garba et al., 2010). Such variation could probably be due to difference in the age and size of the goats, environmental factors interaction with the levels of crude fibre intake. The diets of different proportion of dried plantain and mango peels influenced ether extract intake of goats probably due to the difference in nutrient components of the diets. The observed reduction in ether extract for T_C could be attributed to the low availability of ether extract content present in mango peels (Azevedo et al., 2011) which could not be compensated by the level of concentrate supplement added to the diet. The organic matter intake observed in treatment groups was similar. It would appear that organic matter availability in the diets was better balance as it was consumed from the diets by the goats almost equally.

Sahlu et al. (2004) reported that nutrients requirement depends on body size or growth rate with the quality of the feed and environmental conditions. The final body weight was lower in goats on T_A compared to T_B and T_C. This might be a good indication of low intake of feed and the diet that was not well utilized then interfered with weight gain. The final body weight values recoded in this study were almost in agreement with the range of values (7600 to 9050 g/day) reported for dwarf goats (Ajayi et al., 2005). The daily weight gain followed a similar pattern of variation as observed in final body weight. Similarly, daily body weight gain in $BW^{0.75}$ was best in goats on T_C compared to T_B and T_A. The observed higher daily weight gain value with goats on T_A might be as a result of the ability of the goats to properly utilize the diet for body weight gain when compared with either of the other dietary treatments. This is in consonance with the report of Shalu et al. (2004) that an efficient utilization of nutrients that supply adequate energy and protein is required for optimum growth performance in goats. The daily weight gain recorded in this study is within the range of 19.8 to 77.00 g/day reported by Ahamefule and Udo (2010) for dwarf goats. The feed conversion ration (FCR) that is measured by feed intake per unit weight gain was similar, indicating a better feed conversion ratio of the diets. The efficiency at which goats converted feeds for body weight in the present study compared unfavourably with the previous study of Njidda and Ikhimioya (2010) for goats. However, the marked reduction in feed intake and weight gain in the group of goats on T_A could be as a result of low intake and utilization of the diet.

The influence of the diets of different proportion of dried plantain and mango peels on nitrogen (N) intake and faecal N-output of goats followed the pattern of the feed intake of the diets. Hence the goats could have increased N-intake with increased in daily feed intake to meet their protein requirements from the diets. The observed increase in faecal N-output in the diets could be attributed to the inhibitory effects of residual toxic and astringent factors associated with dried plantain and mango peels. This agrees with the findings of Okoruwa and Adewumi (2010) who reported that increased level of dried pineapple waste in diets of dwarf sheep was found to increase faecal N-output due to residual toxic components associated with the diets. The higher urinary N-output observed in T_A and T_B compared with T_C, could probably due to a reflection of nitrogen in the rumen that depend on the quantity and solubility of the diets, which might have been lost from the rumen as ammonia and later converted to urea before excreted as urine. This confirms the report of Ahamefule and Udo (2010) that nitrogen excreted in urine would depend on urea recycling and the efficiency of ammonia utilization produced in the rumen by microbes for microbial protein synthesis. However, all the diets offered to the goats gave a positive N-balance. The higher positive N-balance observed in T_C and T_B compared with T_A demonstrated that the diets were well utilized and efficiently used as fermentable nitrogen sources for microbial growth in the rumen of the goats as noted by Osakwe et al. (2003). The N-balance values obtained were not in conformity with the values reported by Okoruwa and Adewumi (2010). Nitrogen retention is the proportion of nitrogen utilized by farm animals from the total nitrogen intake for body process, hence the more the nitrogen is consumed and digested the more the nitrogen retained and vice versa, as observed by Okeniyi *et al*. (2010). Nitrogen retention in g/day and percentage were best in goats on T_C possibly because of nitrogen utilization in the rumen. This observation further buttressed by the fact that the diet was well balance in energy and protein which reduced nitrogen excretion in urine (Noblet and Van Milgen, 2004) which were attributed to better nitrogen retention in goats on T_C. The percentage of nitrogen retention values recorded in this study were within the range values (14.87 to 57.24%) reported by Ajayi et al. (2005) for dwarf that are similar in body weight.

The difference in gross energy intake of goats fed elephant grass and different proportion of dried plantain and mango peels followed the same trend as observed in feed intake and nitrogen retention in goats. This observation was contrary to the report of Noblet and Van Milgen (2004) that daily energy intake remains relatively constant across diets irrespective of the intake with different energy densities. The progressive decrease in trend of faecal energy output across diets in response to elephant grass and increased in inclusion level of dried plantain peels could probably due to crude fibre content and the inhibitory effects of residual toxic substance of plantain peels. This observation was in consistent with the report of Ajasin et al. (2004) that although dried plantain peel has a very low residual toxic substances, its total presence could be responsible for high faecal energy output in rabbits. The estimated total energy output followed similar pattern as the faecal energy output assessed. The higher total energy output obtained in goats on T_A could be as a result of higher energy loss in methane and urine. The estimated low values obtained for digestible and metabolizable energy in goats on T_A could probably be explained by high crude fibre intake and imbalance level of nutrient utilization of the diet which leads to a lower metabolizable energy in $BW^{0.75}$. This decrease in metabolizable energy on T_A is in agreement with the finding of Osakwe et al. (2003) who reported that reduction of cellulose digestion lead to low metabolizable energy in small ruminants. The digestible energy values were lower than the average value of 134.06Kcal/g reported by Calegare et al. (2007) while the metabolizable energy in $BW^{0.75}$ values were higher than the mean value of 3.80 Kcal/g/day as earlier reported by Johnson *et al.* (2003). The metabolizability and ME:DE ratio observed is generally low. The average ME:DE ratio of 0.91 in this study is on line with the report of Amaefule et al. (2009) that the ME:DE ratio of complete feeds is relatively constant and equivalent to about 0.96.

Consequently, the energy utilization for dwarf goats was higher on T_C that had the best weight gain.

Hence the energy utilization trail therefore confirmed the nitrogen utilization trial which showed a higher positive nitrogen balance on T_C compared to T_A and T_B

respectively.

CONCLUSION

Based on the results obtained in this study, it is therefore concluded that combination of dried plantain and mango peels in different proportions have a good nutritional potentials and could constitute the main component of goat rations, especially during feed scarcity without any adverse effect on the goats.

The responses in terms of intake, growth rate, nitrogen and energy utilization by the dwarf goats were evidence pronounced when dried plantain and mango peels were fed with concentrate supplement in a ratio of 50:18:32 respectively.

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