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Performance, blood biochemical constituents and mineral balance of west african dwarf sheep fed preserved elephant grass, layers' droppings and cassava peel diets during dry season

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Abstract

An experiment was conducted during the dry season to evaluate the performance, blood biochemical constituents and mineral balance in fifteen West African Dwarf rams fed diets containing preserved elephant grass, layers' droppings, cassava peel and sawdust ash. The three experimental diets contained elephant grass at 45, 40 and 35 %, and layers' droppings at 25, 30 and 35 %, respectively. The quantity of cassava peels and sawdust ash in the three diets were fixed at 28 % and 2 %, respectively. The rams were divided into 3 groups of 5 animals each balanced for body weight. Each group of rams was randomly allocated to one of the experimental diets in a 90-day feeding trial. Results showed that voluntary dry matter intake (DMI) decreased ($P < 0.05$) from 396.92 g/d to 325.88 g/d as the proportion of layers' droppings in the diet increased. The rams fed diet 3 were heavier ($P < 0.05$) compared to the rams on other diets. Packed cell volume, RBC, WBC, BUN, glucose, total protein, Ca^{++}, PO_4^-, K^+, Na^+ and Cl^- were similar ($P > 0.05$) in the rams fed the experimental diets. Significant higher Ca retentions of 95.65 % and 95.58 % respectively, were depicted by the rams fed diets 2 and 3 compared to the rams on diet 1 (93.56 %). Negative P retention was observed in the rams fed diets 1 and 3. The highest ($P < 0.05$) Mg retention of 73.44 % was recorded in the rams fed diet 2. Sodium retention was higher ($P < 0.05$) in the rams fed diet 1 (49.91%) compared to those on other diets. There were no significant differences in K retention in the rams fed the experimental diets. It was concluded that a diet containing 35 % each of elephant grass and layers' droppings with 28 % cassava peel and 2 % sawdust ash could be utilized for feeding sheep during the dry season for good performance.

Keywords: Dryseason feed, WAD sheep, performance, blood constituents, mineral balance.

Introduction

The provision of good quality forage and/ or feed all year round is a major problem of ruminant livestock production in Africa generally and Nigeria in particular. Livestock farmers faced their biggest challenge during the dry season when a "staircase" growth pattern is observed in animals as a result of inadequate feed (Davies and Onwuka, 1993).

Caged layer waste is a rich source of protein ranging between 25 – 30 % of which 40 – 50 % is true protein (Kayongo *et al.*, 1993). It has been successfully used in feeding ruminants (Kayongo and Irungu, 1986; Odhuba *et al.*, 1986; Kayongo *et al.*, 1993). Elephant grass (*Pennisetum purpureum*) is a tropical forage that favours the hot and humid conditions with average annual yield of about 300 tonnes green fodder per hectare equivalent to 49.5 tonnes dry matter (DM) containing 5.3 tonnes crude protein (Hassan *et al.*, 1983). The grass has been utilized in feeding ruminants solely or with supplements (Mpairwe *et al*., 1998; Aroeira *et al*., 1999; Sarwar and Nisa, 1999). Cassava peel is available throughout the year and has been evaluated as feedstuff for small ruminants ((Adegbola and Asaolu, 1986; Ifut, 1989; Adegbola *et al*., 1989; Adeloye *et al*., 1993; Okeudo and Adegbola, 1993; Adebowale and Taiwo, 1996; Lakpini *et al*., 1997; Baah *et al*., 1999). The current practice is to feed caged layer waste or cassava peel separately as supplement to grass the effect of which could be complimentary or substitution of one feedstuff for the other. The most practical and feasible method of improving nutrient supply to these animals is the utilization of a combination of available crop residues, farm wastes and grass hay in a mixed ration. This study assessed the performance, blood biochemical constituents and mineral balance in West African Dwarf sheep fed preserved elephant grass, layers' droppings and cassava peel diets during dry season.

Materials and Methods

Experimental site

The feeding experiment was conducted at the Small Ruminant Experimental Unit of the Teaching and Research Farms, University of Agriculture, Abeokuta. The location, which is 76 m above sea level, falls within latitudes 7° 5.5' - 7° 8.0' N and longitudes 3° 11.2' - 3° 12.5' E. The climate is humid and is located in the derived savanna zone of South Western Nigeria. It receives a mean annual precipitation of 1,037 mm, mean annual temperature of 34.7° C and mean relative humidity of [illegible] %. The experiment was conducted during the [illegible] dry season from January to April.

Ingredient collection and processing

Elephant grass (after 6 to 8 weeks regrowth) was harvested along the Teaching and Research Farm of the University of Agriculture, Abeokuta. The succulent and less hardened parts of the grass were cut, chopped with a sharp cutlass to about 2 cm length and thereafter sun-dried for 4 days to about 10 – 15 % moisture content. The dried grass was then packed into sacks until needed. Fresh caged layer waste was collected from the Poultry Unit of the Teaching and Research Farm of the University of Agriculture, Abeokuta. The droppings were sun-dried on black polythene nylon for 8 days. As the drying progresses, the lumps were manually crushed to reduce the particle size. The dried droppings were thereafter packed into sacks until needed. Fresh cassava peels were collected from different gari-processing locations around the Abeokuta Township. The peels were spread on concrete floor and sun drying was done for 3 days after which the peels were packed into sacks. Fresh wood ash from burnt sawdust was collected from a sawmill. The ash was sieved to pass through a 1 mm screen to remove extraneous materials. The ingredients were preserved for three months (90 days).

Animals and their management

Fifteen West African Dwarf rams, procured from villages around Abeokuta and weighing between 8 and 14 kg were used for the experiment. The animals were quarantined for 21 days during which they were dipped in Asuntol® powder solution (3 g/L of water) against ectoparasites and injected with Ivomec® injection (0.20 ml/10 kg BW) against internal parasites. After 3 days they were injected with Oxytetracycline (L. A.) antibiotics to enhance their resistance to infections and subsequently vaccinated against *Pestes des Petit* Ruminants (PPR) with Tissue Culture Rinderpest Vaccine. During the 21-day period, the rams were maintained on soybean husk, cassava peels, fermented maize wastes and fresh *Panicum* grass. Water was provided *ad libitum*.

After 21 days, the animals were transferred to the experimental pens previously swept clean, washed with Morigad® and Diazintol® solutions to disinfect. The animals were divided into 3 groups of 5 animals each balanced for body weight. Three diets were formulated containing different combinations of dried chopped elephant grass (*Pennisetum purpureum*), caged layer waste, cassava peels and sawdust ash (Table 1) manually mixed together. Each group of rams was randomly allocated to one of the experimental diet. The animals under each group were housed individually in individual pens (each animal is a replicate). Feeding of the animals was done at 4 % of their body weight for 90 days aside from the initial seven days of acclimatization. Water was provided *ad libitum*.

Data collection

Weight of individual animal was measured at the onset of the experiment and subsequently on weekly basis with Measuretech® hanging scale. Residual feed was weighed daily to estimate feed intake. After the feeding trial, 3 rams from each dietary treatment were randomly selected and transferred to individual metabolism cage allowing for separate collection of faeces and urine to determine digestibility and mineral balance, respectively in the rams. The rams were maintained on their previous respective diets with free access to water. The rams were allowed 3 days adjustment period before 7-day total collection of faeces and urine. Faecal collection from each ram was oven dried at 65°C, weighed, bulked and aliquots (25 %) was taken individually for chemical analysis. Urine samples were collected in urine sample bottles previously rinsed with dilute sulphuric acid (10 % H_2SO_4) to preserve nitrogen. Total volume was determined and 25 % stored in the deep freezer at −20°C until required for

Table 1: Ingredients and chemical composition of the experimental diets (%)

	Diets		
Nutrients	1	2	3
Elephant grass	45.00	40.00	35.00
Layer's droppings	25.00	30.00	35.00
Cassava peels	28.00	28.00	28.00
Woodash	2.00	2.00	2.00
Total	100.00	100.00	100.00
Determined analysis (% DM):			
Dry matter	90.62	90.53	90.27
Crude protein	17.44	17.92	18.73
Crude fibre	50.00	37.33	34.67
Ether extract	1.41	1.34	1.31
Ash	9.69	9.26	8.93
Nitrogen free extract	21.46	34.15	36.36
Neutral detergent fibre	86.13	77.27	74.18
Acid detergent fibre	33.24	32.16	25.09
Acid detergent lignin	26.18	24.07	18.26
Calcium	1.70	1.53	1.63
Phosphorus	0.38	0.26	0.28
Magnesium	1.23	0.79	0.66
Potassium	3.60	2.75	3.15
Sodium	1.30	0.83	0.95
Metabolizable energy (MJ/ kg DM)	11.90	10.34	12.16

chemical analysis.

About 10 ml of blood sample taken 4 hr. after feeding was collected from each animal via jugular venipuncture (Frandson, 1986) with hypodermic needle and syringe, which was divided into 5 ml each. The first 5 ml was poured into sample bottle containing anticoagulant ethylenediamine tetracetic acid (EDTA). The blood was centrifuged and plasma harvested to determine Packed Cell Volume (PCV), Red Blood Cells (RBC), White Blood Cells (WBC), glucose, blood urea nitrogen (BUN) and total protein (TP). The other 5 ml was allowed to coagulate and serum saved to determine contents of Ca^{++}, PO_4^{---}, K^+, Na^+ and Cl^-

Chemical analysis

The chemical composition of feed, faecal and urine samples was determined using the procedure of A. O. A. C. (1990). Determination of NDF, ADF and ADL was by the method of Goering and Van Soest (1970). Packed cell volume was determined by microhaemotocrit method. Red blood cell was determined using manual hemacytometer. White blood cell was determined by leucocyte counts. Plasma glucose and plasma urea nitrogen were determined by enzymatic colorimetric method. Spectrophotometer (SP6-400 UV Pye Unicam) reading was done at wavelengths of 600 nm and 550 nm, respectively. Serum concentrations of Ca^{++}, K^+ and Na^+ were determined using Gallenkamp Flame Analyser (FGA-330). Phosphate (PO_4^{---}) ions in serum were determined in trichloroacetic acid filtrate. Serum Cl^- was estimated using colorimetric method (A. O. A. C., 1990). Metabolisable energy (MJ kg^{-1} DM) of the diets was derived from their chemical constituents using the equation of De Boever *et al.* (1997) as M E = 12.86 + 0.0265FAT – 0.0056ADF – 0.0153ASH – 0.0253ADL

Statistical analysis

All the data generated were subjected to one-way analysis of variance (SPSS, 1999) in a completely randomized design while significantly different means were separated using Duncan (1955) Multiple Range Test within the same package.

Results and Discussion

The chemical composition of the experimental diets is shown in Table 1. Crude protein (CP) and CF contents of the experimental diets are reflections of the relative proportions of layers' dropping and elephant grass. The CP increased as the proportion of layers' droppings increased in the diets while the crude fibre reduced as the quantity of elephant grass decreased in the diets. The CP and CF in the present study are higher than those reported by Oladotun *et al.* (2003) arising from the differences in the proportion of layers' droppings used as well as different type and quantity of grasses used in the two studies. The fibre fractions of the diets were very high and decreased as the proportion of elephant grass in the diet decreased. Mpairwe *et al.* (1998) reported high NDF and ADF contents for elephant grass suggesting that the grass contributed the bulk of the fibre fractions. The contents of Ca, P, Mg, K and Na in the experimental diets are higher than the critical values recommended for sheep by McDowell (1985) and the desirable concentrations of mineral in feed dry matter for maintenance recommended for sheep by SCA (1990). The range of 10.34 – 12.16 MJ/kg DM metabolisable energy in the experimental diets is within the range of 6.0 – 13.0 MJ/kg DM recommended for growth (Gatenby, 2002).

The performance indices in the rams offered the experimental diets are shown in Table 2. The voluntary dry matter intake (DMI) decreased ($P<0.05$) as the proportion of layers' droppings in the diet increased. This could be due to lowering of ac-

Table 2: Performance indices of West African Dwarf sheep fed the experimental diets

	Diets			
	1	2	3	±SEM
Average initial weight (kg)	9.57	9.50	9.93	0.021
Average final weight (kg)	13.67	13.50	14.50	0.049
Average daily gain (g/day)	45.56[b]	44.44[b]	50.78[a]	0.307
Average daily gain (g $W^{0.75}$/day)	17.54[b]	17.21[b]	21.40[a]	1.206
Dry matter intake (g/day)	396.92[a]	366.64[ab]	325.88[b]	3.324
Feed conversion ratio	9.61[a]	9.11[a]	7.11[b]	0.120
ME intake (MJ/ kg DM)	5.21[a]	4.19[b]	4.39[b]	0.049

[a,b] means along the same row with similar superscripts are not significant (P>0.05)
ME = Metabolizable energy
SEM = Standard error of means

ceptability of the diet by the increasing proportion of layers' droppings in the diets (Muller, 1980). Rude and Rankins (1993) observed differences in DMI of sheep fed diets containing poultry litter ensiled with grasses. Others (Okeudo and Adegbola, 1993) have shown an increase in the DMI of sheep with inclusion of poultry droppings. When expressed as percentage of body weight (% BW), DMI was 2.91, 2.72 and 2.25 for animals on diets 1, 2 and 3, respectively. This is within the range of 1.5 – 3.0 % BW reported by Gatenby (2002), but less than the value of 4.2 % BW reported for growing lambs of WAD sheep consuming roughage plus concentrate diets (Charray *et al.*, 1992). Although DMI was lowest in the rams fed diet 3, higher (P< 0.05) utilization of the diet is reflected in the feed conversion ratio and weight gain in the rams fed the diet. According to FAO (1995), the energy value of a diet, and the efficiency of its utilization, are largely determined by the relative balances of glucogenic energy, long chain fatty acids and essential amino acids absorbed by the animals. It could then mean that this diet contained a balance of nutrients, which efficiently interacted to give the highest average daily gain. Sainz and Wolff (1990) reported that the rate of fat deposition relate more to the amount of energy available in excess of requirements for maintenance and lean growth. Variations in average daily gains of the rams could be attributed to variation in nutrient supply from the diets (Oddy and Sainz, 2002). Average daily gain in the rams fed the experimental diets is in line with previously reported values of 40 – 60 g/d for West African dwarf sheep fed different combinations of crop residues, agro-industrial by-products, poultry droppings and *P. maximum* (Taiwo *et al.*, 1995; Adebowale and Taiwo, 1996; Oladotun *et al.*, 2003).

There were no statistical differences (P> 0.05) in the haematological and serum biochemical constituents attributable to the diets offered (Tables 3 and 4). The rams offered diet 3 however, had the lowest PCV, RBC, WBC, glucose, plasma urea N and total protein, although they exhibited the highest average daily gain. The highest concentration of all the blood constituents were observed in the rams fed diet 2. The values of PCV, WBC, glucose and urea N were within the normal range in the rams offered diets 1 and 2 (Radostits *et al.*, 1997; Meyer and Harvey, 1998). Poultry droppings are potential sources of pathogenic microorganisms (Martins *et al.*, 1997). The nor-

Table 3: Haematological parameters and blood metabolites of West African Dwarf sheep fed the experimental diets

	Diets		
	1	2	3
Packed cell volume (%)	25.33 ± 3.93	27.67 ± .033	19.67 ± 2.40
Red blood cell (n x10^{12}/L)	2.87 ± 0.83	3.17 ± 0.09	2.33 ± 0.29
White blood cell (n x 10^{9}/L)	6.47 ± 0.18	6.47 ± 0.24	6.27 ± 0.18
Glucose (mmol./L)	2.67 ± 1.24	2.84 ± 0.09	2.11 ± 0.24
Blood urea nitrogen (mmol./L)	3.81 ± 0.63	4.05 ± 0.12	2.97 ± 0.43
Total protein (g/L)	40.67 ± 6.33	44.00 ± 0.58	31.33 ± 3.71

[illegible] values of WBC obtained for the rams offered the experimental diets 1 and 2 depict absence of infection since elevation of WBC suggests infection by microorganisms especially bacteria (Meyer and Harvey, 1998). Glucose is one of the metabolites measured as an indicator of the energy status of the animal. Normal glucose levels in the rams indicate adequate synthesis in the liver from propionate metabolism as the major glucose precursor (Houtert, 1993). The PCV and blood urea N in rams fed diet 3 were lower than the normal range. Blood urea N is an indication of efficiency of utilization of dietary protein. Eggum ([illegible]) reported that the blood urea N levels are highly inversely correlated with net protein utilization. This explains why the urea N of the rams fed diet 3 was lower than the others, but had the highest average daily gain because nearly all the digested protein is used for protein synthesis ([illegible], 1989). Likewise, the diets did not affect serum concentration of total protein. Poultry droppings contains abundant amount of all the minerals (McCaskey *et al*., 1989).

Serum biochemical constituents of WAD sheep fed the experimental diets are shown in Table 4. All the serum minerals in the rams fed the three diets were lower than the normal range (mmol/L) of [illegible] – [illegible], 1.60 – 2.40, 4.0 – 6.0,136 – 154 and 98 – 115 for Ca^{++}, PO_4^{---}, K^+, Na^+ and Cl^-, respectively but higher than the critical levels in the blood (Meyer and Harvey, 1998). The diet offered could not be said to have negative effects on the serum haematological and biochemical constituents of the rams since those constituents that were normal prior to the feeding of the experimental diets (PCV 22.00 – 37.00 %, RBC (x10^{12}/L) 2.40 - 4.20, WBC (x 10^{9}/L) 6.20 – 6.80, Glucose (mmol/L) 2.20 – 3.85, BUN (mmol/L) 3.21 – 5.71, Total protein (g/L) 35.00 – 59.00, Ca^{++} (mmol/L) 1.05 – 1.78, PO_4^{---} (mmol/L) 0.58 – 1.00, K^+ (mmol/L) 2.10 – 3.50, Na^+ (mmol/L) 79.00 – 133.00 and Cl^- (mmol/L) 57.00 – 96.00) were still normal after the experiment and no clinical signs of diseases were shown throughout the period of the experiment. Most studies involving the use of combinations of grasses and poultry droppings did not include haematological and biochemical constituents. Therefore little comparison could be made. Rude *et al.* (1994) reported that only serum chloride and urea N concentrations were altered significantly while other biochemical constituents remain unchanged in lambs fed poultry litter diets. In cattle, (Silanikove and Tiomkin, 1992; Rankins *et al.,* 1993) serum calcium and chloride concentrations decreased while serum phosphorus increased linearly with increased dietary poultry litter in the diets.

Table 4: Serum biochemical constituents of West African Dwarf sheep fed the experimental diets (mmol./L)

	Diets		
	1	2	3
Ca^{++}	1.23 ± 0.19	1.32 ± 0.02	0.93 ± 0.12
PO_4^{---}	0.68 ± 0.10	0.74 ± 0.02	0.53 ± 0.07
K^+	2.40 ± 0.63	2.57 ± 0.03	1.90 ± 0.27
Na^+	91.67 ± 14.10	99.33 ± 1.20	71.00 ± 8.74
Cl^-	66.00 ± 10.26	72.33 ± 1.20	51.00 ± 6.11

Table 5: Calcium balance of West African Dwarf sheep fed the experimental diets

	Diets			
Items	1	2	3	±SEM
Intake (g/day)	7.45	6.20	5.88	0.075
Excretion (g/day):				
Faecal	0.40	0.19	0.16	0.012
Urinary	0.08	0.08	0.10	0.001
Absorption (g/day)	7.04	6.01	5.72	0.063
% of intake	94.50	96.94	97.28	0.131
Retention (g/day)	6.97^a	5.93^b	5.62^b	0.064
% of intake	93.56^b	95.65^a	95.58^a	0.108

[a, b] Means along the same row with similar superscripts are not significant (P>0.05)
SEM = Standard error of means

Calcium balance of West African Dwarf rams fed the experimental diets is shown in Table 5. Calcium (Ca) intake, excretion and absorption were not significantly different (P>0.05) in the rams fed the experimental diets. The rams offered diet 1 had a significantly higher (P<0.05) Ca retention compared to those on other diets. Calcium retention, expressed as percentage of intake, was significantly lower (P<0.05) in rams fed diet 1 but higher in those fed diets 2 and 3, which had similar (P>0.05) Ca retention. High Ca absorption and retention (% of intake) could be attributed to the high quantity of ash in poultry droppings (Holzer, *et al.*, 1986). High Ca absorption in the rams agrees with Cooke and Fontenot (1990) who reported high apparent absorption of Ca in sheep fed animal waste supplemented diets.

Phosphorus balance of West African Dwarf rams fed the experimental diets is shown in Table 6. Phosphorus (P) intake, excretion, absorption and retention were not significantly different (P>0.05) in the rams fed the experimental diets. However, in rams fed both diets 1 and 3 absorption and retention of P were negative but positive in diet 2. The observed negative P balance is contrary to the report of Ben-Ghedalia *et al.* (1982) that sheep effectively absorbed P from poultry manure. Most of the P absorbed by the rams was excreted in the faeces. Cooke and Fontenot (1990) attributed high P excretion in sheep to high serum inorganic P, which was not high in this study. In the rams that exhibited negative P retention, faecal excretion of P is greater than intake suggesting that the faecal excretion of P included metabolic sources from digested rumen microor-

Table 6: Phosphorus balance of West African Dwarf sheep fed the experimental diets

Items	Diets 1	2	3	±SEM
Intake (g/day)	1.66	1.05	1.11	0.031
Excretion (g/day):				
Faecal	1.79	0.88	1.64	0.044
Urinary	0.05	0.05	0.07	0.001
Absorption (g/day)	- 0.13	0.17	- 0.53	0.077
% of intake	- 7.83	16.19	- 47.75	2.930
Retention (g/day)	- 0.05	0.12	- 0.60	0.034
% of intake	- 3.01	11.43	- 54.05	3.121

SEM = Standard error of means

Table 7: Magnesium balance of West African Dwarf sheep fed the experimental diets

Items	Diets 1	2	3	±SEM
Intake (g/day)	5.39	3.20	2.38	0.141
Excretion (g/day):				
Faecal	1.44	0.65	0.50	0.046
Urinary	0.20	0.20	0.21	0.049
Absorption (g/day)	3.95^{a}	2.55^{b}	1.88^{b}	0.096
% of intake	73.28^{b}	79.69^{a}	78.99^{a}	0.319
Retention (g/day)	3.75^{a}	2.35^{b}	1.67^{b}	0.096
% of intake	69.57^{b}	73.44^{a}	70.17^{b}	0.189

a,b Means along the same row with similar superscripts are not significant (P>0.05)
SEM = Standard error of means

ganisms and bile. Secretion of P proximal to the abomasum and absorption from the small intestine has been reported (Giduck, 1982; Greene *et al.*, 1983ab; Rahnema and Fontenot, 1983). It could be that both the secreted and ingested P was not properly absorbed in the small and large intestine.

Magnesium balance of West African Dwarf rams fed the experimental diets is shown in Table 7. Magnesium (Mg) intake and excretion were not influenced (P>0.05) by the experimental diets fed to the rams. Absorption of Mg in rams fed diet 1 was higher (P<0.05) than in animals fed diets 2 and 3. When expressed as percentage of intake, Mg absorption was lower (P<0.05) in rams fed diet 1 than in rams offered diets 2 and 3. Magnesium retention followed a similar trend as in Mg absorption. The appearance of Mg in urine suggests that it was absorbed in excess from the diet. This is in line with Kaneko (1989) who reported that Mg appear in urine when the filter load exceeds the maximal tubular re-absorptive capacity. The high Mg absorption indicates that the

Table 8: Potassium balance of West African Dwarf sheep fed the experimental diets

Items	Diets			
	1	2	3	+SEM
Intake (g/day)	15.76	11.04	11.37	0.236
Excretion (g/day):				
Faecal	6.51	5.03	5.05	0.077
Urinary	2.24	2.20	2.41	0.010
Absorption (g/day)	9.25	6.11	6.32	0.159
% of intake	58.69	55.34	55.59	0.185
Retention (g/day)	7.01	3.91	3.91	0.162
% of intake	44.48	35.42	34.39	0.511

SEM = Standard error of means

Table 9: Sodium balance of West African Dwarf sheep fed the experimental diets

Items	Diets			
	1	2	3	+SEM
Intake (g/day)	5.69	3.36	3.43	0.120
Excretion (g/day):				
Faecal	0.92	0.72	0.73	0.010
Urinary	1.93	1.97	2.32	0.020
Absorption (g/day)	4.77[a]	2.64[b]	2.70[b]	0.110
% of intake	83.83[a]	78.57[b]	78.72[b]	0.272
Retention (g/day)	2.84[a]	0.67[b]	0.38[b]	0.122
% of intake	49.91[a]	19.94[b]	11.08[b]	1.846

[a, b] Means along the same row with similar superscripts are not significant (P>0.05)
SEM = Standard error of means

Mg in the diet is highly available. Magnesium absorption in the rams is higher than the 41.6 % reported for sheep fed poultry litter supplemented diets (Ben-Ghedalia *et al.*, 1982). This might be due to the higher percentage of Mg in caged layer waste (0.67 %) compared to poultry litter (0.44 %) as reported by Fontenot (1999).

Potassium balance in West African Dwarf sheep fed the experimental diets is presented in Table 8. Potassium (K) intake, excretion, absorption and retention were not significantly different (P>0.05) in the rams fed the experimental diets. Apparent K absorption (percentage of intake) in all the rams is lower than the 90 % value previously reported (Chicco *et al.*, 1972). Retention of K in the rams is higher than 10 – 19 % reported by Chester-Jones *et al.* (1989).

Sodium balance of West African Dwarf rams fed the experimental diets is shown in Table 9. Sodium (Na) intake and excretion were not significantly different (P>0.05) in the rams fed the experimental diets. Sodium absorption and reten-

...on followed a similar trend and were significantly higher (P< 0.05) in rams fed diet 1 compared to rams on diets 2 and 3. Apparent Na absorption (percentage of intake) is close to the reported values of 84 – 96 % in wether lambs (Grace *et al.*, 1974). The trends in the absorption and retention of K and Na in rams offered diets 2 and 3 suggests that a larger quantity of the ingested K and Na is excreted in faeces and urine respectively, to maintain K and Na balance in the body systems.

Conclusion

There was a significant variation in the response of the rams fed the experimental diets. The rams fed diet 3 (35 % elephant grass, 35 % layers' droppings, 28 % cassava peels and 2 % sawdust ash) performed better in terms of feed conversion ratio and average daily gain. All the rams offered the experimental diets were in positive mineral balance except the rams offered diets 1 and 3, which had negative phosphorus balance. A diet consisting of equal proportion of elephant grass and layer droppings (35 % each) mixed with 28 % cassava peels and 2 % wood ash is recommended for dry season feeding of sheep.

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