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Haematological Indices and Serum Biochemical Profiles of Dwarf Goats Fed Elephant Grass and Varying Levels of Combined Plantain with Mango Peels

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Authors' contributions

This work was carried out in collaboration between the two authors. Author MIO designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author IK managed the analyses of the study and managed the literature searches. The two authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

The experiment was carried out to determine the replacement value of plantain and mango peels combination for elephant grass, using haematological indices and serum biochemical profile by dwarf goats. Eighteen West African dwarf goats with average weight of 6.00±0.57kg and aged between 6 to 7 months old were used for the study in the Department of Animal (sheep and goat unit), Ambrose Alli University, Ekpoma between July and October 2012. The dwarf goats were allotted to three dietary treatments (T_1, T_2 and T_3) with six animals per treatment in a complete randomized design. The compared diets were; T_1 (elephant grass and concentrate in a ratio of 68:32 which served as control group), T_2 and T_3 68:32 (Combination of plantain with mango peels and concentrate in ratios of 55:13:32 and 50:18:32 respectively). Results showed that initial haemoglobin (8.08g/dl), white blood cell ($8.96x10^9$/l), sodium (119.62mmol/l), phosphorus (4.00mg/dl), potassium (4.59mmol/l) and final white blood cell ($11.02x10^9$/l), cholesterol (69.03mg/dl), creatinine (1.02mg/dl), sodium (130.72mmol/l), phosphorus (4.01mg/dl) were significantly ($P<0.05$) highest with animals on T_1. Animals on T_2 had the highest ($P<0.05$) in initial glucose level (76.02mg/dl). Initial cholesterol (70.42mg/dl) and final packed cell volume

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(25.02%), haemoglobin (11.01g/dl), red blood cell ($11.21x10^{12}$/l), urea (23.38mg/dl) were significantly ($P<0.05$) better for animals on T_3. No significant ($P>0.05$) difference was observed in initial packed cell volume, total packed cell volume, albumin, globulin, creatine and final total protein, albumin, globulin, creatine and final total protein, albumin, globulin, glucose, calcium with potassium. It can be concluded that plantain with mango peels in a ratio of 50:18 enhance haematological indices and serum biochemical profile for West African dwarf goats.

Keywords: Plantain peels; mango peels; haematology; serum biochemistry; goats.

1. INTRODUCTION

The need to increase small ruminant livestock production is as a means of alleviating the overwhelming shortage of animal protein is very vital to humanity. The supply of animal protein in Nigeria is lower than the demand, thus acute shortage of animal product in the diet of many Nigerians. Sheep and goats serve primary as source of meat but also provide milk, skins and manure. They produce about 16% of the world's meat despite their contribution to the total world's milk and skin products [1]. To improve small ruminant productivity their feeding regimes should be reconsidered.

Poor nutrition is one of the main constraints of small ruminant livestock productivity in the tropics. Even were forages resources are abound, seasonal fluctuation in their nutritive value make sustainable gains in production from good management and diseases controlled programme unrealistic [2]. This is primarily because they are predominantly grazing on natural pasture which is often poor in nutritive values, most especially during the dry season. The steady increase in the cost of conventional feeds is additional factor to scarcity of forages thus, this necessitate investigation into the use of cheaper alternative feed resources that are locally available and less competitive in feeding ruminants.

Plantain and mango peels are such alternative feeds that can be used in feeding small ruminants. Plantain (*Musa paradisiacal*) and mango (*Mangifera indica*) are most important tropical and sub-tropical fruits of the world. Mango consists of edible pulp, inedible kernel and inedible peel [3], while plantain contains edible pulp and inedible peel [4]. However, a huge amount of waste is generated from these fruits during industrial processing, which have a serious disposal problem in the environments. The utilisation of these fruit peels as alternative feeds that are readily available and cheaper have been researched in details for ruminant livestock production. These peels are good sources of energy, minerals and dietary fibre but low in crude protein. Ajila et al. [5] reported that fibre from mango peels have a better nutritional quality than those found in cereals due to their greater soluble dietary fibre to insoluble dietary fibre ratio. Nevertheless, evidence is presented in literature to show that when fruit peels are properly selected and combined according to their nutritional characteristics, adequate and productive diets could be provided all-year round for sustainable livestock productivity [6].

Blood is an important index of physiological and pathological changes in an organism, that is used in assessing the body's ability to respond to haematological and serum biochemical upset. Ogunbajo et al. [7] observed that nutritional studies should not be limited to performance alone, but the effect on the blood constituents is also vital tools that help to detect any deviation from normal in the animal's body. Currently in veterinary practices a

diagnosis is considered in complete or not definitive, if information obtained from history and chemical examination is not combined with laboratory test of blood constituents. The present study was therefore designed to assess the haematological and serum biochemical profiles of dwarf goats fed elephant grass and vary levels of combined plantain with mango peels.

2. MATERIALS AND METHODS

2.1 Experimental Site

The study was conducted at the small ruminants section of the Teaching and Research Farm, Ambrose Alli University, Ekpoma, Edo State, Nigeria. The site is located in the Longitude 6.09°E and Latitude 6.42°N with average rainfall and temperature of about 1556mm and 30°C per annum respectively.

2.2 Experimental Diets

Elephant grass was harvested within the Teaching and Research Farm and chopped manually into about 6 to 7cm. Plantain and mango peels were collected fresh in convergence of local processors located within Ekpoma. They were also chopped and dried under shade for 7 days to obtain air dry basis before milled. The experimental diets comprised basal and concentrate supplement. The basal diets constituted elephant grass and plantain with mango peels while the gross compositions of the concentrate supplement diet is shown in Table 1. The basal and concentrate supplement diets were in ratio of 68:32 respectively. Experimental diet T_1 (which was the control group consisted of elephant grass and concentrate supplement in a ratio of 68:32). T_2 (constituted the combination of plantain with mango peels and concentrate supplement in a ratio of 55:13:32), while T_3 (comprised mixture of plantain and mango peels with concentrate supplement in a ratio of 50:18:32 respectively).

Table 1. Gross composition (% DM basis) of the concentrate supplement diet

Ingredients	Composition
Wheat offal	78.00
Brewery dried grain	20.00
Limestone	0.75
Dicalcium phosphate	0.50
Salt	0.50
Vitamin	0.25
Total	**100**

2.3 Experimental Animals, Feeding and Management

Eighteen growing West African dwarf goats, aged between 6 and 7 months with mean body weight of 6.00±0.57kg were used for the study. The experimental animals were source from the livestock market at Ekpoma. On arrival, the animals were given prophylactic treatments against ecto and endo parasites. The animals were inter allotted to the three dietary treatments after 21 days of adaptation period in a completely randomized design with six animals per treatment. Experimental diets were fed to animals in the morning (8.00am) once daily at the rate of 5% (DM basis) of their body weight. Animals were also having free access to water.

2.4 Blood Samples Collection and Analysis

Blood samples were collected from each animal before commencement of the feeding trial and at the last day of the study before terminating the experiment. Blood samples were collected by jugular-venipuncture of each animal using disposable syringes and sterile needles (18 gauge inches). Prior to feeding in the morning, bleeding was done and an average of 10ml of blood was collected from each animal. The blood samples were placed in three vacuitainers. One is containing ethylene diamine tetra-acetic acid (EDTA) for haematological studies as described by Al-Eissa and Alkahtani [8]. Another containing sodium oxalate fluoride for glucose preservation, before blood glucose levels were determined by enzymatic colourimetric test as reported by Waziri et al. [9]. While the third universal bottles without anticoagulant were placed with the remaining blood sample and allowed to stand for about 2 hours at room temperature. The universal bottles were thereafter centrifuged at 700xg for 15 minutes, the serum separated were decanted and stored in a freezer at -10ºC for blood biochemical parameters test as reported by Gambo et al. [10].

2.5 Chemical and Statistical Analyses

Samples of the experimental diets were analyzed for proximate analysis using the procedures of AOAC [11].

Data generated from the haematological indices and serum biochemical profiles were subjected to one way analysis of variance (ANOVA). Significant difference between treatments means were separated using Duncan's Multiple Range Test [12].

3. Results and Discussion

The proximate composition of elephant grass (EG), plantain peels (PL), mango peels (MP) and concentrate supplement (CS) are shown in Table 2. The dry matter of the experimental diets varied from 85.24% in CS to 88.90% in PL.

Table 2. Proximate composition (% DM basis) of the basal and supplementary diets

Parameters	Basal diets			Concentrate supplement
	EG	PL	MP	CS
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	0.24	1.06
Ash	10.95	6.52	3.34	7.95
Crude fibre	29.55	5.81	5.24	12.06
Nitrogen free extract	50.23	78.51	81.86	58.95

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

The high dry matter observed in the feeds implied that, they can be stored for all-year feeding and used as feeds for all ruminant livestock. Crude protein content ranged from 7.92% in PL to 19.98% in CS. The crude protein obtained in EG, PL and MP appeared to be low, hence CS was added to augment the protein content of the diets. The crude protein value of the CS was higher than the crude protein requirement of 15 to 18% for growing kids and lambs as reported by Aruwayo et al. [13]. Ether extract and ash values were 1.15 and

10.95, 1.24 and 6.52%, 0.42 and 3.34, 1.06 and 7.95% for EG, PL, MP and CS respectively. The low ether extract and ash contents observed in MP indicated that MP contributed low oil and minerals to the diets. Crude fibre was low in MP (5.24%) and PL (5.81%) than CS (12.06%) and EG (29.55%), thus PL with MP and CS were combined in dietary treatments (T_2 and T_3). The nitrogen free extract that ranged from 50.23% in EG to 81.86% in MP was ranked as carbohydrate rich feeds due to their relatively high content in the diets. However, the crude protein and crude fibre observed in PL and MP were compared favourable to what were reported by Fanimo and Oduronbi [4] and Ajila et al. [5].

Table 3. Effect of replacing plantain with mango peels for elephant grass on haematological parameters of dwarf goats

Parameters		Treatments			SEM±
		T_1	T_2	T_3	
PCV (%)	Initial	25.00	24.96	24.98	1.04
	Final	24.67^{b}	25.00^{a}	25.02^{a}	1.05
Hb (g/dl)	Initial	8.08^{a}	7.26^{b}	7.99^{b}	0.62
	Final	8.35^{b}	10.65^{a}	11.01^{b}	0.75
RBC $\left(\times 10^{12}/L\right)$	Initial	10.01^{a}	9.04^{b}	8.25^{c}	0.42
	Final	9.98^{c}	10.26^{b}	11.21^{a}	0.38
WBC $\left(\times 10^{9}/L\right)$	Initial	8.96^{a}	7.28^{b}	8.07^{a}	0.79
	Final	11.02^{a}	10.02^{b}	9.99^{b}	0.92

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

Table 3, presents the result for the haematological parameters of the experimental animals. Waziri et al. [9] reported that haematological parameters of most goats have been studied with the aim of establishing normal value ranges and deviation from them may indicate a distance in the physiological process. The initial packed cell volume (PCV) which were 25.00, 24.96 and 24.99% for T_1, T_2 and T_3 respectively were not significantly differ (P>0.05) between treatment groups. Final PCV showed significant (P>0.05) difference between treatment groups with animals on T_2 (25.00%) and T_3 (25.02%) significantly (P<0.05) higher than T_1 (24.67%). The increase in final PCV values for animals on T_2 and T_3 might be due to improve nutrient in the diets which indicates high tendency for compensatory accelerated production of PCV. Compensatory accelerated production has been shown to return PCV to normal following infection and stress in animals [14]. The PCV values observed in this study were comparable with the range of values (25-30%) earlier reported for WAD goats by Daramola et al. [15]. The initial and final haemoglobin (Hb) concentration values were 8.08 and 8.35, 7.26 and 10.65, 7.99 and 11.01g/dl for T_1, T_2 and T_3 respectively. Though significant difference (P>0.05) existed between treatments in initial Hb concentration, the values were low. The low Hb concentration of the animals before the feeding trial implies improper utilization of protein intake for the formation of Hb and parasite infection. Final Hb concentration were significantly (P<0.05) higher T_2 and T_3 compared to T_1. The higher values obtained for animals on T_2 and T_3 after the feeding trail suggests their superiority in terms of their capability of supporting high oxygen carrying capacity of the blood [16]. Initial red blood cell (RBC) for animals on $T_1\left(10.01\times10^{12}/L\right)$ and $T_3\left(8.25\times10^{2}/L\right)$ but final RBC was higher in $T_3\left(11.21\times10^{2}/L\right)$ followed by $T_2\left(10.26\times10^{2}/L\right)$ before $T_1\left(9.98\times10^{2}/L\right)$. The low final RBC counts recorded for animals on T_1 corroborates the relatively low final PCV and Hb concentration observed in T_1 which reveals the possible susceptibility of

animals to iron deficiency anaemia and depression of hypochromasia [17]. The Hb and RBC values observed in this study confirmed with the $Hb(7.60\,\text{to}\,10.30 g/dl)$ and $RBC(8.32\,\text{to}\,11.80\times10^{2}/l)$ range of values reported by Daramola et al. [15] for WAD goats. Initial white blood cell (WBVC) concentration was not significantly (P>0.05) different between $T_1(8.96\times10^{9}/L)$ and $T_3(8.07\times10^{9}/L)$ but $T_2(7.28\times10^{9}/L)$ was significantly (P<0.05) lower than T_1 or T_3. Final WBC were also similar for animals on $T_2(10.02\times10^{9}/L)$ and $T_3(9.99\times10^{9}/L)$ but significantly difference (P<0.05) from $T_1(11.02\times10^{9}/L)$. This observation implies that feeding plantain with mango peels to goats on T_2 and T_3 did not cause health hazard to the animals, though animals on T_2 may support some haemopoietic function which might be attributed to the increase in immune cells to offer good health and defence mechanise as observed in T_1. The WBC counts obtained in this study were comparable with the range of values (9.42 to 13.08 x 10^9/L) reported by Waziri et al. [9] for Sahel goats.

Table 4. Serum biochemical parameters of dwarf goats fed experimental diets

Parameters		Treatments			SEM±
		T_1	T_2	T_3	
Total protein (g/l)	Initial	6.09	5.79	5.99	0.09
	Final	6.10	6.12	6.41	0.10
Albumin (g/dl)	Initial	4.00	3.89	3.94	0.02
	Final	4.01	4.02	4.10	0.01
Globulin (g/dl)	Initial	2.09	2.01	2.04	0.05
	Final	2.10	2.10	2.13	0.03
Cholesterol (mg/dl)	Initial	65.97^{b}	64.82^{b}	70.42^{a}	1.07
	Final	69.03^{a}	66.09^{b}	62.01^{b}	1.05
Creatinine (mg/dl)	Initial	1.08	1.12	1.16	0.06
	Final	1.02^{a}	0.93^{b}	0.99^{b}	0.01
Urea (mg/dl)	Initial	18.26^{a}	15.02^{b}	16.01^{b}	0.52
	Final	19.95^{b}	20.06^{b}	23.38^{a}	0.60
Glucose (mg/dl)	Initial	69.99^{b}	76.02^{a}	75.99^{a}	1.14
	Final	90.07	91.01	91.28	1.20

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

Presented in Table 4, is the serum biochemical parameters of dwarf goats fed experimental diets. The initial and final total protein for animals were not significantly affected (P>0.05) across the dietary treatments. The total protein values for initial and final were 6.09 and 6.10, 5.97 and 6.12, 5.99 and 6.41g/dl for T_1, T_2 and T_3 respectively. The total protein values obtained in this study were close to the average value $(7.30 g/dl)$ as reported by Taiwo and Ogunsanmi [18] for dwarf goats.

Initial and final albumin followed similar pattern of variation as observed in total protein. The initial albumin values ranged from 3.89g/dl in T_2 to 4.00g/dl in T_1 while the final albumin values ranged from 4.01g/dl in T_1 to 4.10g/dl in T_3. Dairo [19] reported that albumin is an important blood clot factor due to its ability to prevent haemorrhage, therefore the higher the value the better it is to the animals. The initial and final globulin of the experimental animals

were similar, hence no significant difference (P>0.05) existed among treatment groups. The globulin initial and final value ranged from 2.01 to 2.09g/dl and 2.10 to 2.13g/dl respectively. However, final total protein, albumin and globulin increased slightly compared with initial total protein, albumin and globulin. This could probably due to inadequate nutrition the animals before the experiment which was improved and ascribed to proper balancing of the ingredients in the treatment diets. Oboh et al. [20] reported that serum total protein of an animal is an indirect indices for measuring the nutritional protein adequacy of the animal. Initial cholesterol was significantly (P<0.05) higher in T_3 (70.42g/dl) than those in T_1 (65.97g/dl) and T_2 (64.82g/dl), while final cholesterol was higher in T_1 (69.03g/dl) and T_2 (66.09g/dl) compared with T_3 (62.01g/dl). The initial serum cholesterol concentration for animals on T_3 appeared to have been significantly (P<0.05) increased in mobilization of cholesterol from the liver or involvement of the diet altering the plasma low density of lipoprotein [21] before the commencement of the feeding trial, but final cholesterol levels appeared to declined slightly with increasing levels of plantain peel inclusion in the diets. Thuds the trend of data appeared to suggest high levels of elephant grass and plantain peel increased serum cholesterol concentration in the animals. The initial and final serum creatinine values range from 1.08 to 1.16mg/dl and 0.93 to 1.02mg/dl respectively. Initial creatinine was not significantly (P>0.05) influenced across treatments with lowest value being obtained for animals on T_1 and highest on T_3. Final serum creatinine was highest in T_1 followed by T_3 before T_2 but significant (P<0.05) difference only existed between T_1 and T_2 or T_3. Values of serum creatinine obtained at the beginning and end of the study fell within the average value (0.94mg/dl) for Sahel goat as reported by Waziri et al. [9] but significantly (P<0.05) higher than values reported by Ikhimioya and Imasuen [21] for WAD goats. Prvulovic et al. [22] reported that creatinine level in serum has direct correlation with muscle mass and kidney function in animals. The initial urea concentration was significantly higher (P<0.05) in T_1 (18.26mg/dl) compared to T_2 (15.02mg/dl) and T_3 (16.01mg/dl). Final urea concentration was similar between T_2 (20.06mg/dl) and T_1 (19.95mg/dl) but significant (P<0.05) existed between T_3 (23.38mg/dl) and T_1 or T_2. The higher value obtained in final serum urea for animals on T_3 was an indication of inferiority of efficiency utilization of nitrogen and urea recycling which might have affected the amino balance. This fact confirmed from the low value observed in serum total protein for animals on T_3, which are indicators of low utilization protein as reported by Cetin *et al* [23]. Glucose levels of initial and final values were 69.99 and 90.97, 76.02 and 91.01, 7.99 and 91.28mg/dl for T_1, T_2 and T_3 respectively. Initial glucose level was significantly (P<0.05) higher in T_3 and T_2 compared with T_1. Though no significant (P>0.05) was observed between treatment groups in final glucose levels, values on T_2 and T_3 were slightly higher than T_1. Konlan et al. [24] reported that blood glucose level is maintained as a result of glucose exclusion from the tissue together with an increase in the use of ketone and fatty acids.

Table 5, shows plasma minerals of dwarf goats fed experimental diets. The initial and final plasma sodium values were 119.62 and 130.72, 110.43 and 120.01, 103.92 and 119.32 mmol/L were significantly (P<0.05) highest in T_1 and lowest in T_3. The low initial and final sodium levels observed for animals on T_3 could be as a result of variable dietary intake of salt and loss of sodium ion in urine. Sodium values observed in this study were comparable to the mean value (131.97 mmol/L) reported by Taiwo and Ogunsanmi [18] for sheep. There were not significant (P>0.05) difference between treatment for initial and final calcium levels across the dietary treatments. The initial and final calcium levels were 8.77 and 8.79 mg/dl in T_1, 8.81 and 8.85mg/dl in T_2 as well as 8.90 and 8.96mg/dl in T_3. The final calcium levels were similar among treatment groups and slightly higher than initial calcium levels. This means that quality of the test feeds were good enough to maintain the calcium levels of the animals. The initial and final phosphorus levels in T_2 (3.08 and 3.90 mg/dl) and T_3 (3.94 and

3.96 mg/dl) were similar and significantly (P<0.05) lower than T_1 (4.00 and 4.01mg/dl). The increased levels of phosphorus in T_1 could probably due to improve phosphorous in the diet intake that was well utilized by the animals. Initial potassium concentration levels were significantly (P<0.05) higher for animals on T_1 (4.59mmol/L) compared to T_2 (3.96mmol/L) and T_3 (3.00mmol/L). Final potassium values were 4.16, 4.08 and 4.03 for T_1, T_2 and T_3 respectively. No significant (P>0.05) difference existed between treatments in final potassium. This implies that the ability of the animals to respond lactic acidosis, circulating failure infection and renal diseases were compromised with the inclusion levels of the test feedstuff in the diets. The potassium values obtained in this study were compared favourably with the mean value (4.70mmol/L) of potassium level for Sahel goats as reported by Waziri et al. [9].

Table 5. Plasma minerals in dwarf goats fed elephant grass and plantain with mango peels

Parameters		Treatments			SEM±
		T_1	T_2	T_3	
Sodium (mmol/L)	Initial	119.62[a]	110.43[b]	103.92[c]	2.01
	Final	130.72[a]	120.01[b]	119.32[c]	2.03
Calcium (mg/dl)	Initial	8.77	8.81	8.90	0.91
	Final	8.97	8.85	8.96	0.89
Phosphorous (mg/dl)	Initial	4.00[a]	3.08[b]	3.94[b]	0.02
	Final	4.01[a]	3.90[b]	3.96[b]	0.05
Potassium (mmol/L)	Initial	4.59[a]	3.96[b]	3.00[b]	0.04
	Final	4.16	4.08	4.03	0.03

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

4. CONCLUSION

Results obtained in the present experiment confirm a positive effect of using plantain with mango peels as alternative feeds for dwarf goats. The response in terms of haematological indices and serum biochemical profiles by dwarf goats indicated that plantain with mango peels in a ratio of 50:18 can serve as a sustainable feedstuff for dwarf goats most especially during the dry-season without adverse effects. The decreased of serum cholesterol level in the diet was additional advantage in the treatment of arteriosclerosis and other cardiovascular disorders associated with hypercholestrosis.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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