Blood profile and blood minerals concentration of Red Sokoto bucks fed diets containing graded levels of potato peels supplemented with Gamba grass (*Andropogon gayanus*)

Shittu Hammed Abiodun*, Adole, Patrick Ojiya and Aireavbouan, David Ideyoma
Department of Animal Production, University of Agriculture Makurdi, PMB 2373 Benue State, Nigeria
*Corresponding author: hshittu23@gmail.com
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Abstract

A total of 18 Red Sokoto bucks of about 7-9 mo, weighing between 7.0 - 12.0 kg were used in a completely randomized design in a feeding trial. Blood samples were obtained from the animals through the jugular venipuncture to evaluate the haematological parameters, serum indices and blood mineral concentration of Red Sokoto bucks fed diets containing graded levels of sweet potato peels supplemented with Gamba grass. Water was offered to the animals *ad libitum*. Four diets were formulated and compounded to contain 0, 50, 75 and 100% graded sweet potato peel meal, in a 12-wk feeding trial. The experimental diets did not have any effect on the haematological indices with the exception of the white blood cell differentials which differed significantly ($P<0.05$): such as lymphocyte (62.33-73.00%), neutrophil (24.67-32.67%), eosinophil (1.00-2.67%) and monocytes (1.33-4.67%). The results of the serum biochemical indices and mineral concentration showed that there was no significant effect ($P> 0.05$) of the diet on serum biochemical values. This result showed that the health status was not compromised. Therefore, sweet potato peels can replace maize offal in feeding ruminants at 100% successfully without any detrimental effects on the haematological parameters, biochemical indices and mineral concentrations of the animals.

Key words: sweet potato peels, ruminants, blood minerals and haematological parameters.

Introduction

Livestock industry in Nigeria is of major concern since animal protein sustainability has been faced with various challenges. The animal protein intake in Nigeria has been reported to be low due to high cost of livestock products which results from rapid increase in the cost of most feedstuff, mainly conventional feed ingredients (Sobayo et al., 2015). However, nutrition is one of the most important factors limiting animal production in most part of the world. It's more pronounced in the Tropics, where ruminant animals suffer from scarcity in feed supply and pasture quality, most especially during the dry season when the natural vegetation is of poor nutritive value (Ososanya et al., 2013).

In an attempt to bridge the gap and rescue this nutritional problem, there is need for utilization of readily available, cheap and indigenous sources of protein and energy, especially those that attract no competition from man (Onyeonagu et al., 2010). The use of agricultural and agro-industrial by-products is a possible option to ameliorate both the high cost of feed ingredients and scarcity. Sweet potato peels are agricultural by-products from sweet potato peeled for

direct consumption. Sweet potato peel is one such alternative feedstuff. Potato peel has high nutritional value which includes high source of fibre. Potato peels contain 5.91% crude protein, 4.71% ether extract, 6.02% ash, 3.56% crude fibre and 71.16% NFE (Solomon et al., 2015). Potato peels also have high antioxidant properties (Dusuki et al., 2019).

Haematological and serum biochemical indices help in diagnosis of disease condition, thereby enhancing prognosis and assessment of therapy and toxicity of drugs and substances used by the animals. This assay helps in determining the physiological, nutritional and pathological status of the animal Fajemisin and Adeleye, (2005). This study was therefore designed to evaluate the effects of replacing maize offal with graded levels of sweet potato peels on haematological, serum and blood mineral concentration of Red Sokoto bucks supplemented with *Andropogon gayanus* grass.

Materials and Methods

Experimental Site

The experimental site was the sheep and goat unit of the Teaching and Research Farm, Federal University of Agriculture Makurdi, Benue state. Makurdi is located on latitude 7^{o} 43'N and longitude 8^{0}3'E. The area is warm with a minimum temperature range of 24.20 ^{0}C ±1.40 ^{0}C and a maximum temperature range of 36.33 ^{0}C ±3.70 ^{0}C. The annual rainfall averages between 1508-1616 mm and relative humidity is between 39.50 ±2.20% and 64.00±4.8% (TAC, 2009).

Diet Preparation

Sweet potato (*Ipomea batata*) peels were collected from various retailers and rural farmers within Makurdi metropolis. The collected sweet potato peels were immediately sundried on concrete floors till crispy to touch, crushed into meal and stored for later use. Four experimental diets were formulated and compounded to contain sundried sweet potato peels (SPP) replacing maize offal at 0, 50, 75 and 100% (Table 1) representing T1, T2, T3 and T4, respectively.

Table 1: Dietary composition of the experimental diets

Ingredients	Experimental diets			
	T1(0%PP)	T2 (50%PP)	T3 (75% PP)	T4 (100% PP)
Maize offal	71	35.5	17.75	-
Rice offal	5	5	5	5
PKC	5	5	5	5
SBM	16	16	16	16
PP	-	35.5	53.25	71
Bone ash	2	2	2	2
Salt	1	1	1	1
Total	100	100	100	100
Determined analysis (%)				
Dry matter	93.60	93.05	92.05	93.55
Crude protein	15.76	14.88	12.60	11.38
Ash	7.5	11.50	8.00	15.75
Ether extract	5.00	5.00	4.75	2.50
Crude fibre	8.50	9.50	8.00	14.50
NFE	64.72	59.31	66.40	50.91
NDF	53.00	34.50	36.50	47.50
ADF	11.00	16.00	12.50	20.00
ADL	4.50	8.50	4.00	13.00

PKC: Palm kernel cake, SBM: soy bean meal, PP: potato peels, NFE: nitrogen free extract, NDF: neutral detergent fibre, ADF: acid detergent fibre, ADL: acid detergent lignin

Experimental Animals and Design

Sixteen bucks of Red Sokoto goats of about 7-9 mo, weighing between 7.0 - 12.0 kg were obtained from goat markets in Nasarawa State. Prior to the beginning of the experiment, they were quarantined and acclimatized for 28 d during which the animals were given antibiotics, dewormed with Albendazole following the recommended dosage as well treated against both ecto- and endo-parasites using Ivomectin. They were randomly allotted into 4 treatment groups of 4 animals per treatment in a completely randomized design and each animal was a replicate. The experiment lasted for 12 wk.

Blood Sample Collection and Analysis

Blood was collected from the bucks on the last day of the experiment through the jugular vein using needles and syringes into two sample bottles with or without 2 mg of

ethylene diamine tetra acetic acid (EDTA) for haematological parameters, serum biochemical indices and blood mineral concentration. The sample bottles were preserved in a plastic container containing ice packs and taken to the laboratory for analysis. Haematological parameters such as packed cell volume (PCV), haemoglobin (Hb) concentration, red blood cells (RBC), total white blood cells (WBC), and white blood count differentials were determined using standard procedures (Schalm et al., 1975). Mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated as described by Jain (1986). The biochemical indices determined were Total protein, Albumin, Glucose, Asparte Aminotransferase (AST) and Alanine Aminotransferase (ALT). Standard procedures for the biochemical analysis were followed (Schalm et al., 1975; Jain, 1986). While, blood minerals concentration such as copper (Cu), iron (Fe), manganese (Mn), zinc (Zn), sodium (Na), calcium (Ca) and aluminum (Al) were evaluated through spectrophotometric analysis.

Statistical Analysis

Data obtained were subjected to one-way analysis of variance (ANOVA) in a complete randomized design (CRD), using the Statistical Package of Statistical Analysis System (SAS, 2002). Treatment means were separated using the Duncan Multiple Range Test.

Results and Discussion

The results for the haematological indices of Red Sokoto goats fed graded level of sweet potato peel meal are represented in Table 2. There was no significant difference ($P>0.05$) in all the haematological parameters, except Lymphocyte, Neutrophil, Eosinophils, and Monocytes which differed significantly ($P<0.05$). The PCV value (23.67-29.33%) fell within the normal range of PVC for goats (22-38%) as reported by Kaneko et al. (2008). Opara et al. (2010) reported a packed cell volume of 28.4% for apparently healthy West African dwarf goats, which falls within the range (23.67-29.33%) obtained in this study. The PVC obtained from this research can also be compared to the mean volume of 29.4% reported by Daramola et al. (2005). However, Hyelda et al. (2017) reported a higher value (25.3-38.3%) when Red Sokoto goats were fed desert date (*Balanites aegyptiaca*) leaves as supplement to urea treated maize stovers.

Table 2: Effects of graded levels of sweet potato peels on heamatological indices of Red Sokoto goats supplemented with Gamba grass

Parameters	Experimental diets				SEM
	T1	T2	T3	T4	
PCV (%)	23.67	25.00	24.67	29.33	2.90
RBC ($\times 10^3$/µl)	14.60	13.00	11.53	15.13	2.36
WBC ($\times 10^6$/µl)	5.27	9.13	7.50	6.73	1.70
Hb (g/dl)	7.87	8.33	8.23	9.77	0.96
MCV (fl)	17.17	19.17	21.20	22.17	2.81
MCH (pg)	5.93	6.37	7.07	5.90	0.65
MCHC (g/dl)	33.23	33.33	33.37	33.27	0.08
Lymphocyte (%)	62.33^{b}	73.00^{a}	65.67^{ab}	68.33^{ab}	2.57
Neutrophils (%)	32.67^{a}	25.00^{b}	26.33^{b}	24.67^{b}	1.80
Eosinophil (%)	2.00^{ab}	1.00^{b}	2.67^{ab}	2.33^{ab}	0.47
Basophil (%)	0.00	0.00	0.33	0.00	0.17
Monocytes (%)	2.33^{ab}	1.33^{b}	4.67^{a}	4.67^{a}	0.73

$^{a, b, c,}$ Means on the same row with different alphabetic superscript differs significantly ($P<0.05$).
T1= Control diet with 0% sweet potato peel, T2= 50% sweet potato peel meal inclusion, T3= 75% sweet potato peel meal inclusion, T4= 100% sweet potato peel meal inclusion, Packed cell volume (PCV), red blood cell (RBC), white blood cell (WBC), haemoglobin (Hb), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC).

Red blood cell (RBC) values were within 11.53-15.13 x 10^3/ml and white blood cell (WBC) values were within 5.27-9.13 x 10^3/ml. Obtained value for RBC was far above the normal range of 3.90 to 4.34 x 10^3/ml as reported by Weiss and Wardrop (2011). The WBC obtained falls within the normal range of 7.4 to 9.0 x 10^3/ml reported by Kaneko et al. (2008). RBC was far higher than the values of 1.80-2.10 $\times 10^6$/µl reported by Okunlola et al. (2015), while Hyelda et al. (2017) reported lower (24.9- 38.3 $\times$ 10^3/ml) WBC values. Low RBCs count may be associated with iron deficiency, bleeding, anemia or some vitamin deficiency. The high RBC values in this study may be a result of high level of nutrition of the diets. However, Gartner et al. (1969) observed excitement or strenuous exercise tended to increase RBC during handling which might lead to the release of adrenaline and hence spleen contracts and this might cause the release of more RBC into circulation (Schalm et al., 1975).

Hb which ranged from 7.87 -10.4 g/dl fell within the range of 7-15 g/dl reported by Daramola et al. (2015). Samira et al. (2016) reported a mean value of 8.6 g/dl, which is slightly lower than the least value obtained in this study. Oloche et al. (2019) observed higher Hb values (12.72-13.36 g/dl). This is an indication that the diets did not have negative effect on blood formation.

MCV, MCH and MCHC values were within the normal range reported by CDL (2001): MCV 15-23 fl, MCH 5.5-8.0 pg and MCHC 32.5-38 g/dl. MCV values for this study ranged from 17.17 to 22.17 fl, below

the normal range of of 75.5-85.5 fl (Weiss and Wardrop, 2011) and those obtained by Oloche et al. (2019) between 17.09 to17.60 fl. MCH values were however lower than 37.8 pg reported by Opara et al. (2010) for WAD goats and 35.94 pg reported by Njidda et al. (2013) for Kano Brown goats. Okunlola et al. (2015) reported much higher values (40.95-51.00 pg) of mean corpuscular haemoglobin for Sokoto Red goats fed *Adansonia digitata* fruit meal supplement. This is an indication that the animals were not anaemic.

There were significant differences ($P<0.05$) in the WBC differential counts. Lymphocytes value for T2 (73.00%) differed significantly ($P<0.05$) from T1 (62.33%). These however fall within the range of 50.2-71.1% reported by Hyelda et al. (2017) for Red Sokoto goats fed desert date (*Balanites aegyptiaca*) leaves as supplement to urea treated maize stovers. Olusanya et al. (1976) however observed that lymphocytes were more than neutrophils in circulation in goats, like other ruminants. Conversely, Opara et al. (2010) also reported mean lympoctes of 70.3% for WAD goats which was in consonant with the present findings. Ganong (2005) however reported lymphocytes as key elements in the production of immunity, and low levels could be due to bacterial infections, aplastic anaemia, and some forms of leukaemia, while high values could be observed in viral infections. The neutrophils was significantly different ($P<0.05$) with the highest value in T1 (32.67%) and the lowest in T4 (24.67%), the values obtained fell within the range of 23.9-49.8% for Red Sokoto goats reported by Hyelda et al. (2017). T1 (2.00%), T3 (2.67%) and T4 (2.33%) differed significantly for eosinophils. Neutrophils and eosinophils followed definite pattern. Monocyte values also ranged from 1.33-4.67%, however, T3 (4.67), T4 (4.67) were similar and differed significantly from T1 (2.33%). The monocytes values obtained (1.33-4.67%) are higher than 2.0% reported by Njidda et al. (2013) for Borno White goats. The values are also higher than 2.4% observed by Opara et al. (2010).

Table 3 shows the serum biochemical indices of the experimental bucks fed diets containing varying levels of graded level of sweet potato peel meal. Values obtained for total protein in this study did not show any significant difference ($P>0.05$) among the treatments. The mean values obtained were 5.93 g/dl, 5.80 g/gl, 5.66 g/dl, 6.33 g/dl for T1, T2, T3 and T4, respectively. The values obtained in this study were within the normal reference range of 6.1 to 7.6 g/dl as reported by Saka et al. (2016). This is also in agreement with Daramola et al. (2005) who reported means between 6.3 to 8.5 g/dl of albumin for clinically healthy WAD goats. Treatments with the test ingredients were similar to the control ($P>0.05$), implying that the total protein range for the animals in the present study was normal. The result of the proximate analysis of feed samples showed that bucks fed T4 had the highest total protein (6.33 g/dl). Albumin values of the control and bucks fed experimental diets did not differ significantly ($P>0.05$). The range was between 3.46-3.56 g/dl for T1 to T4. Observed values were comparable to 3.40 – 4.52 g/dl and 2.20 – 4.30 g/dl reported by Ogunleke et al. (2014) and Daramola et al. (2005) for WAD goats. Kraft and Durr (1999) also reported values of 2.8 to 4.3 g/dl. Low albumin is a sign of poor health and a predictor for a bad outcome (Dr Kastow.Com.2009). Saka et al. (2016) also reported similar values of 2.63-3.52 g/dl for WAD goats fed diets containing graded levels of malted sorghum sprouts mixed with pineapple waste-based diet. Higher albumin value implied that the animals were healthy. The results of AST and ALT revealed that there was no significant difference ($P>0.05$) among the dietary treatments. This implied

that there was no organ damage in the experimental animals. Glucose level of the various treatments in this study showed no significant difference (P>0.05) which ranged from 45.23 to 38.33 g/dl for T1 to T4. Kaneko (1997) recorded normal range of glucose of 2.78 to 4.16 mmol/l. However, Olafadehan (2011) observed that goats fed tannin-rich *Pterocarpus* e*rinaceus* or *Andropogon* grass sole diet had depressed serum glucose compared with animals on mixed forage diets.

Table 3: Effects of graded levels of sweet potato peels on serum biochemical indices of Red Sokoto goats supplemented with Gamba grass

Parameters	Experimental diets				
	T1	T2	T3	T4	SEM
Albumin g/dl	3.46	3.43	3.00	3.56	0.14
Total protein/dl	5.93	5.80	5.66	6.33	0.13
Glucose g/dl	45.23	43.23	40.66	38.33	1.34
AST g/dl	117.80	117.63	122.30	124.13	1.36
ALT g/dl	38.76	38.73	37.66	38.06	0.54

Ns. = no significant difference, T1= Control diet with 0% sweet potato peel, T2= 50% sweet potato peel meal inclusion, T3= 75% sweet potato peel meal inclusion, T4= 100% sweet potato peel meal inclusion

Table 4 shows the effects of graded levels of sweet potato peel meal on the blood mineral concentration of Red Sokoto bucks supplemented with Gamba grass. Copper values differed significantly (P<0.05) across treatments. T_1 (0.81) and T_4 (0.81) differed significantly (P<0.05) from T_2 (0.57) and T_3 (0.56). However, this was an indication that the experimental diet increased the cu content of the blood. Copper interacts with Iron and Zinc in antagonistic relationships. Fe ranged between 0.90-1.41 which were significantly different among treatments: T_1 (1.17) and T_4 (1.41) were similar (P<0.05) while T2 and T3 were also similar and differed from T1 and T4. Fe is known to be involved in cellular respiration and oxygen transport via hemoglobin which is evident in the haematological parameters. Approximately 50% of the body's iron is involved in hemoglobin. Fe is also known to antagonize copper and zinc availability (Rick, 2007). Manganese value ranged from 0.61-0.72. T_1 (0.71) and T_4 (0.72) diffeeds significantly (P<0.05) from T_2 (0.64) and T_3 (0.61). Mn has been reported to be essential for proper brain and nerve functions, fat and sugar metabolism and connective tissue production. Zinc values were between 0.06-0.07. In this study, zinc is the most deficient among other minerals. The Zn values followed a definite pattern like Cu, Fe and Mn. T_1 (0.07) and T_4 (0.07) differed significantly from T_2 (0.06) and T_3 (0.06). Observed values in this study were lower than 1.69-2.53 mg/dl Zn for goats reported by Olukiran (2016). Alemu (2010) reported that zinc deficiency could result in stiff joints, salivation, swelling of the feet, poor testicular development and low libido. This was not the case with the experimental animals. Sodium values were between 0.23-0.29, indicating that the animals had no problem with amino acid and glucose

transport as well as muscle contractions. Calcium values ranged from 0.33-0.43 mg/dl and treatments with SPP were similar with the control. This meant that the experimental animals had adequate Ca in their system for utilization and there was no problem of Ca deficiency which could lead to retardation of growth, as well as bone deformation. Obtained values in the study were lower than 9.2-11.2 mg/dl reported by Radostits et al. (2000) for cattle, sheep and pig. Sowande et al. (2008) however, reported higher values of 5.00-5.94 mg/dl for WAD goats and sheep fed natural pasture during the dry and wet seasons. Aluminum values were 0.35, 0.32, 0.31, and 0.36 for T_1, T_2, T_3 and T_4, respectively. There was no significant difference (P>0.05) among the treatments. Although T4 (0.36) had the highest value numerically, but there was no definite or particular trend.

Table 4: Effect of graded levels of sweet potato peel meal on the serum mineral concentration of Red Sokoto bucks supplemented with Gamba grass

Parameters (µg-1)	Experimental diets				SEM
	T1	T2	T3	T4	
Copper	0.81[a]	9.57[b]	0.56[b]	0.81[a]	0.05
Iron	1.17[a]	0.96[b]	0.90[b]	1.41[a]	0.09
Manganese	0.71[a]	0.64[b]	0.61[b]	0.72[a]	0.02
Zinc	0.07[a]	0.06[b]	0.06[b]	0.07[a]	0.00
Sodium	0.29[a]	0.24[b]	0.23[b]	0.27[a b]	0.01
Calcium	0.43	0.35	0.33	0.41	0.02
Aluminium	0.35	0.32	0.31	0.36	0.01

[a, b, c,] Means on the same row with different alphabetic superscript differs significantly (P<0.05).
T1= Control diet with 0% sweet potato peel, T2= 50% sweet potato peel meal inclusion, T3= 75% sweet potato peel meal inclusion, T4= 100% sweet potato peel meal inclusion
*= Significant ns = Not significant

Conclusion

It can be concluded from this study that sweet potato peels could replace 100% maize offal in the diets of goats without detrimental effects of its inclusion in their diets to compromise the health status of the animals (haematology, serum biochemical parameters and blood mineral metabolites) and at such farmers can include it in the diet of their animals.

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