Nigerian J. Anim. Sci. 2019, 21 (3): 230-237

Growth response and blood profile of Kano brown goats fed *Gmelina arborea* leaves and supplemented with diets containing water soaked sweet orange (*Citrus sinensis)* peels

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Target audience: *Animal Scientists, Livestock Farmers, Fruit processors*

Abstract

Twenty male Kano brown grower goats weighing 116.75 kg - 9.00kg, and aged between 5 - 8 months were used in a completely randomized design to assess the growth performance and blood profile of Kano brown goats fed Gmelina arborea leaves and supplemented with concentrate diets containing different levels of water soaked sweet orange peel meal (WSSOPM). The orange peels were collected from markets within Makurdi township and immediately soaked in a large plastic container for 24 hours, thereafter it was drained using baskets and sun-dried 3days. The dried orange peels were packed and crushed into a meal and bagged in synthetic bags for use. Four diets were formulated and compounded to contain 0%, 50%, 60% and 70% WSSOPM, and these were designated T1, T2, T3 and T4 respectively in a forty-two day feeding trial. Results showed that there were no treatment effects (P>0.05) on mean daily weight gain, total forage intake and feed conversion ratio. However, treatment effect was apparent (P<0.05) on the total concentrate intake, total feed intake and mean daily feed intake. The haematological parameters measured did not show significant differences (P>0.05) except in neutrophil values. The neutrophil values of T4 (40.80%) were significantly higher (P<0.05) than those of T1 (32.40%), T2 (37.40%) and T3 (38.60%). The serum biochemistry values were all similar (P>0.05) among the treatments except the cholesterol values. The cholesterol value of T1 (142.34mg/dl) was significantly higher than the rest treatments, while T2 (85.82mg/dl) was lower (P<0.05) than T3 (108.12mg/dl). Water soaked sweet orange peel meal can replace up to70% of maize offal in goat diets without adverse effects on the performance and blood indices.

Key words: *Performance, haematology, serum biochemistry, sweet orange peels, Kano brown goats*

Description of Problem

The potentials of small ruminant production in alleviating the low animal protein intake by man in developing nations such as Nigeria need no emphasis (1). Goats are considered superior to other ruminant species in their utilization of poor quality and high fibre feeds (2). However, the dry season period results in a rapid decline in the quantity and quality of forages leading to low forage intake and digestibility with resultant poor animal performance (3). Other researchers have reported that meeting the nutritional needs of ruminant animals throughout the year has been a major challenge facing livestock farmers in the tropics due to the seasonality of forages (4). This has necessitated the use of concentrate supplements to enable the animals go through the long dry periods without the adverse effects of inadequate feeding such as decreased productivity and death in severe cases. Conventional feed ingredients, particularly those that supply energy such as maize, sorghum, and millet are quite expensive. This is orchestrated by the demands for these feed ingredients by man, other livestock species and alternative uses (5). The use of unconventional feedstuff materials that are cheap, viable, and available and of low demand by man and other livestock becomes

imperative for use in small ruminant diets for their survivability. More so, increased production levels of food crops (and fruit crops) in Nigeria has brought about an unprecedented amount of crop residues and by products (straws, haulms, stover cobs, vines, peels, brans, leaves, chaff etc.) as left over after crop harvest (6). Sweet orange fruit peel is one of such by-products and if properly enhanced, it can be a useful energy providing feed ingredient in the diets of small ruminants. Sweet orange peels compete favourably in proximate composition with maize and maize offal, but it is also reported to contain phyto-nutrients such as tannin, saponin, limonene, phytate, oxalate and flavonoids (7) which limit its use at high levels particularly in non-ruminants diets. Sweet orange peels are available throughout the year and it is cheap. This study was therefore designed to evaluate the growth performance and blood profile of Kano Brown goats fed diets containing graded levels of water soaked sweet orange peel meal.

Materials and Methods

The experiment was carried out at the Teaching and Research Farm, University of Agriculture, Makurdi. The sweet orange peels were collected from sweet orange retailers within Makurdi Township in synthetic bags. The collected peels were turned into a large plastic container and soaked in water for 24 hours. Thereafter, the peels were drained using locally made baskets (from palm fronds) and sun-dried on concrete slabs for 48 hours. The dried peels were packed and crushed into a meal using a cereal milling machine and stored in synthetic bags for use. Four diets were formulated and compounded to contain 0%, 50%, 60% and 70% water soaked sweet orange peel meal (WSSOPM) and designated T1, T2, T3 and T4 respectively.

A total of twenty Kano Brown goats weighing between 6.750 - 9.000kg and aged between 7-10 months were bought from Northbank goat market in Makurdi and used for the experiment. The animals were randomly distributed into four treatment groups of five [5] animals each in a completely randomized design. The bucks were housed individually, and each animal was fed 200g of the concentrate at 8:00hr daily while the forages were served *ad libitum* at 10.00 hour and 14.00 hour respectively. Feeding of the forage twice daily was to help reduce feed wastage. Feeding of the forage was done by tying together small bundles of the forge and suspending it from the roof of each compartment, down to the animal using light ropes. This was done to encourage intake and to prevent the animals from trampling underfoot the forage. Mineral supplements were provided for each animal in form of mineral blocks. All the experimental animals were daily provided with fresh clean water.

The feed intake was calculated by subtracting the remnants from the initial quantity of feed that was fed to each animal on daily basis. The animals were weighed weekly to assess their weight changes. On the last day of the feeding trial, blood samples were collected aseptically from each goat via the jugular vein into two sets of sterile sample bottles. One set contained ethylene diamine tetra acetic acid (EDTA) for haematological assay, while the second set of sample bottles were plain bottles for serum biochemical assay. Data generated from the study was subjected to analysis of variance using statistical software (8). Means that showed statistical differences were separated using the same statistical package.

Results and Discussion

The determined analysis of the experimental diets fed to the Kano Brown goats is presented in Table 1. The result for the performance of the Kano brown goats fed the experimental diets is presented in Table 2.The mean daily weight gain values were 64.76g.

46.67g, 42.63g and 44.28g for T1, T2, T3, and T4 respectively, and there were no significant differences (P>0.05) among the treatments. This implies that replacing maize offal with WSSOPM up to 70% level also support weight gains of the animals and did not cause weight losses.

Table 1: Dietary composition of the experimental diets fed to the goats

	Experimental diets			
Ingredients (%)	T1	T2	T3	T4
Brewer dried grains	10.00	10.00	10.00	10.00
Maize offal	72.67	36.335	29.47	21.80
Sweet orange peel meal	0.00	36.335	43.20	50.87
Soybean meal	14.33	14.33	14.33	14.33
Bone ash	2.00	2.00	2.00	2.00
Common salt	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00
Determined analysis (%)				
Dry matter	90.29	90.33	90.25	90.14
Crude protein	13.68	13.79	13.87	14.49
Crude fibre	9.35	9.75	9.64	9.58
Ether extract	3.54	3.52	3.59	3.56
Nitrogen free extract	66.69	66.08	66.22	65.58
Ash	6.74	6.86	6.68	6,79

T1 = 0% water soaked sweet orange peel meal, T2 = 50% water soaked sweet orange peel meal, T3 = 60% water soaked sweet orange peel meal, T4 = 70% water soaked sweet orange peel meal

Observed values in this study were higher than 30.93 - 32.74g/day reported by (9) for Red Sokoto goats fed diets containing Irish potato (*Solanum tuberosum L.*) peels as replacement for maize offal, 20.12- 38.43g/day reported by (3) for West African dwarf goats fed unripe plantain peels as replacement for maize and 7.55-19.39g/day reported by (10) for West African dwarf goats fed *Panicum maximum* supplemented with *Myrianthus arboreus l*eaf meal concentrates. The total concentrate intake was between 2.675 - 4.466 kg, with T1 (4.47kg) significantly higher (P<0.05) than the rest of the treatments. This was probably because T1 being the control diet may have been more palatable, thus, the animals ate more of the concentrate in T1, but the forage intake values (15.71-16.38kg) which did not show significant differences (P<0.05) among the treatment indicated that the animals consumed adequate concentrate supplements to boost forage intake, and that the supplements consumed supplied sufficient nutrients necessary for microbial activities. Mean daily feed intake values followed a similar trend as the total concentrate intake values. The values ranged between 441.40-482g/day and T1 was significantly higher (P<0.05) than the rest treatments. Observed values were were comparable with 473.93-503.40g/day reported by (11) for red Sokoto bucks fed graded levels of Lablab (*Lablab purpureus*) hay as supplement to maize stover basal diet and 390.04-444.38g/day reported by (12) for Kano Brown goats. Feed intake values were however, higher than 296.4-313.70g/day reported by (3) for West African dwarf goats fed unripe plantain peels as replacement for

maize and 313.18-340.34g/day reported by (10) for West African dwarf goats feed *Panicum maximum* supplemented with *Myrianthus arboreus* leaf meal concentrates. (13) reported that factors affecting feed intake include dietary crude protein, palatability, gut fill and rumen out flow rate/retention in the rumen. In addition, soaking the sweet orange peels reduces the astringent taste peculiar to orange peels, and gives a pleasant smell, this may have improved the palatability of the diets containing the test ingredients so that the goats were able to consume sufficient quantity of the concentrate as observed in this study. The values for feed conversion ratio were between 8.0-12.33 and there was no significant difference (P>0.05) among the treatments, implying treatments that contained the test ingredient were not inferior to the control, as animals in these treatments also effectively converted the feed to edible muscle fibre which was reflected in the weight changes.

Table 2: Performance of the goats fed the experimental diets

	Experimental diets				
Indices	T1	T2	T3	T4	SEM
Initial weight (kg)	7.70	7.70	7.70	7.71	0.30^{ns}
Final weight (kg)	10.42	9.66	9.49	9.57	0.37^{ns}
Total weight gain (kg)	2.72	1.96	1.79	1.86	0.31^{ns}
Mean daily weight gain (g)	64.76	46.67	42.63	44.28	7.31^{ns}
Total forage intake (kg)	15.78	16.32	15.71	16.04	0.31^{ns}
Total concentrate intake (kg)	4.47^{a}	2.94^{b}	2.83^{b}	2.68^{b}	0.31*
Total feed intake (kg)	20.25^{a}	19.26^{b}	18.53^{b}	18.71^{b}	0.40*
Mean daily feed intake (g)	482.00^{a}	458.60^{b}	441.40^{b}	445.60^{b}	9.63*
Feed conversion ratio	8.02	9.83	10.35	10.06	1.79^{ns}

a,b=means on same rows having different super script are significantly different (P<0.05), ns=nnot significant (P>0.05), SEM = standard error of mean

Observed values for feed conversion ratio were similar with 9.22-11.53 reported by (14) for WAD goats fed quality fermented corn cob based diets, and comparable with 9.09-16.73 reported by (3) for West African dwarf goats, but better than 17.55-43.84 reported (10) for West African dwarf goats feed *Panicum maximum* supplemented with *Myrianthus arboreus l*eaf meal concentrates, and 17.15-31.91 reported by (15) for West African dwarf goats fed diets containing graded levels of malted sorghum sprout mixed with pineapple waste based diet. The result for the haematology of the Kano brown goats fed the experimental diets is presented in Table 3. None of the haematological indices showed significant treatment effects (P>0.05) except the neutrophils values. The PCV values ranged between 25.20-28.40%, this was normal and within the reference range of 22 -38% PCV reported by (16) and (17) for clinically healthy goats. Observed values were comparable with 23.50-27.76% reported by (18) for West African dwarf goats fed complete diets containing graded levels of sweet orange peel meal. Higher PCV values of 35.60-45.00 were reported by (12) for Kano Brown goats fed diets containing 15% and 30% levels of protein supplements, while (19) reported values of 33.75-37.50% for red Sokoto bucks fed diets containing varying levels of yam peel meal with *Ficus polita* as basal diets. The red blood cells (9.68-12.96x10^{6}/ul) and the haemoglobin (8.38-9.42g/dl) values were within normal reference range for goats (17). The packed cell volume, red blood cells and haemoglobin

values all indicated that the experimental animals were not anaemic and also that the presence of the WSSOPM in the diets did not interfere with the oxygen carry capacity of the blood. The neutrophil values were (32.40-40.80%), and T4 (40.80%) was significantly higher (P<0.05) than the rest treatment. Although values showed treatment effect, however, they were within the normal reference range of 30-48% reported by (17) and (16) for clinically healthy goats. Neutrophils are the main defender of the body against infection and antigens, high levels of neutrophils may indicate an active infection while low count may mean a compromised immune system or depressed bone marrow (16). These were not the case in this study, showing that the immune system of the goats was not compromised.

Table 3: Haematology of the Kano Brown goats fed the experimental diets

	Experimental diets				
Indices	T1	T2	T3	T4	SEM
Packed cell volume (%)	28.40	25.20	25.40	26.80	1.13^{ns}
Red blood cells $x10^9$/ul	12.96	12.06	11.14	9.68	1.44^{ns}
Haemoglobin (g/dl)	9.42	8.38	8.80	8.92	0.18^{ns}
Neutrophils (%)	32.40b	37.40b	38.60b	40.80a	1.87*
Lymphocytes (%)	59.60	55.00	55.20	53.60	3.10^{ns}
Eosinophils (%)	0.80	2.40	2.20	1.80	0.86^{ns}
Monocytes (%)	1.60	4.20	3.00	2.40	1.09^{ns}
Basophils (%)	1.40	1.00	1.00	0.60	0.68^{ns}
White blood cell ($x10^9$/dl)	6.00	4.08	3.64	6.18	1.13^{ns}
MCV (fl)	22.16	23.06	25.08	29.51	3.19^{ns}
MCH (pg)	7.34	7.62	8.60	9.82	1.04^{ns}
MCHC (mg/dl)	33.15	32.99	34.62	33.29	0.65^{ns}

a,b=means on same rows having different super script are significantly different (P<0.05), ns=not significant (P>0.05), SEM = standard error of the mean, MCV = Mean corpuscular volume, MCH= Mean corpuscular haemoglobin, MCHC= Mean corpuscular haemoglobin concentration.

The result for the serum biochemistry for the experimental goats is presented in Table 4. Aside the cholesterol values, none of the other parameters was significantly different (P>0.05) among the treatments. Total protein values were 6.52, 6.04, 5.88 and 5.78g/dl and there was no treatment effect (P>0.05) among the treatments. The similarities (P>0.05) of the total protein values for the treatments containing the test ingredient with the control means that there was no protein-energy malnutrition (20) as a result of replacement of maize offal with the WSSOPM and also that the crude protein levels of the experimental diets containing the test ingredient were adequate.

Table 4: Serum biochemistry of the Kano Brown goats fed the experimental diets

	Experimental diets				
Indices	T1	T2	T3	T4	SEM
Total protein (g/dl)	6.52	6.04	5.88	5.78	0.70^{ns}
Albumin (mg/dl)	3.00	3.44	3.24	3.48	0.14^{ns}
Globulin(mg/dl)	3.52	2.60	2.64	2.30	3.94^{ns}
SGOT (IU)	36.30	43.78	21.02	23.98	10.71^{ns}
SGPT (IU)	10.10	10.88	10.08	12.98	1.97^{ns}
Urea (mg/dl)	28.56	24.82	31.96	33.72	2.02^{ns}
Creatinine (mg/dl)	1.04	1.04	1.16	1.02	0.10^{ns}
Cholesterol (mg/dl)	142.34^{a}	85.82^{c}	108.12^{b}	97.02^{bc}	18.47*

a,b,c=means on same rows having different super scripts are significantly different (P<0.05), ns=not significant (P>0.05), SEM = standard error of mean, SGOT=Serum glutamic oxaloacetic transaminase, SGPT= serum glutamic pyruvic transaminase.

Normal total protein values implies adequacy in crude protein diets, implying that the experimental goats were not fed with diets deficient in CP. Values in this study were higher than 5.08-5.40g/dl reported by (21) for WAD goats fed varying levels of corncobs and 3.33-5.52g/dl reported by (22) for WAD bucks fed *Panicum maximum* and Bambara nut (*Vigna subterranean*) seed meal. (3) reported slightly higher values of 6.46-7.41g/dl for goats. Albumin is a very strong indicator of health and values in this study ranged between 3.00-3.48g/g/dl which was normal and within the reference range of 2.40-4.40 reported by (3) and 2.30-3.60g/dl reported by (17) for clinically healthy goats showing that the experimental animals were not sick. The cholesterol values showed significant differences (P>0.05) among the treatments. The values were 142.34, 85.82, 108.12 and 97.02mg/dl for T1, T2, T3 and T4 respectively. The value for T1 (142.34mg/dl) was significantly higher (P<0.05) than the rest treatments, while T2 (85.82mg/dl) was the lowest (P<0.05), but similar to T4 (97.20mg/dl), and between T3 and T4, there was no difference. Although treatment effect was apparent (P<0.05) in cholesterol values, observed values were within safe levels. Previously, (23) had established that cholesterol levels of 180mg/dl and below is safe in ruminants and may not result to arteriosclerosis. Cholesterol is a group of fats vital to cell membranes, nerve fibre and bile salts and it is a necessary precursor for the sex hormone (24). This implies that its functions to the cell membrane, nerve fibre and bile salt was not hampered with, and its precursory activities for the sex hormones were not compromised.

Conclusion and Applications

1. Water soaked sweet orange peel meal is a potent energy feed ingredient and it is recommended for usage in goat diets for improved productivity particularly during the long dry season.
2. Replacing maize offal with water soaked sweet orange peel meal did not have deleterious effect on the blood profile of the Kano Brown goats.

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