Nigerian J. Anim. Sci. 2019, 21 (2): 39-46

Influence of dietary supplementation of *Piliostigma reticulatum* pods with or without charcoal on growth performance, hematology, and carcass traits in goats fed a concentrate-based diet

Zubair J.I.*, Abubakar M.L., Yusuf M.K., Useni S.S., Adeyemi K.D. and Mshelia A.N.

Bioresources Development Centre (BIODEC), National Biotechnology Development Agency (NABDA), Kano, Nigeria.

***Corresponding Author:** iamzubair22@gmail.com **Phone Number: +2348067354369 and**

Target Audience: Farmers, Animal Scientist, Nutritionist, Extension experts

Abstract

This study evaluated the growth performance, hematology and carcass attributes of goats fed diet supplemented with Piliostigma reticulatum pod meal (PRPM). Nine Red Sokoto bucks (BW, 12.5kg, 5 months old) were randomly assigned to three isocaloric and isonitrogenious diets namely; a basal diet without PRPM (Control), diet supplemented with 20% PRPM, and diet supplemented with 20% PRPM and 0.03% charcoal in a completely randomized design. The goats were fed for 60 d, and slaughtered. Diet had no effect ($p>0.05$) on dry matter intake, body weight gain and feed efficiency in goats. The control goats had lower ($p<0.05$) packed cell volume than the goats fed other dietary treatments. Dietary treatments did not affect the concentration of hemoglobin, white blood cells, and red blood cells in goats. Slaughter weight, dressing percentage, and weight of prime cuts did not differ ($p>0.05$) among the treatments. These results suggest that PRPM could be utilized in diets without compromising growth performance, hematological indices, and carcass traits in goats.

***Keywords**:* dressing percentage, feed efficiency, packed cell volume, prime cuts, red blood cell

Description of Problem

One of the major constraints to ruminant livestock productivity in Nigeria is the low feed availability and poor nutritive value of pasture and/or forage particularly during the dry season (1, 2). Thus, the use of all year – round novel feedstuffs offers considerable merits for promoting the nutritional base to enhance the productivity of ruminant livestock (1, 3). This is particularly relevant to the trend towards increased meat production to meet with the ever–increasing Nigerian population. Fodder trees and shrubs play vital role in ruminant production in the tropics due to their ability to maintain their nutritive value during the dry seasons (2, 4). *Piliostigma reticulatum* is a leguminous medium-sized tree and grow wild in the tropics (5). In northern Nigeria, *Piliostigma reticulatum* is one of the commonest species of *Piliostigma* (6, 7).

Piliostigma reticulatum is locally known as Kalgo and Kargo (8). The nutritional profile and anti-nutritional factors of *Piliostigma reticulatum* pods have been documented (4, 8, 9). Nonetheless, *Piliostigma reticulatum* pod has not been extensively studied for its potential use in ruminant nutrition. In addition, we explore the potentials of charcoal to

counteract the possible deleterious effects of the anti-nutritional factors in *Piliostigma reticulatum* pod. The objective of this study was to assess the impact of dietary supplementation of *Piliostigma reticulatum* pod meal on growth performance, hematology, and carcass traits in goats fed a concentrate-based diet.

Materials and methods

Experimental location, goats, and diets

The experiment was conducted at the Animal Bioresources Development Centre farm, Bayero University New site, Kano, Kano state, Nigeria. Its bears a coordinate of longitude 9^0 30^0 and 12^0 30^0 N and latitude 9^0 30^0 and 8^0 42^0 E in the semi-arid zone in the semi-arid of Nigeria at an altitude of 460 m above sea level (10). The climate is characterized by a defined wet season (May to September) and dry season (October to April). The mean annual rainfall ranges from 600 - 1000 mm (11).

Nine Red Sokoto bucks with average mean body weight of 12±0.30 kg and about 5 months old were purchased from a local Farm in Kano, Kano state Nigeria. Prior to the commencement of the trial, the goats were treated against internal and external parasite by administering subcutaneous ivomec injection (0.2 ml per head). A broad-spectrum antibiotic (Ox tetracycline, L.A) was given at the rate of 0.2ml per head. The goats were randomly assigned to three dietary treatments in a completely randomized design. Feed and water were supplied *ad libitum*.

Piliostigma reticulatum pods were collected within the premises of Bayero University, air-dried, packed and stored until used. The experiment lasted 60 days. The experimental diets were concentrates formulated to meet the nutrient requirement of growing goats according to the NRC requirements (12). The experimental diets included a basal diet without *Piliostigma reticulatum* pods, a basal diet with 20% *Piliostigma reticulatum* pods, (T2) and a basal diet with 20% *Piliostigma reticulatum* pods and 0.03% charcoal. The chemical composition of the experimental diets was assessed following the protocol of AOAC (13) while acid detergent fibre (ADF) and neutral detergent fibre (NDF) were determined following the protocol of Van Soest *et al*. (14). The ingredients and the chemical composition of the dietary treatments are presented in Table 1 and Table 2 respectively. The goats were fed twice a day at 7:00a.m and 4.00 p.m. The feeds were offered to the goats at 3% of body weight. Feed intake was estimated as the difference between feed offered and refusals and feed conversion ratio was estimated. The quantity of feed offered (dry matter) was adjusted to account for changes in body weight. The goats were weighed on the first day of the feeding trial and fortnightly thereafter.

Blood collection and profiling

Blood samples (4 ml) were collected from each goat through jugular venipuncture into EDTA bottles every week. The blood samples were analyzed for red blood cells (RBC), packed cell volume (PCV), hemoglobin (HgB), and white blood cells (WBC) using automatic hematology analyzer (CELL- DYN 3700 Abbott, USA).

Table 1: Ingredient composition of dietary treatments

	Dietary treatments[1]		
Ingredients (%)	T1	T2	T3
Maize offal	55.00	35.00	35.00
Soya bean meal	25.50	25.50	25.50
Wheat offal	16.00	16.00	16.00
Piliostigma reticulatum pods	-	20.00	20.00
Charcoal*	-	-	0.03
Bone meal	2.00	2.00	2.00
Salt	1.00	1.00	1.00
Vitamin premix	0.5	0.5	0.5
TOTAL	100	100	100

[1]T1=Control diet, T2=diet supplemented with 20% *Piliostigma reticulatum* pods. T3=diet supplemented with 20% *Piliostigma reticulatum* pods and 0.03% charcoal.

Table 2: Chemical composition of dietary treatments

	Dietary treatments[1]			
Chemical composition (%)	T1	T2	T3	*Piliostigma reticulatum* pods
Dry matter	90.70	91.30	91.30	92.30
Crude protein	19.90	19.67	19.58	17.81
Crude fibre	33.15	36.58	37.03	45.26
Neutral detergent fibre	50.65	48.79	48.78	46.68
Acid detergent fibre	46.48	40.95	40.95	36.87
Ether extract	7.67	6.67	6.33	6.30
Ash	13.15	11.35	12.08	5.84
GE, Mcal/kg (Calculated)	3.29	3.27	3.27	
Tannin	1.24	1.29	1.33	1.41

[1]T1=Control diet, T2=diet supplemented with 20% *Piliostigma reticulatum* pods. T3=diet supplemented with 20% *Piliostigma reticulatum* pods and 0.03% charcoal.

Carcass evaluation

At the end of the feeding trial, the goats were fasted overnight with *ad libitum* access to water. The goats were weighed, and slaughtered by conventional neck-cut. After slaughter, the head was excised from the atlanto-occipital joint, the forelimbs were excised from the carpal joint while the hind limbs were removed from the tarsal joint. Thereafter, the carcasses were flayed and analysed as described by (15).

Statistical analysis

Data obtained for growth performance and carcass traits were subjected to analysis of variance (ANOVA) procedure (16) suitable for completely randomized design. Data obtained for hematological indices were subjected to a repeated measure analysis using the mixed procedure of SAS (16) in which dietary treatment, days of sampling and interaction between dietary treatments and sampling days were fitted as fixed effects while goats and baseline values of parameters were fitted as random effects. Duncan multiple range test was used to compare the treatment means at $p<0.05$.

Results

The growth performance indices of Red Sokoto goats fed diet supplemented with *Piliostigma reticulatum* pods are presented in

Table 3. Dietary treatments had no effect ($p>0.05$) on dry matter intake, body weight gain, daily gain and feed efficiency in goats. The nutrient intake of goats fed diet supplemented with *Piliostigma reticulatum* pods are presented in Table 4. The intake of crude protein, ash, ether extract, NDF, ADF and crude fibre did not differ ($p>0.05$) among the treatments.

The hematology parameters of goats as influenced by dietary treatments and experimental period are presented in Table 5. The T3 goats had the highest PCV, which was significantly different from those of goats fed other dietary treatments. The control goats had lower PCV that was significantly different from goats fed other dietary treatments. The concentration of WBC, RBC and HgB were not affected ($p>0.05$) by dietary treatments. The RBC, PCV, and WBC in goats increased ($p<0.05$) as sampling week progressed. There was no significant interaction ($p>0.05$) between dietary treatment and sampling period on hematological indices in goats. The carcass traits of goats fed diet supplemented with *Piliostigma reticulatum* pods are presented in Table 6. Dietary treatments had no significant effect ($p>0.05$) on slaughter weight, dressing percentage and weight of carcass cuts in goats.

Table 3: Growth performance indices in goats fed diet supplemented with *Piliostigma reticulatum* pods.

Parameter	Dietary treatments[1]			SEM	P value
	T1	T2	T3		
Initial body weight (kg)	12.00	12.01	12.20	0.56	0.240
Final body weight (kg)	13.86	13.74	13.94	0.39	0.071
Body weight gain (kg)	1.86	1.73	1.74	0.22	0.217
Daily gain (g/day)	31.00	28.83	29.00	0.02	0.412
Feed intake (g/day)	540.00	530.00	530.00	15.12	0.194
Feed efficiency ratio	0.06	0.05	0.06	0.02	0.423

[1]T1=Control diet, T2=diet supplemented with 20% *Piliostigma reticulatum* pods. T3=diet supplemented with 20% *Piliostigma reticulatum* pods and 0.03% charcoal.

Table 4: Nutrient intake in goats fed diet supplemented with *Piliostigma reticulatum* pods.

Parameter (g/day)	Dietary treatments			SEM	P value
	T1	T2	T3		
Crude protein	107.46	104.25	103.77	6.34	0.192
Crude fibre	179.01	193.87	196.26	20.74	0.081
Neutral detergent fibre	273.51	258.59	258.53	18.29	0.078
Acid detergent fibre	250.99	217.04	217.04	30.23	0.231
Ether extract	41.418	35.35	33.55	8.28	0.128
Ash	71.01	60.16	64.02	12.45	0.564

[1]T1=Control diet, T2=diet supplemented with 20% *Piliostigma reticulatum* pods. T3=diet supplemented with 20% *Piliostigma reticulatum* pods and 0.03% charcoal.

Table 5: Hematological indices in goats fed diet supplemented with *Piliostigma reticulatum* pods.

Parameter	Dietary treatments[1]				Period (weeks)									P value		
	T1	T2	T3	SEM	1	2	3	4	5	6	7	8	SEM	D	P	D*P
PCV[2] (%)	22.95^{c}	24.52^{b}	26.45^{a}	0.38	23.07^{f}	25.57^{ef}	23.97^{de}	24.56^{cd}	25.00^{bc}	25.36^{ab}	25.63^{ab}	25.98^{a}	0.15	<.0001	<.0001	0.368
WBC[3] (x10^{9}/L)	5.74	5.50	5.86	0.07	4.81^{g}	5.15^{fg}	5.48^{fe}	5.77^{de}	6.15^{cd}	6.57^{bc}	7.03^{ab}	7.33^{a}	0.12	0.201	<.0001	0.964
RBC[4] (10^{12}/L)	6.35	6.06	6.59	0.91	5.05^{c}	5.27^{bc}	5.52^{abc}	5.66^{abc}	5.79^{abc}	5.91^{ab}	6.04^{ab}	6.12^{a}	0.17	0.091	0.0009	0.912
HgB[5] (g/L)	94.40	91.80	92.90	5.02	84.10	85.20	86.62	88.20	91.01	92.42	94.30	95.81	3.00	0.101	0.064	0.901

[1]T1=Control diet, T2=diet supplemented with 20% *Piliostigma reticulatum* pods. T3=diet supplemented with 20% *Piliostigma reticulatum* pods and 0.03% charcoal. D=Dietary treatments. P= Period. [2]Packed cell volume, [3]White blood cells, [4]Red blood cells. [5]Haemoglobin

Table 6: Carcass characteristics of goats fed diet supplemented with *Piliostigma reticulatum* pods.

Parameters	Dietary treatments[1]			SEM	P value
	T1	T2	T3		
Slaughter weight (kg)	13.86	13.54	13.84	0.39	0.071
Carcass weight (kg)	5.99	5.95	6.10	0.12	0.072
Dressing percentage (%)	43.27	44.21	44.50	1.32	0.101
Shoulder (kg)	1.78	1.81	1.85	0.03	0.062
Loin (kg)	0.48	0.56	0.50	0.02	0.171
Thigh (kg)	1.30	1.35	1.32	0.08	0.217

[1]T1=Control diet, T2=diet supplemented with 20% *Piliostigma reticulatum* pods. T3=diet supplemented with 20% *Piliostigma reticulatum* pods and 0.03% charcoal.

Discussion

Dietary supplementation of *Piliostigma reticulatum* pods did not affect feed intake and body weight gain in goats. This observation suggests that the level of *Piliostigma reticulatum* pods fed in this trial was well accepted and had no deleterious effects on rumen fermentation and body weight gain in goats. This observation is consistent with the nutritional potential of *Piliostigma reticulatum* pods (4, 9). In line with the current observation, a survey of small ruminant farmers in Jigawa state, Nigeria showed that 62.7% of the farmers fed *Piliostigma reticulatum* pods to their animals during the dry season (9). The range of daily body weight gain (28-30 g/day) observed in our study is similar to the value (30.3g/day) reported in earlier study in which sugarcane peels was fed to Kano brown bucks (3). The values obtained for nutrient intake in this study were similar to the results of previous studies in which unconventional feedstuffs were fed to goats (1, 3).

Blood profiling is an effective strategy for assessing the physiological and health status of livestock (17, 18). In this trial, there was no mortality and no visible sign of sickness was noticed in the goats. This observation further attests to the non-toxicity and perhaps the suitability of *Piliostigma reticulatum* pods in ruminant diets. Herein, dietary supplementation of *Piliostigma reticulatum* pods did not affect hematological parameters

except PCV in goats. Nonetheless, the values of RBC, PCV, HgB and WBC observed in our findings were within the range of reference values (HgB, 80-120 g/L; PVC, 22-38%; RBC, 5-8 $x10^{12}$/L, WBC, 4-14 $x10^{9}$/L) reported for clinically healthy goats (19, 20).

Goats fed *Piliostigma reticulatum* pods had higher PCV values compared with those fed control diets. This observation suggests that the phytochemicals in PRPM induced a better transportation of oxygen and absorbed nutrient and thus enhanced primary and secondary polycethemia (21, 22). A similar increase in PCV was observed in Red Sokoto goats fed tannin rich *Pterocarpus erinaceus* based diets (23).

The normal RBC values observed in the present study indicated that dietary *Piliostigma reticulatum* pods did not induce haemolyticanaemia and depression of erythrogenesis (20, 23). The lack of significant differences in the concentration of hemoglobin among the treatments indicates the absence of microcytic hypochromic anaemia, which may be caused by the deficiency and/or improper use of iron for the synthesis of HgB (19, 23).

The increase in PCV, WBC and RBC as the experimental period progressed could be attributed to changes in the demands for metabolism occasioned by the increase in the body weight of the goats. Similar changes in hematological variables were reported in Mehsana goats due to age differences (24). The increase in PCV over the experimental period could be due to the increase in RBC or the decrease in in the circulating blood plasma (21). The increase in RBC and HgB over experimental period suggests the need for high oxygen demand resulting from increase in body weight of the goats. This observation is consistent with the findings reported in Sannen goat kids (25).

Contrarily, there were no changes in the PCV, RBC, HgB and WBC in sheep measured over a 90 d feeding trial in spite of changes in body weight (18).

Dietary supplementation of *Piliostigma reticulatum* pods did not affect carcass weight in goats. The similarity in carcass weight could be attributed to the similar body weight gain and slaughter weight among the treatments. Dressing percentage measures the carcass weight relative to the live weight of an animal and tt is influenced by breed, sex, body conformation, state of maturity, slaughter weight and gut contents (26, 27). Diet had no effect on dressing percentage in goats. This finding might be due to the similar slaughter weight and carcass weight among the dietary treatments. Contrary to our findings, dietary supplementation of *Acacia etbaica* and *Dichrostachys cinera* fruits increased the dressing percentage of Abergelle goats (28). The values of dressing percentage observed in the current study is similar to the values reported in previous studies in goats (28, 29). As with most livestock species, nutritional status, weight at slaughter, and carcass weight of goats influence carcass components (27). Herein, carcass components did not differ among the dietary treatments. This finding could be attributed to the similar carcass weights across the dietary treatments.

Conclusion and Applications

1. The incorporation of 20% *Piliostigma reticulatum* pods in the diet of goats did not have deleterious effects on growth performance, hematology and carcass traits in goats.
2. Further study to determine the suitability of incorporating higher levels of *Piliostigma reticulatum* pods in the diet of goats is suggested.
3. Further studies to elucidate nutrient digestibility and rumen metabolism as influenced by dietary supplementation of *Piliostigma reticulatum* pods in goats are suggested.

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