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Performance and toxicological effects of cooked baobab (*Adansonia digitata* L.) seed meal on West African dwarf goats

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Target audience: *Animal Scientists, Livestock farmers, Feed millers and Processors*

Abstract

Twelve West African dwarf bucks aged 5-7 months of age, and having an average weights 6.67 kg were used to evaluate the effect of cooked baobab seed meal (CBSM) on the performance and blood profile of West Africa dwarf (WAD) goats for 12 weeks. The bucks were distributed into four treatment groups (n=3), using completely randomised design. Baobab seeds were cooked in boiling water for one hour, sun-dried and crushed into a meal. Four diets were compounded and designated; A (0%), B (25%), C (50%) and D (75%) CBSM. Results showed that there were no significant differences (P>0.05) in all the performance indices measured. The mean daily feed intake values (345.50-367.47 g/day) and mean daily weight gains (7.54-17.06 g/day) were similar (P>0.05) across the treatments. Haematological parameters; packed cell volume, white blood cells, haemoglobin, lymphocytes and neutrophils all showed treatment effect (P<0.05). Treatment effects (P<0.05) were also observed in values of serum albumin, serum glutamic oxaloacetate transaminase and triglyceride among the treatments, however, all the treatment values were within normal ranges. Cooked baobab seed meal up to 75% could be used by farmers as replacement for soybean in the diets of WAD goats with no toxic effects on blood profile or performance.

Keywords: *West African dwarf goats, Adansonia digitata, performance, toxic effects, blood profile.*

Description of Problem

Small ruminants are an integral part in the livestock production system in Nigeria (1) which suggests the relative importance of small ruminants in the livestock economy. They are considered superior to other ruminant species in utilization of low quality and high fibre feeds (2). Small ruminants fair better when a strategic combination of energy and protein rich diets are used for their feeding (3). Sheep and goats are capable of improving the low animal protein intake by man in developing nations like Nigeria (4, 5). Although goats are endowed with these great potentials, however, their productivity is bedevilled with challenges, amongst which is sustained feed availability all the year round. Ruminant livestock farmers are not able to adequately feed their animals with high quality forage all the year round due to seasonal fluctuations in feed availability (6). In Nigeria, during the rainy seasons, there exists abundant resource of forage species for livestock feeding. However, the scenario is quite different during the dry season as most of the forage species dry up. A more critical situation is experienced in the Northern parts of the country where ruminant livestock species like cattle, sheep and goats are in greater numbers. Grasses which are the most abundant basal feed for small ruminants most times dry up during the dry season and become dormant, except they are irrigated (7). More so, in areas where some forage species survive, they are usually in short supply, fibrous and lignified with low protein values leading to poor digestibility and significant weight losses of the animals (8). Limited supply of feed all through the year is an important challenge that necessitates drastic measures to mitigate its debilitating effects on goat production.

Supplementation with concentrate diets is one potent to ameliorate this menace, but the high cost of conventional feedstuff impedes this measure. The African baobab tree (*Adansonia digitata* L.) and its related species belong to the family of *Malvacea* (9). It is deciduous tree having a peculiar growth structure consisting of a massive, bottle-shaped trunk and relatively sparse canopy and reaches heights of up to 25 m high and can live for thousands of years (10). Baobabs trees are widespread all over the hot, drier regions of tropical Africa and are prevalent south of the Sahara and are commonly considered as an African symbol (10). The tree is well adapted to the arid parts of Central Africa and widely spread in the savannah regions of Nigeria (11). The bark, leaves and fruits are used in many parts of Africa as food and in traditional medicine. Baobab seeds are rich in protein and contains substantial amount of energy (12). Baobab seed meal has been reported to contain 19.50% CP, 15.60% CF, 13.40% EE, 44.60% NFE and 3.10% ash (13). The whole seeds are also said to contain 20.13% CP, 7.89% CF, 24.72% EE, 39.90% NFE and 7.36% ash (14). Though richly endowed nutritionally, (15) reported that baobab seeds also contain oxalates, phytates and saponins. Baobab seeds in addition contain 3-7% tannin and saponins, 2% phytate and 10% oxalate (16).

A readily available and fast means of assessing the clinical and nutritional status of animals on a feeding trial may be the use of blood analysis (17). It is therefore important to evaluate the blood parameters particularly when unconventional feeds are fed to animals in order to determine the performance of such animals and the suitability of such feeds on the specie of livestock that is been used (18). This study was therefore designed to evaluate the effects of cooked baobab seed meal on the performance and blood indices and of West Africa dwarf goats fed diets containing graded levels of *Adansonia digitata* seed meal.

Table 1: Composition of experimental diets fed to the bucks

	Experimental diets			
Ingredients (%)	A (0%)	B (25%)	C (50%)	D (75%)
Maize	10.00	10.00	10.00	10.00
Maize offal	64.18	64.18	64.18	64.18
Soybean meal	22.82	17.12	11.41	5.70
Baobab seed meal	0.00	5.70	11.41	17.12
Bone ash	2.00	2.00	2.00	2.00
Common salt	1.00	1.00	1.00	1.00
Total	100	100	100	100

A = 0% cooked baobab seed meal, B = 25% cooked baobab seed meal, C = 50% cooked baobab seed meal, D = 75% cooked baobab seed meal

Materials and methods

Location of study

The experiment was conducted at the Teaching and Research Farms of Federal University of Agriculture, Makurdi, Nigeria. Makurdi is in the Southern guinea savanna vegetation zone of Nigeria, on latitude 07^{o} 41′N and longitude 08^{o} 31′E with the relative humidity of 47% to 85% and ambient temperature range of 17.3-35.6^{o} C. The climate of the area is tropical with a rainy season stretching from April to October, and Annual rainfall varying from 1317-1323 mm (19).

Collection and preparation of test ingredient

Baobab seeds were procured from Kanke local government area of Plateau State. The collected seeds were turned into boiling water and allowed to cook for one hour. The cooked seeds were then drained using plastic baskets, sun-dried and crushed into a meal. Four diets were formulated and compounded to contain 0%, 25%, 50% and 75% cooked baobab seed meal (CBSM), and designated A, B, C and D respectively.

Experimental goats, housing and management

Twelve (12) West Africa Dwarf goats with an average weight of 6.67 kg were sourced from retailers in Lafia market, Lafia local government, Nasarawa State, Nigeria. Sequel to the arrival of the goats, the animal house was disinfected with Izal® and allowed to dry. The floor was covered with wood shavings and equipped with drinking troughs. On arrival, the goats were vaccinated with PPR vaccine and given ivermectin as prophylaxis for ecto and endo parasites. Subsequently, the animals were randomly distributed into four treatment groups (n=3). Daily concentrate rations of 200g were served to each animal at about 8:00 hour and at 10:00 hour. The forage was provided to the animals *ad libitum* by suspending the forage down to the animals from the roof of the compartment using light ropes. This reduced the forage wastage and enhanced intake. Fresh, cool and clean water was daily supplied to the animals to drink at will.

The initial weights of the animals were determined at the onset of the feed trial and thereafter weekly to evaluate changes in weight. Feed intake was calculated as the difference of initial quantity of feed served and the remnants of both forage and concentrate supplement. Weight gain was recorded as the difference between the final weight and the initial weight of each animal. On the last day of the feeding trial, blood sample was collected from each animal via the jugular vein into an ethylene diamine tetra acetic acid (EDTA) this was to enable the assay of the haematological indices and into plain sample bottle for biochemical indices could also be assayed.

Experimental design

The completely randomized design (CRD) was used for the experiment. The study lasted for 12 weeks.

Data analysis

Data generated from the study was subjected to the analysis of variance using the MINITAB 16 (20) statistical software. Means separation was achieved using the Fishers least square difference.

Results and Discussion

The performance of the WAD goats supplemented with CBSM is presented in Table 2. Mean daily weight gain values were between 7.54 -17.06 g/day, and there was no significant difference (P>0.05) among the treatments. This implies that the diets containing the test ingredient sustained the bucks and did not cause weight losses.

Observed mean daily weight gain values were comparable with 12.46-19.21 g/day reported by (21) for West African dwarf goats fed malted sorghum sprouts mixed with pineapple waste and slightly higher values of 14.59 - 23.00 g/day reported by (22) for WAD goats fed diets containing treated and untreated sweet orange (*Citrus sinensis* L.) peels with gamba grass as the basal diet. Higher mean daily weight gain values of 42.63-64.76 g/day were reported for Kano brown goats feed *Gmelina arborea* leaves and supplemented with diets containing water soaked sweet orange peels (23).

Mean daily feed intake values were between 343.50-367.40 g/day with no apparent treatment effect (P>0.05). Feed intake is one of the most important factors affecting the productivity of small ruminants, if the voluntary intake is too low the rate of production will be depressed (24). This implies that the treatments containing CBSM did not depress feed intake. Factors that affect feed intake include palatability and appetite. Palatability is the degree of acceptability of a feed to the taste of an animal and it is determined by the appearance, odour, taste, texture, temperature and other sensory properties of the feed (25). This indicates that all the dietary treatments which contained the CBSM were palatable and accepted by the goats like the control thus orchestrating the similarity (P>0.05) in feed intake across all the treatments. Observed mean daily feed intake values were higher than 297.70-312.50 g/day reported by (22) for West Africa dwarf goats fed diets containing treated and untreated sweet orange (*Citrus sinensis* L.) peels with gamba grass as the basal diet and 294.41 - 313.70 g/day reported by (26) for West African dwarf goats fed unripe plantain peels as supplement for maize. Higher values of mean daily feed intake of 441.40-482.00 g/day were however reported by (23) for Kano brown goats fed *Gmelina aborea* leaves and supplemented with diets containing water soaked sweet orange peels.

Table 2: Performance of the WAD goats fed the experimental diets

	Experimental diets				
Parameters	T1	T2	T3	T4	SEM
Initial weight (kg)	6.65	6.65	6.67	6.68	0.45 ns
Final weight (kg)	8.08	7.50	7.12	7.95	0.46ns
Total weight gain (kg)	1.43	0.85	0.45	1.40	0.21ns
Mean daily weight gain (g/day)	17.06	10.12	7.54	16.67	3.00ns
Concentrate intake (kg)	10.37	9.04	10.14	10.52	1.18ns
Forage intake (kg)	19.67	19.99	19.45	20.35	0.25ns
Total feed intake (kg)	30.05	29.03	29.59	30.87	1.13ns
Mean daily feed intake (g)	357.69	345.50	352.28	367.47	13.43ns

T1 = 0% Cooked baobab seed meal, T2 = 25% Cooked baobab seed meal, T3 = 50% Cooked baobab seed meal, T4 = 75% Cooked baobab seed meal, ns = Not significantly different (P>0.05), SEM = Standard error of the mean

Haematology of the experimental bucks fed CBSM is presented in Table 3. The PCV values were between 25.67-33.33% and there were significant differences (P<0.05) among the treatments. The PCV values of treatments B, C and D were not significantly different (P<0.05), but higher than the control A (25.67%). Baobab seed meal seems to improve the PCV of the animals on the treatments with CBSM. PCV values of all the experimental animals were within normal reference range of 21-35% reported by (27) for West African Dwarf goats, and also within 22 - 35% reported by (28) for goats. Observed values are comparable with 27.25 - 32.75% reported by (29) for Red Sokoto goats fed baobab (*Adansonia digitata* L.) fruit meal supplement. However, (23) reported higher values of 33.75-37.50% for Red Sokoto goats fed diets containing varying levels of yam peel meal with *Ficus polita* leaves as basal diet. The haemoglobin (Hb) values were between 8.33-11.13 g/dl and treatment effect was apparent (P<0.05). Haemoglobin values of bucks fed CBSM as basal diet; B (10.83 g/dl), C (10.60 g/dl) and D (11.13 g/dl), were significantly higher (P>0.05) than the control A (8.33 g/dl). Baobab seeds have been reported to be rich in iron (16) this may have positively influenced the Hb values of bucks fed with CBSM meal. The Hb values were within the normal reference range of 7.00-15.00 g/dl reported by (27) for WAD goats. Observed values of Hb were comparable with 8.55-12.58 g/dl reported by (29) for Red Sokoto goats fed baobab fruits meal supplements, but lower values of 8.38-9.42 g/dl reported by (23) for Kano brown goats fed *Gmelina arborea* leaves and supplemented with diets containing water soaked sweet orange peels. Moderately higher Hb values of 11.28-12.78 g/dl for Red Sokoto goats fed diets containing varying levels of yam peel meal with *Ficus polita* leaves as basal diet was reported by (22). The MCHC were between 32.57-34.27 g/dl and within the normal range of 30.00-36.00 g/dl reported by (36) for healthy goats (29) and comparable to 33.33-33.55 g/dl for Red Sokoto goats fed baobab fruit meal. Observed PCV, Hb and MCHC values of bucks' feed CBSM meal were within normal reference values implying that the presence of the test ingredient in the diets did not induce anaemia in experimental animals.

Defence of the body against invasion by pathogens and foreign bodies are the major function of WBC therefore animals with very low white blood cells are usually exposed to higher risk of disease infection, but those with normal WBC counts are capable of generating antibodies in the process of phagocytosis and more capable of fighting diseases (30) which further enhances adaptability to local environment (31, 29, 32, 33). The white blood cell (WBC) values ranged from 15.70-22.40 ($x10^3$/l), and differences in WBC values were seen (P<0.05) among the treatments, notwithstanding, observed values were similar with 6.50-20.10 ($x10^3$ u/l) reported by (27) for WAD goats. This suggests that CBSM did not exert immunosuppressive effect on the experimental bucks. Values in this study were comparable with 17.16-24.67 ($x10^3$ u/l) reported by (34) for pedi goats fed varying levels of *Vachellia karroo* leaf meal in *Setaria verticillata* hay based diet. Lower WBC values of 5.30 - 7.40 ($x10^3$ u/l) for WAD goats fed complete diets containing graded levels of sweet orange feel meal was reported by (35). Eosinopils count were between 4.33-5.00%, and within 1-7% reported by (27) for WAD goats and 1-8% reported by (36) for healthy goats. Normal values of eosinophils observed in this study imply that there were no allergic reactions from the animals in the course of feeding on the diets. Neutrophils counts range from 33.00-47.00% and within the normal reference range of 17.00 - 52.00% reported by (27) for WAD goats and 30.0-48.00% reported by (37) for healthy goats. High neutrophils (neutrophilia) indicate the presence of microbial infection or inflammation, while low neutrophils (neutropenia) could be as a result of chronic infection, toxic effects of feed constituents or drug on the bone marrow (36, 23). The normal neutrophils values observed in this study show that the CBSM did not compromise the immunity of the animals.

Table 3: Haematology of the experimental bucks fed the diets containing CBSM

	Experimental diets				
Parameters	A	B	C	D	SEM
Packed cell volume	25.67[b]	33.33[a]	31.67[a]	32.33[a]	0.80*
Haemoglobin	8.33[a]	10.83[b]	10.60[b]	11.13[b]	0.34*
White blood cells	15.70[b]	19.83[a]	20.47[a]	22.40[a]	0.75*
MCHC	32.57	32.57	33.57	34.27	1.04ns
Lymphocytes	55.00[a]	43.33[b]	37.67[b]	40.35[b]	1.99*
Eosinophils	4.33	4.33	5.00	5.00	0.65ns
Neutrophils	33.00[b]	46.33[a]	47.00[a]	46.33[a]	1.82*

A = 0% Cooked baobab seed meal, B = 25% Cooked baobab seed meal, C = 50% Cooked baobab seed meal, D = 75% Cooked baobab seed meal, Ns = Not significantly different (P>0.05), SEM = Standard error of the mean, MCHC = Mean corpuscular haemoglobin concentration

Serum biochemical profile of the goats fed the experimental diets is presented in Table 4. The total protein (TP) values were between 64.47-70.73 g/l were within the normal reference range of 63-85 g/l reported by (27) WAD for goats. Serum proteins are important in osmotic regulation, immunity and transport of several substances in the animal body (38). This implies that the crude protein levels of the diets were adequate and there were no abnormalities in TP functions. Observed values were within 58.00-78.00 reported by (39) for WAD goats fertilized maize leaf concentrate diets. Similar TP values of 64.20-74.00 g/l were reported by (26) for WAD goats fed unripe plantain peels as replacement for maize, while (35) reported higher values of 75.78-80.06 g/l for WAD goats fed complete diets containing graded levels of sweet orange peel meal. The albumin values range between 23.27-31.10 g/l and showed treatment effect (P<0.05) among the treatments. Bucks fed with CBSM had albumin values {B (29.83 g/l), C (31.10 g/l) and D (30.60 g/l)} that were significantly higher (P>0.05) compared to the control A (23.27 g/l). Albumin is a protein made by the liver. It makes up 40 to 60% of the total proteins in the body fluid. Albumin keeps fluid from leaking out of blood vessels, nourishes tissues, and functionally transports hormones, vitamins, drugs, and substances like calcium throughout the body (40). Observed albumin values for all the treatments were within 22.00-43.00 g/l reported by (27) of for healthy WAD goats and 21.50-44.50 g/l by (39) for WAD goats fed fertilized maize leaf concentrate diets, while (21) reported albumin values of 26.30-35.20 g/l for West African dwarf goats fed diets containing graded levels of malted sorghum sprout mixed with pineapple waste based diet. The albumin values of all the experimental bucks that were fed with CBSM were normal. This indicates that CBSM did not alter the normal functioning of the albumin that would have resulted to a deleterious health effect.

The SGOT values were between 93.47-140.3 IU/l and showed significant differences (P<0.05) among the treatments. Treatments A (93.47 IU/l) and C (104.10 IU/l) were lower (P<0.05) than B (140.3 IU/l), but B (140.30 IU/l) was similar (P<0.05) to D (113.80 IU/l). It is released into the blood stream in the event of damage to hepatocytes (41). Although variations (P<0.05) were observed in the SGOT values, however, the values were within the reference range of 66.0-230.0 IU/l reported by (36) for healthy goats. Observed values of SGOT were comparable with 83.00-101.75 IU/l reported by (34) for pedi goats fed varying levels of *Vachellia karroo* leaves meal in *Setaria verticillata* hay based diets, while (35) reported higher values of 180.20-198.33 IU/l for WAD goats fed complete diets containing graded levels of sweet orange peel meal. SGPT values ranged between 18.50-23.10 IU/l and did not show treatment effect (P<0.05). Observed SGPT values were within the normal range of 15.3-33.10 IU/l reported by (36) for healthy goats and comparable with 25.75-43.00 IU/l reported by (34) for pedi goats fed varying levels of *Vachellia karroo* leaves meal in *Setaria verticillata* hay based diets. SGOT and SGPT are liver enzymes and they form a major constituent of the liver cells. When the liver cells get damaged or injured, these enzymes seep into the blood stream, raising their blood levels (41). SGOT and SGPT values in this study were within the normal range and indicate that incorporating CBSM into the diets of the experimental bucks did not cause hepatic damage.

Total bilirubin (Tbil) values were between 0.022-0.036 mg/dl and did not show treatment effect among the treatments. Observed values were normal and within the range of 0-0.09 mg/dl reported by Plumb (36) for healthy goats. Values were also within the range of 0.011-0.875 mg/dl reported by (42) for healthy captive Persian wild goats. The direct bilirubin (Dbil) values were between 0.014-0.0277 mg/dl. Observed values of Dbil were within 0.00 - 0.079 mg/dl reported by (42) for healthy captive Persian wild goats. Tbil and Dbil values all further indicate that CBSM was not injurious to the liver of the experimental animals. Creatinine values ranged between 0.72-0.99 mg/dl and comparable with 0.50 - 0.85 mg/dl reported by (23) for red sokoto goats, while (43) reported 0.45 - 0.72 mg/dl for WAD goats fed Bambara nut seed meal. Higher creatinine values of 2.10–2.19 mg/dl for WAD goats fed unripe plantain peels as replacement for maize was reported by (26). This implies that inclusion of CBSM in the diets did not result in muscle wastage in the experimental animals.

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

	Experimental diets				
Parameters	A	B	C	D	SEM
TP (g/l)	64.47	70.73	68.17	66.30	2.626^{ns}
Albumin (g/l)	23.27^{b}	29.83^{a}	31.10^{a}	30.60^{a}	0.991*
Globulin (g/l)	41.20	40.90	36.83	35.70	2.564^{ns}
Urea (mmol/l)	6.367	5.067	6.633	5.433	0.455^{ns}
SGOT (IU/l)	93.47^{b}	140.3^{a}	104.1^{b}	113.8^{ab}	8.426*
SGPT (IU/l)	18.50	20.00	21.43	23.10	1.345^{ns}
Tbil (mg/dl)	0.029	0.022	0.036	0.029	0.18^{ns}
Dbil (mg/dl)	0.027	0.015	0.016	0.014	0.051^{ns}
Creatinine (mg/dl)	0.72	0.83	0.93	0.99	0.51^{ns}

a, b, c = Means on the same row with different superscript are significantly different (P<0.05).
* = Significantly different (P<0.05), ns = Not significantly different (P>0.05), SEM= Standard error of the mean, SGOT= Serum Glutamic Oxaloacetate Transaminase, SGPT = Serum Glutamic Pyruvate Transaminase, TP= Total protein, Tbil= Total bilirubin, Dbil= Direct bilirubin

Other haemato-chemicals values of the experimental goats are presented in Table 5. The low density lipoprotein (LDL) values ranged between 0.27-0.62 mmol/l and did not show treatment effect (P<0.05) among the treatments. In this study, triglyceride values ranged from 0.17-0.63 mmol/l and showed significant treatment effect (P<0.05), but within the normal reference range of 0.16-1.60 mmol/l reported by (27) for WAD goats. Variation in triglyceride values in the treatment groups did not follow any specific trend. Triglyceride values was lowest in T3 (0.17 mmol/l) and highest in T1 (0.63 mmol/l). Similar values of 0.38-0.72 mmol/l for Karadi sheeps were previously reported by (44). Total cholesterol values ranged between 1.14-2.20 mmol/l, this was within the normal range of 1.0-3.0 mmol/l reported by (45) for goats. This implies that the meats from these animals did not have more than normal level of fat and are safe for human consumption. Other researchers, (34) reported lower total cholesterol values of 0.72-1.25 mmol/l for pedi goats fed varying levels of *Vachellia karroo* leaf meal in *Setaria verticillata* hay based diet.

Sodium ion values ranged between 139.5-143.9 mmol/l, and within the range of 124-146 mmol/l reported by (27) for WAD goats and 133.5-154 mmol/l reported (36) for healthy goats. Observed values are comparable with 136.65-140.47 mmol/l reported by (34) for pedi goats fed varying levels of *Vachellia karroo* leaf meal in *setaria verticillata* hay based diet. Sodium ions are important for neuronal transmission and electrolyte balance. Normal sodium ions in experimental implies that the animals were healthy. Potassium (K^+) values were between 3.47-4.00 mmol/l and did not show treatment effect ($P<0.05$) among the treatments. Values were normal and within the normal reference range of 3.00-6.00 mmol/l reported by (27) for WAD goats. K^+ is responsible for normal cardiac and neuromuscular functioning and enzymatic activation this indicates that the animals' hearts and nervous systems were functioning properly. Chloride values ranged between 88.67-91.57 mmol/l and did not show treatment effects ($P<0.05$) among the treatments, Cl^- maintains serum acid base balance regulated by the lung and kidney, similarity of treatments containing the test ingredient with the control implies that the CBSM did not exert harmful effects as to hamper with normal chlorine functioning.

Table 5: Other haematochemicals of the experimental diets

Parameters	Experimental diets				SEM
	A	B	C	D	
HDL (mmol/l)	0.65	0.72	0.69	0.39	0.06^{ns}
LDL (mmol/l)	0.27	0.62	0.43	0.59	0.11^{ns}
Trigyceride (mmol/l)	0.63^{a}	0.34^{b}	0.17^{c}	0.28^{bc}	0.0.04*
Tchol (mmol/l)	1.24	1.79	1.14	2.20	9.01^{ns}
Sodium (mmol/l)	139.5	139.8	141.4	143.9	1.14^{ns}
Potassium (mmol/l)	3.50	4,00	3.67	3.47	0.15^{ns}
Chloride (mmol/l)	91.57	88.67	88.67	90.17	1.84^{ns}

a, b, c = Means on the same row with different superscript are significantly different ($P<0.05$).
* = Significantly different ($P<0.05$), ns = Not significantly different ($P>0.05$), SEM = Standard error of the mean, HDL= High density lipoprotein, LDL= Low density lipoprotein, Tchol= Total cholesterol

Conclusions and Applications

1. From the study, it has been demonstrated that ≤75% CBSM can be used in the diets of WAD goats with no compromise on the performance of the experimental animals.
2. The CBSM in the experimental diets at the maximum concentration used in the study had no toxic effects on haematological indices investigated.
3. CBSM diets will be particularly important for goat production during the long dry

seasons and for animals that need only maintenance diets.

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