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Research Article

Effects of Soybean Milk Chaff on the Performance and Blood Characteristics of West African Dwarf Male Goats

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Abstract

The need to use alternative non-toxic ruminant feed sources that are viable, available, cheap, rich in protein and not in direct competition with man cannot be overemphasized. A total of sixteen male growing West African dwarf (WAD) goats of about 5 - 7 months of age weighing between 5.25 - 8.45 were used to evaluate the performance and blood characteristics of WAD goats fed Soybean milk chaff meal (SMCM) in a completely randomised design for a period of 77 days. The collected SMCM was immediately sun-dried for about three days, thereafter; the crumbs were crushed into a meal. Four diets were formulated and compounded to contained 0%, 30%, 60% and 90% SMCM respectively. Results showed that there were significant differences ($P < 0.05$) among the treatments in total weight gain, mean daily weight gain and total concentrate intake. The haematological indices showed significant differences ($P < 0.05$) among the treatment means only in haemoglobins ($10.55 - 12.53 \times 10^{12}$/l) and white blood cells ($11.98 - 19, 39 \times 10^{9}$/l) values, while rest parameters were similar ($P > 0.05$) across the treatments. Apart from the albumin, globulin, creatinine, high density lipoprotein, low density lipoprotein and total cholesterol, all the other serum biochemical parameters showed significant differences ($P < 0.05$) among their treatment means. The study showed that soybean milk chaff can be incorporated in the diets of WAD goats up to 90% level without toxic effects on the serum profile of the goat.

Keywords: Soybean Milk Chaff; West African Dwarf Goats; Performance; Blood Characteristics

Introduction

The West African dwarf goat represents a major livestock resource in the humid West and Central Africa where they are distributed across 15 countries [1]. In Nigeria, goats play a major significant role in the livestock production systems [2], where they are not only a source of income to farmers, but also serve as a source of protein to man, are used as gift for marriages, thanksgiving, provide raw materials for our industries as well as manure for soil improvement. Animal protein is one of the most important components of human diets and its consumption varies from country to country [3]. In Nigeria, the human population is estimated at about 140.4 million [4], this population is continually on the increase annually. The increase has led to more demand for animal and animal products to meet up with the minimum animal protein requirement per individual per day. The protein intake of an average Nigerian is estimated at 45.5 g per head per day. This is lower than the 70 g per head per day recommended minimum intake by the Food and Agricultural Organization of which 50% (35g) should be of animal source [5]. The potential of small ruminant production in alleviating the low animal protein intake by man in developing nations such as Nigeria cannot be overemphasized [6]. Although small ruminants have the capacity to ameliorate the inadequacy in protein intake because of their short generation interval and proficiency, meeting the nutritional needs of these animals has been the age long challenge. Ahamefule and Elendu [7] had earlier reported that feed shortage is a major constraint to goat production in Nigeria. Goats suffer scarcity of feed especially during the long dry season when the natural pasture and the post-harvest crop residues are depleted in most nutrients and can barely sustain their maintenance [8]. Lamidi *et al* [9] also had reported that the available forages for most part of the year are low in protein content which leads to marked decreased voluntary intake and digestibility, and subsequently to substantial weight loss of the animals during this period. It has been established that ruminants do better when energy and protein rich diets are strategically combined for feeding [10], but the expensive nature of conventional feed as a result of competition between man and livestock makes this strategic combination difficult [11]. There is thus the need to use alternative feed sources that are not in direct competition with man but are viable, available and cheap.

Previous findings show that with the prevailing circumstances it was less likely that there will be surplus from conventional cereals and pulses upon which livestock production can develop and therefore suggested the "waste to wealth" approach of directing efforts towards harnessing and utilizing by-products and wastes which are not directly been utilized by man [12,13]. Soybean milk chaff is one such by-product. It is also known as Okara [14] and it is obtained after preparation and filtering soybean to have the milk. This soybean milk waste has been used in poultry diets and it is reported to have crude protein content between 22 - 26%, lipids 9.3 - 22.3%, high amounts of isoflavones, polyunsaturated fatty acids, linolenic and linoleic acid [15,16]. It is available all the year round and can be collected from retailers of soybean milk at little or no cost. It is beige in colour like mushroom and has a light, crumbly fine grained texture [17]. Soybean milk chaff if properly harnessed can be a potential feed ingredient. It is imperative to evaluate blood parameters particularly when unconventional feeds are fed to animals in order to determine the performance of the experimental animals as well as the suitability of such feed on the specie of livestock that is been used [18].

Haematological parameters are important and reliable medium used to monitor and evaluate the health and nutritional status of animals [18,19]. This study was therefore designed to evaluate the effects of soybean milk chaff meal on the performance and blood characteristics of West African dwarf bucks.

Materials and Methods

Experimental site

The experiment was carried out at the Teaching and Research Farm, University of Agriculture Makurdi. Makurdi is located on latitude 7041´N, longitude 38031´E and 9m above the sea level. It has a tropical climate with a distinct wet and dry season. The wet season is between the months of April to October and has a well distributed rainfall with monthly average rainfall of 153 mm and an annual average of 1344.3 mm [20].

Collection of test ingredient and diet preparation

Soybean milk chaff was collected from soybean milk retailers within Makurdi metropolis, at little or no cost. This was immediately sun-dried under for 3 days on concrete slabs. When it was dry and crispy, the crumbs were packed and crushed into meal using a cereal milling machine and bagged into synthetic bags for use. Four experimental diets were formulated and compounded to contain 0%, 30%, 60% and 90% SMCM and the diets were designated T1, T2, T3 and T4 respectively.

Experimental animals housing and management

The experimental house was a dwarf walled building with elaborate windows space and a high roof for proper ventilation. The house was divided individual compartments. Each compartment was equipped with feeding troughs and drinkers. Two weeks to the arrival of the animals, the animal house was thoroughly washed and disinfected using Izal© solution and allowed to dry. Wood shaving was spread on the concrete floor to serve as litter material and bedding. The feeding and drinking troughs were also properly washed and sun-dried. A total of sixteen WAD bucks weighing between 5.25 - 8.45 kg and aged between 6 to 8 months were purchased from medium scale goat sellers at Daudu Market in Guma local government area of Benue State, Nigeria and used for the experiment. The animals were vaccinated against Peste des petits ruminants (PPR) using the PPR vaccine and dewormed using Albendazole. The animals were weighed on arrival, and randomly distributed into four treatment groups designated T1, T2, T3 and T4 (n = 4 per group). The bucks were fed 200 g of the concentrate supplements at 8:00 hour daily, and at 10.00 hour, gamba grass was fed to the goats *ad libitum*. The grass was served to animals in small bundles suspended from the roof of each compartment and kept within the reach of the animals to encourage feed intake and to reduce wastage of the grass. Cool clean water was supplied to the goats *ad libitum* every day. The animals were given 7 days to get used to the feed and the environment before data collection began. The experiment lasted for 77 days.

Data collection

Daily records of quantity of feed served and feed remnants was kept, and feed intake was calculated by subtracting the quantity of remnant feed from the quantity of the feed that was given. The animals were weighed weekly to evaluate their weekly weight changes.

Blood collection

Blood was collected into two sets of sample bottles; ethylene diamine tetra acetic acid (EDTA) containing bottles for haematological indices, while the plain sample bottles were used for serum biochemical indices. The feed samples were oven dried at a temperature of 100°C to constant weight and ground using the hammer mill to pass through 1 mm sieve; these were then sealed in air tight containers for the analysis of their proximate constituents according to standard procedures described by AOAC [21].

Experimental design

The experimental design for the study was the completely randomized design. The feeding trial lasted for a period of 77 days.

Statistical analysis

Data generated from the study were expressed as means ± standard error of the mean (SEM) for the measure of central dispersion. One-way analysis of variance was used to compare more than two means at 5% significant level using Minitab statistical software version [22].

Results and Discussion

The result of the proximate composition of the experimental diets is presented in Table 1. Performance of the West African dwarf goats fed the experimental diets is shown in Table 2. All the parameters measured were similar (P > 0.05) across the treatments except total weight gain, mean weight gain and concentrate intake. Mean daily weight gain values were between 3.14 - 24.91 g/day. Mean daily weight gain values of animals in T1 (24.91 g/day) was significantly higher than T3 (3.41 g/day), but similar to T2 (12.01) and T4 (11.24 g/day). However, there were no significant differences (p < 0.05) between T1, T2 and T4. The values for T3 (3.41 g/day) was significantly lower than the control value (24.19 g/day), this may not be attributed to the presence of SMCM in the diet, because T4 (90% SMCM) was similar (P > 0.05) with the control. All the treatments however provided sufficient nutrient for maintenance and minimal growth. Observed values for the mean daily weight gain were similar with 3.27 - 24.70 g/day reported by Oloche *et al* [23] for West African dwarf goats fed diets containing graded levels of sweet orange peel meal. Comparable values of 10.20 - 13.40 g/day were reported by Ososanya [24] for WAD lambs fed varying levels of Broiler litter. The concentrate intake for T1 (12.89 kg) was significantly higher (P < 0.05) than the rest of the treatments. But, comparing treatments T2 (8.87 kg), T3 (8.18 kg) and T3 (9.04 kg), there were no differences. This observation suggests that because, T1 (control) with higher crude protein and palatability enhanced more consumption of T1. On the other hand, there was no significant difference (P > 0.05) in total forage intake among the treatments. This implies that treatments containing the test ingredient did not interfere with forage intake. The mean daily feed intake was between 326.31 - 373.10 g/day and similar (P > 0.05) across the treatments. This implies that the test diets containing SMCM were equally acceptable comparable to the control. Observed values were similar to 340.60 - 354.43 g/day reported by Ibhaze [25] for West African dwarf goats fed maize cob diets and 296.51 - 315.33 g/day reported by Oloche *et al* [26] for West African dwarf goats fed gamba grass supplemented with diets containing treated and untreated sweet orange peel meal. However, higher values of 462.81 - 485.84 g/day were reported by Enilorunda et al [27] for Yankassa sheep fed corn husk supplemented with cassava leaf meal and *leuceana* leaf meal.

Ingredients	Experimental diets			
	T1	**T2**	**T3**	**T4**
Maize	10.00	10.00	10.00	10.00
Maize offal	64.18	64.18	64.18	64.18
Soybean	22.82	15.97	9.13	2.28
Soybean milk meal	0.00	6.85	13.69	20.54
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
Determined analysis (%)				
Dry matter	93.18	93.52	93.25	93.23
Crude protein	21.60	20.11	19.24	17.84
Crude fibre	3.43	4.35	5.68	6.58
Ether extract	6.05	7.38	8.47	8.91
Nitrogen free extract	60.03	59.91	56.85	57.70
Ash	8.88	8.24	9.76	8.97

Table 1: Composition of the experimental diets fed to the bucks.

T1: 0% Soybean Milk Chaff Meal; T2: 30% Soybean Milk Chaff Meal; T3: 60% Soybean Milk Chaff Meal; T4: 90% Soybean Milk Chaff Meal.

The result for the serum biochemistry of WAD goats fed SMCM is presented in Table 3. The values for the total protein ranged from 58.93 - 65.13 g/dL. T3 (65.13 g/dL) and T4 (64.60 g/dL) containing 60% and 90% of SMCM respectively were not significantly different (P > 0.05) but were both higher than T1 (61.55 g/dL) and T2 (58.93 g/dL). There was no protein–energy malnutrition resulting from incorporation of SMCM in the diets as evident in the adequate supply and utilization of protein in the diets by the bucks [28]. Observed values were comparable with 59.0 - 78.0 g/dL reported by (Jawasreh *et al* [29] for clinically healthy goats. Values in this study were higher than 50.8 - 54.0 g/dL reported by Ogunleke *et al* [30] for WAD goats fed varying levels of corncobs and 33.3 - 55.2 g/dL reported by Odoemelam *et al* [31] for WAD bucks fed *Panicum maximum* and Bambara nut (*Vigna subterranean*) seed meal.

Parameters	Experimental diets				
	T1	T2	T3	T4	SEM
Initial weight (kg)	6.99	6.99	6.96	6.97	0.48ns
Final weight (kg)	8.89	7.91	7.24	7.84	0.50^{ns}
Total weight gain (kg)	1.91^{a}	0.93^{ab}	0.26^{b}	0.87^{ab}	0.05^{*}
Daily weight gain (g)	24.91^{a}	12.01^{ab}	3.41^{b}	11.24^{ab}	4.76^{*}
Total concentrate intake (kg)	12.89^{a}	8.87^{b}	8.18^{b}	9.04^{b}	0.88^{*}
Total forage intake (kg)	15.84	17.31	17.45	16.98	0.74^{ns}
Total feed intake (kg)	28.73	26.22	25.13	25.51	1.02^{ns}
Mean feed intake (g)	373.10	340.58	326.31	331.33	13.22^{ns}

Table 2: Performance of the West African dwarf bucks fed the experimental diets.

a,b: Means on the same row having different superscripts are significantly different (P > 0.05); ns: Not Significantly Different (P < 0.05); SEM; Standard Error of the Mean; T1: 0% Soybean Milk Chaff Meal, T2: 30% Soybean Milk Chaff Meal; T3: 60% Soybean Milk Chaff Meal, T4: 90% Soybean Milk Chaff Meal.

Serum albumin gives an indication of the nutrients status of animals [32] and a very strong predictor of health condition of both animals and humans. The albumin and globulin values obtained in this study did not show treatment effects (P > 0.05) and within the normal range for WAD goats. In this study, the values which range between 25.73 - 28.10 g/dL were within the normal range of 2.40 - 4.40 g/dL reported by Plumb [33] for clinical healthy goats. The blood urea values ranged between 3.35 - 4.85 mmol/dL. T2 (4.85 mmol/dL) was significantly higher (P < 0.05) than the rest treatments. However, there was no significant difference between T1, T3 and T4. Observed values were within the normal range 0.8 - 9.7 mmol/dL reported by Daramola *et al* [34] for West African dwarf goats, while Ibhaze and Fajemisin [35] reported higher values of 12.11 - 19.77 mmol/dL for WAD goats fed pulverized bio-fibre wastes based diets. Since the difference observed among the treatments did not follow a specific trend, it cannot be attributed to treatment effect. The SGOT also showed significant differences (P < 0.05) among the treatments. T2 (130.27 IU/L) was significantly higher (P < 0.05) than the rest treatments, while T1 (125.03 IU/L) was higher than T3 (105.60 IU/L) and T4 (103.80 IU/L). Although these values showed statistical difference, they were within normal reference range of 66.0 - 230 IU/L reported by Plumb [33] for clinically healthy goats. Observed values were higher than 79.00 - 101.75 IU/L reported by Brown *et al* [36] for indigenous Pedi goats fed varying levels of *Vachellia karoo* leaf meal. The SGPT values were between 22.15 - 34.00 IU/L, and there were also significant differences (P < 0.05) among the treatment means. However, the values of SGPT in this study were within the normal reference range of 22.15 - 34.00 IU/L reported by Plumb [33] for healthy goats. Observed values were lower than 37.45 - 48.60 IU/L reported by Oloche *et al* [26] for WAD goats fed complete diets. Other researchers [36] reported values of 25.75 - 36.75 IU/L for Pedi goats fed varying levels of *Vachellia karoo* leaf meal at 25 - 50% levels. SGOT and SGPT are essential liver enzymes and indicators of effects of zenobiotics and toxic substances on hepatocytes. In this study, both SGOT and SGPT were within normal reference ranges, which strengthens our observation that the test ingredient was non-toxic and such safe for use as fed supplements in animals.

Parameters	Experimental Diets				
	T1	T2	T3	T4	SEM
Total Protein (g/dL)	61.55^{bc}	58.93^{c}	65.13^{a}	64.60^{ab}	1.12*
Albumin (g/dL)	25.73	25.95	28.10	26.98	0.76^{ns}
Globulin (g/dL)	35.83	32.98	37.02	37.63	1.39^{ns}
Urea (mmol/L)	3.35^{b}	4.85^{a}	3.73^{b}	3.68^{b}	0.31*
SGOT (Ul/L)	125.03^{b}	130.27^{a}	105.60^{c}	103.80^{c}	1.21*
SGPT (Ul/L)	22.15^{c}	22.68^{c}	29.73^{b}	34.00^{a}	0.80*
ALP (Ul/L)	839.5^{a}	762.50^{ab}	654.50^{b}	823.00^{a}	38.34*
Creatinine (mmol/L)	94.75	72.25	91.30	92.25	8.65^{ns}

Table 3: Serum biochemistry of the experimental bucks.

abc: Means across the same row differently superscripted differ significantly (P < 0.05); NS: Not Significant; SGOT: Serum Glutamate Oxaloacetate Transaminase; SGPT: Serum Glutamate Pyruvate Transaminase; ALP: Alkaline Phosphate; HDL: High-Density Lipoprotein.

The result for other haemato-chemicals of the experimental bucks is presented in Table 4. The cholesterol value were between 1.50 - 2.01 mmol/L and there was no treatment effect (P > 0.05) among the treatments. The test ingredient in the diets of the bucks did not cause hypercholesterolemia in the goats. Cholesterol levels were therefore normal, indicating that the meat from the experimental goats was safe and may not alter the iatrogenic index in humans after consumption. Observed values in this study were comparable with reference values of 1.70 - 3.50 mmol/L [37] for clinically healthy goats. Garba and Abubakar [38] reported values of 2.70 - 3.60 mmol/L for Yankasa rams fed graded levels of Tamarindus indica (tamarind) leaves. Bilirubin values ranged between 3.00-3.25 mg/dL and was within 1.70 - 4.30 mg/dL which are the reference values for goats [37]. This indicates that treatments containing SMCM diets did not cause hyperbilirubinemia, a condition associated with excessive breakdown of red blood cells. The creatinine values ranged from 72.25 - 94.75 g/dL, and did not show significant differences (P > 0.05) among the treatments. Observed values were normal and within the reference range of 60 - 135 mmol/L [37] for clinically healthy goats. This suggests that increasing the levels of SMCM from 30 - 90% in the diets of the goats did not have deleterious effect on the lean tissue mass of the animals as to cause loss of body weight. Observed values of creatinine in this study were comparable with 69.30 - 78.10 mmol/L reported by Oloche *et al* [26] for WAD goats fed complete diets containing graded level of sweet orange peel meal, while Garba and Abubakar [38] reported 75.00 - 100.00 mmol/L.

Sodium and potassium are the two major blood electrolytes. Na+ and K+ act as extra cellular cation, acts and intracellular cations respectively [33]. Values for sodium in the study were between 135.50 - 142.68 mmol/L and were within the normal range of 133.50 - 154.00 mmol/L reported by Plumb [33], and 124.00-146.00 mmol/L reported by Daramola *et al* [34] for healthy goats. Values of potassium ions ranged between 2.65 - 4.73 mmol/L and showed variation among the treatments. Mean value of potassium ion in animals was significantly higher P < 0.05) in T4 (4.73 mmol/L), and least in T2 animals (2.65 mmol/L) indicating treatment effects. However, observed values were within the normal range of 3.00 - 6.00 mmol/L) reported by Daramola *et al* [34] for healthy West African dwarf goats. This implies that using up to 90% SBMC in the diets of the experimental bucks did not lead to imbalance in the serum cations. The chloride (Cl-) values ranged from between 93.08 - 102.53 mEq/L and the values showed significant difference (P < 0.05) among the treatments. The observed values were normal and within the reference range of 99.00 - 99.50 mEq/L reported by Garba and Abubakar [38] for clinically healthy goats. This suggests that increasing the levels of SBMC up to 90% in the diets of goats did not significantly alter the serum electrolytes of the goats.

The result for the haematology of the experimental goats is presented in Table 5. The haemoglobin (Hb) and the WBC varied significantly (P < 0.05) among the treatments, while the rest parameters were similar (P > 0.05). The PCV values were between 32.25-39.50% and within the normal reference range of 22 - 38% [37,39] for clinically healthy goats. Observed values were comparable with 35.78 - 36.77 g/dL PCV values for WAD goats fed *Panicum maximum* and Bambara groundnut (*Vigna subterranean*) seed meal supplemented diets reported by Odoemelam *et al* [31]. Oloche et al [26], however reported lower values of 23.50 - 27.75% for WAD goats fed complete diets containing graded levels of sweet orange peel meal. The haemoglobin (Hb) values ranged between 10.55 - 12.53 g/dL. The Hb values of animals in T2, T3 and T4 were similar (P > 0.05), but significantly lower compared to the control, T1 (12.53). However, Hb values were within the normal range of 8 - 12 g/dL for WAD goats [37,39]. Observed values of Hb were similar with 11.80 - 12.20 g/dL reported by Odoemelan *et al* [31] for goats, and within normal reference range of 7 - 15 g/dL reported by Daramola *et al* [34] for healthy goats. Normal PCV and Hb values observed in this study, suggests that SMCM diet was non-toxic to haematopoietic cells, nor induced anaemia in the bucks.

Parameters	Experimental Diets				
	T1	T2	T3	T4	SEM
HDL (mmol/L)	1.15^a	0.71^a	0.91^a	1.11^a	0.18^{ns}
LDL (mmol/L)	0.980^a	1.308^a	1.285^a	1.113^a	0.17^{ns}
Trig (mmol/L)	0.45^c	2.13^b	2.39^a	2.29^{ab}	0.08*
Tchol (mmol/L)	1.52^a	2.01^a	1.64^a	1.59^{ab}	0.20^{ns}
Tbil (mmol/L)	2.00^b	2.35^b	2.25^b	3.25^a	0.13*
Dbil (mmol/L)	1.45^c	1.85^{ab}	1.88^{ab}	2.33^a	0.16*
Na^+ (mmol/L)	140.67^a	135.30^b	142.25^a	142.68^a	1.04*
K^+ (mmol/L)	3.35^c	2.65^d	4.10^b	4.73^a	0.17*
Cl^- (mEq/L)	102.53^a	96.93^b	94.03^c	93.08^c	0.73*

Table 4: Some haemato-chemicals of the experimental goats.

abc: Means across the same row differently superscripted differ significantly (P < 0.05). NS = Not significant. SEM: Standard Error of the Mean; LDL: Low-Density Lipoproteins; Tbil: Total Bilirubin; Dbil: Direct Bilirubin; Trig: Triglycerides; Tchol: Total Cholesterol; Na^+: Sodium; K^+: Potassium; Cl^-: Chloride.

Mean corpuscular haemoglobin concentration (MCHC) values ranged between 31.38 - 33.50 g/dL. Observed values of MCHC were within the normal reference range of 30 - 36 g/dL reported by Byers and Kramer [39] for healthy goats. The mean corpuscular haemoglobin (MCH) values of animals fed with SMCM ranged from 31.15 - 39.35 pg and were below the normal range (52.00 - 82.00 pg), but similar to the control. The MCH, and MCHC showed treatments effect (P < 0.05) between the groups. Low MCH and is an indication of anaemia [40], however the animals did present with symptoms of anaemia. And because observed values were similar to the control, SMCM cannot be implicated. Therefore SMCM did not have negative effect on these parameters MCH and MCHC.

The white blood cells (WBC) values ranged between 11.98 - 19.38×10^9/L. WBC values of bucks in T1 (11.98) and T2 (14.30) were significantly lower than T3 (18.43) and T4 (19.38). Notwithstanding, observed values were within the normal reference range of 6.8 - 20.1($\times10^3$/L) reported by Daramola *et al* [34] for healthy WAD goats. WBC values obtained in this study were higher than

5.30 - 7.40 ($\times 10^3$/L) reported by Oloche *et al* [26] for WAD goats fed complete diets containing graded levels of sweet orange peel meal, while Saka *et al* [41] reported values of 8.90 - 14.90 ($\times 10^3$/L) for WAD goats fed diets containing graded levels of malted sorghum sprout mixed with pineapple waste base diets. White blood cells and the differentials help to fight against infections and defend the body against invasion by foreign organisms [42]. Animals with abnormally low white blood cells are exposed to high risk of disease infections, while those with abnormally high WBC counts are capable of generating antibodies and an indication of chronic infection [43]. The WBC values observed in this study indicate that SMCM did not decrease the ability of the bucks to resist disease invasion, or compromise the health of the bucks.

The neutrophils values ranged between 46.25 - 48.25% and were within the reference range of 20 - 50% reported by Plumb [33]. Observed values were comparable with 40 - 50.50% reported by Finangwai [44] for Kano brown bucks fed diets containing graded levels of cotton seed cake, but higher than those of Saka *et al* [42] for WAD goats fed graded levels of malted sorghum sprout mixed with pineapple waste. The eosinophil values ranged between 3.50 - 4.25% and were within the normal range of 3-8% reported by MVM [37] for healthy goats. The functions of eosinophil include killing of cells, modulation of inflammatory responses and trapping of foreign proteins introduced into the body produced by bacteria and parasites [45]. The lymphocytes values ranged between 40.25 - 46.50%. There were no significant differences ($P > 0.05$) among the treatments. The values observed in this study were within the normal range of 20 - 90% [39] for healthy goats. This indicated that the SMCM did not compromise the immune system of the experimental animals. High lymphocytes values are associated with stress and response to the environment [46]. Values obtained from this study showed that the experimental environment was favourable and the animals were not subjected to abnormal stress conditions. Platelets values ranged from 98.63 - 105.40 cells/L. There were no significant difference ($P > 0.05$) among the treatments. Low platelets most often result to prolong clotting time, and in the event of injury, severe haemorrhage and death may occur [40]. The values observed in this study suggests that the animals had no clotting disorders.

Conclusion

This study showed that replacing soybean meal with soybean milk chaff meal (SMCM) up to 90% level had no adverse or deleterious effects on the performance, serum biochemical and haematological parameters investigated. In addition, the safety and health of the animals were not compromised; farmers can therefore incorporate up to 90% of SBMC as maintenance diets in goats feeds especially during the long dry season to forestall eminent weight losses associated those periods.

Parameters	Experimental diets				
	T1	T2	T3	T4	SEM
PCV (%)	39.50	32.25	33.75	34.50	2.12^{ns}
Hb (g/dL)	12.53^{a}	11.03^{b}	11.55^{ab}	10.55^{b}	0.43
WBC (x10^9/L)	11.98^{b}	14.30^{b}	18.43^{a}	19.38^{a}	1.27*
MCH (pg)	38.33	39.35	38.48	31.15	6.08^{ns}
MCHC (g/dL)	31.60	33.50	33.25	31.38	1.62^{ns}
Neutrophils (%)	47.50	46.25	48.25	48.00	1.91^{ns}
Eosinophils (%)	4.00	4.25	3.50	3.50	0.72^{ns}
Lymphocytes (%)	46.50	40.25	44.50	45.75	1.73^{ns}
Platelets (cells/L)	104.20	105.40	98.63	104.12	29.83^{ns}

Table 5: Haematological indices.

a, b: Means in the same row with different superscript differ significantly ($P < 0.05$); SEM: Standard Error of Mean; PCV: Packed Cell Volume; Hb: Haemoglobin; WBC: White Blood Cell; MCH: Mean Corpuscular Haemoglobin; MCHC; Mean Corpuscular Haemoglobin Concentration.

Conflict of Interest

The authors declare that there is no conflict of interest.

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