Haematological Profile and Liver Function Indices of Broiler Chickens Fed Groundnut Roselle and Baobab Seed Cake Diets with and Without Multienzymes Supplementation

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Abstract
Major challenge with use of non-conventional feed ingredients is their antinutrients composition, which can affect nutritional and health status of domesticated animals. Haematological values and liver enzymes present in their blood cells are used to detect these changes. The study was designed to analyze the haematological profile (total blood count, TBC) and liver function indices (serum biochemical profile, SBP) of broiler chickens fed three protein diets (groundnut (GNC), roselle (RSC) and baobab seed cake (BSC) diets) partly substituting soya bean meal, with and without multienzymes supplementation. A total of 352 and 330 Cobb 500 broiler chicks were allocated to four and five dietary treatments with control as maize-soya bean meal diet. Feeding Trial 1 contained GNC, RSC and BSC, while Trial 2 were fed BSC and RSC with and without multienzymes, in a complete randomized design (CRD), at 20% inclusion level for 49 days. Analysis of variance (ANOVA) and least significant difference (LSD) were used to analyze the data collected and separate means respectively. The result in Trial 1 showed that across the treatments, basophil levels were significant ($P<0.05$) and all the parameters tested for the serum biochemical test were not significant ($P>0.05$), except alkaline phosphatase (ALP) which was lower in birds fed BSC but was comparable to birds in control group. Total blood counts and serum biochemical profile of birds were not affected significantly ($P>0.05$) with dietary inclusion and multienzymes supplementation in Trial 2. It was concluded that the inclusion of GNC, RSC and BSC in broiler chickens' diet at 20% did not affect their health and nutritional status.

Keywords: antinutrients, broiler chickens, haematology, liver, seed cakes

1. Introduction

Haematological values (like packed cell volume (PCV), haemoglobin (Hb) and total protein) and liver enzymes present in blood cells are used to detect routinely individual's adaptability to the environment, pathological and nutritional conditions in domesticated animals [1] and some of the factors are; feed and nutrient restriction [2], water restriction [3], age [4], administration of drugs [5], breed [6] and aflatoxin [7]. The results of the levels of liver enzymes, white blood cells, blood glucose and total proteins among others give idea about the overall health and nutritional status of the bird.

Feed constitutes 70-80% of production cost and oil meals and seed cakes are among the largest cost items by volume in poultry feeds [8] which is made up of roughly 30-35% of the diet. Increase in price

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of feed ingredients, day-old chicks and cost of poultry products like meat and egg in Nigeria is a problem that affects the poultry industry; therefore, many feed millers and poultry farmers have reduced production to maximize profit, due to high cost of production. Three major conventional plant protein sources commonly used in Nigeria are SBM, GNC, RSC and BSC. High demand for meat, egg and increase in production cost made them become more expensive. Additionally, non-conventional feed ingredients are practically or traditionally not used in animal feed and in commercial rations produced for livestock. Soya bean meal has high energy, significant fat content and fiber [9] while crude protein for GNC is 40.1 - 50.90% with a mean value of 45.6% [10]. Roselle contains 38.57% crude protein CP [11], is high in lysine and improves feed intake, it contains high amount of protein, lipids, dietary fiber, and minerals [12]. Baobab has 20-36% CP, also high in energy, have ANFs such as tannins, saponins, phytates, and oxalates, with good aroma and improves feed intake [13].The major challenge with use of non-conventional feed ingredients as alternative source of protein in broiler chicken diets, is their antinutrient composition like cyanide, phyto-haemaglutinin, tanins, saponins, phytates, trypsin inhibitors and cyanogenic glycoside, that can affect nutritional and health status of domesticated animals like broiler chickens. Therefore, scientists have been using them to substitute the expensive ones.

Anti-nutritional factors (ANFs) in feed ingredients affect palatability, feed intake, digestion, nutrients absorption and utilization of feed. They have negative effects at higher levels, but some may exert beneficial effects when consumed at low level. Furthermore, the mechanism of action for both are the same. The ANFs are harmful and toxic, higher levels in feed can be evaluated by carrying out a total blood count or serum biochemical test, to have an insight on the immunity of the chickens, nutritional status and quality of feed ingredients and feed. Over the years, the quality of non-conventional feed ingredients has been improved with multienzyemes addition, to increase performance and growth efficiency of broiler chickens. This study therefore evaluated the effect of feeding GNC, RSC and BSC diets partly substituted with soya bean cake with and without multienzymes supplementation on TBC and SBP of broiler chickens.

2. Materials and methods

Experimental site

The research was conducted at the Teaching and Research Farm in Poultry Unit of the Department of Animal Science, Ahmadu Bello University, Zaria, Kaduna State, Nigeria from August 2019 to February, 2020. The area is in the Northern Guinea Savanna Zone, at latitude 11009'01.78"N and longitude 7039'14.79"E [14], at an elevation of 671 m above sea level. It has an average annual rainfall of about 700-1400 mm, with distinct dry and rainy seasons, highest ambient temperature ranges and fluctuates from 26 to 32 ^{o}C [15] depending on the season, with a relative humidity of 21 and 72% in the dry and wet seasons, respectively.

Experimental feed ingredients and birds

The birds were sourced from Olam farm in Kaduna State, while feed ingredients were purchased from a commercial feed mill in Zaria. Baobab seed cake was sourced from National Research Institute of Chemical Technology (NARICT) Basawa, Zaria.

Experimental design and management of birds

In trial one and two, 352 and 330 Cobb 500 broiler chicks were assigned into four and five dietary treatments, each were replicated 4 and 3 times with 22 chicks for Trial 1 and 2 respectively, in a complete randomized design (CRD). Each feeding trial lasted for seven (7) weeks. All biosecurity measures and routine management were adhered to, feed and water were provided ad-libitum throughout the trials.

Feeding Trial 1 was carried out in July to October 2018 and Trial 2 in December to February 2019 respectively.

Experimental diets

Four and five nitrogenous and caloric diets with 23 and 20% crude protein were formulated for starter and finisher phases respectively for Trial 1 and 2 as shown in Table 1. Groundnut cake, RSC and BSC were included at 20% and served as the experimental diets for Trial 1, BSC and RSC with and without multienzymes served as experimental diets for Trial 2, multienzymes (Maxigrain (E);

protease 4000 IU, xylanace10000IU, phytase 2500 FTU and cellulase 10000 IU) was incorporated based on manufacturer's dose (100 g/1000 kg diet), while diet with maize-soya bean meal served as control for both trials.

Table 1. Composition of broiler starter chicken diets containing groundnut roselle and baobab seed cakes partly substituting soya bean meal

Ingredients	Diets							
	Starter diet				Finisher diet			
(Feeding trial 1)	SBM	GNC	RSC	BSC	SBM	GNC	RSC	BSC
Maize	58.80	58.70	55.90	56.80	59.00	58.8	56.80	57.00
Soya Bean Meal	35.00	15.00	15.00	15.00	29.00	10.00	10.00	10.00
Groundnut Cake	0.00	20.00	0.00	0.00	0.00	20.00	0.00	0.00
Roselle Seed Cake	0.00	0.00	20.00	0.00	0.00	0.00	20.00	0.00
Baobab Seed Cake	0.00	0.00	0.00	20.00	0.00	0.00	0.00	20.00
Maize Offal	0.00	0.00	0.00	0.00	7.00	6.00	5.00	7.00
Blood Meal	2.00	2.00	5.00	4.00	1.00	1.00	4.00	2.00
Bone Meal	3.00	3.00	3.20	3.00	3.00	3.00	3.00	3.00
Limestone	0.50	0.50	0.20	0.50	0.25	0.25	0.25	0.20
Common Salt	0.25	0.25	0.25	0.25	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Lysine	0.00	0.10	0.00	0.00	0.00	0.20	0.20	0.00
*Vit-min premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
TOTAL	100	100	100	100	100	100	100	100
(Feeding trial 2)	RSC	RSC + E	BSC	BSC + E	RSC	RSC + E	BSC	BSC + E
	Calculated analysis							
ME (kcal/kg)	2900	2900	3000	3000	2900	2900	3000	3000
Crude Protein (%)	23.00	23.00	22.00	22.00	20.00	20.00	20.00	20.00
Crude Fiber (%)	2.60	3.86	4.32	3.52	3.21	3.80	4.59	3.46
Ether Extract (%)	2.69	4.27	4.24	3.35	2.54	3.80	4.30	3.90
Calcium (%)	1.32	1.32	1.37	1.33	1.23	1.23	1.32	1.25
Phosphorus (%)	0.85	0.85	0.81	0.85	0.88	0.87	0.79	0.88
Methionine (%)	1.51	1.27	1.28	1.46	0.5	0.48	0.49	0.51
Lysine (%)	0.51	0.50	0.51	0.53	1.28	1.16	1.27	1.19
Cost/kg ($/kg)	0.307	0.293	0.297	0.254	0.290	0.282	0.288	0.238

Note: ingredients composition for trial 1 and 2, were the same except in trial 2, where multienzymes was added to RSC and BSC at 100 g/1000 kg of diet, soya bean cake diet also served as control for trial 2, E = multienzymes. Bio-mix broiler finisher premix per kg diet: Vit A, 10 I.U; Vit D3, 2 I.U; Vit E, 23 mg; Vit K3, 2 mg; Vit B1, 1.8 mg; VitB2, 5.5 mg; Niacin, 27.5 mg; Panthonenic acid, 7.5 mg; Vit B6, 3 mg; Vit B12, 0.015 mg; Folic acid, 7.5 mg; Biotin, 0.06 mg; Cholin Chloride, 0.3 mg; Cobalt, 0.2 mg; Copper, 3 mg; Iodine, 3 mg; Iron, 1 mg; Manganese, 20 mg; Selenium, 40 mg; Zinc, 30 mg; Antioxidant 1.250 mg, *Vit-min Premix: Vitamin Mineral Premix. SBM = Soya Bean Meal, GNC = Groundnut Cake, RSC = Roselle Seed Cake, BSC = Baobab Seed Cake ME = Metabolizable Energy, dollar to naira rate= 1$ equals ₦360.45 (2019 exchange rate).

Table 2 shows the antinutritional factors of the seed cakes, SBM had the highest saponin value while BSC had the least, for tannin, BSC had the least and GNC recorded the highest level of 2.55. Phytates record indicated that RSC had the highest value with low record of 0.07 for SBM. The resulting meals from seeds like roselle seed used for small-scale edible oil production contain low levels of antinutrients-tannin, F amylase inhibitors, protease (chymotrypsin, trypsin) inhibitors, phytic acid, gossypol [20].

Data collection

Total blood count.

At the end of the growth trials, four (4) and three (3) birds from each treatment were randomly selected for collection of blood samples, 2.0 ml of blood samples was collected using sterile bottles containing anticoagulant ethylene diamine tetra acetic acid (EDTA) for TBC test. The White Blood Cell Count (WBC), Red Blood Cell Count (RBC), packed cell volume (PCV) and Hemoglobin (Hb) were analysed using Wintrobe microhaematocrit, Neube haematocyatometer and cyanohaemoglobin

using the procedures described by Coles (1986) [16]. The analyses were conducted at the Clinical Pathology Laboratory of Ahmadu Bello University Teaching Hospital, Zaria

Table 2. Antinutritional factors in the experimental seed cakes

Seed cakes	Anti-nutritional Factors		
	Saponin	Tannin	Phytates
Soya Beans Meal	44.65	2.02	0.07
Groundnut Seed Cake	24.35	1.60	0.09
Roselle Seed Cake	15.80	2.30	0.19
Baobab Seed Cake	16.70	2.55	0.14

Serum Biochemical Profile

A sample of 2.0 ml of blood was collected from sixteen and fifteen birds at the end of the feeding Trial 1 and 2 respectively, one from each replicate into sterile bottles without anticoagulant for serological studies to determine serum biochemical profile of the broiler chickens. The analyses were conducted at the Clinical Pathology Laboratory of Ahmadu Bello University Teaching Hospital. Albumin and total serum protein were determined using methods described by Peters et al. [17] while the globulin was obtained by difference. Alkaline phosphatase (ALP), alanine transaminase (ALT) and aspartate transaminase (AST) were determined according to the method of Reitman and Frankel [18]. Jaffe reaction was used to determine serum creatinine while serum urea was determined by dimethyl monoxide method [19].

Statistical analysis

Data collected were analyzed using the Statistical Analysis System (SAS, 2002) ANOVA procedure [21] and means were separated statistically using Least Significant Difference (LSD).

3. Results and discussion

Feeding Trial 1

Total blood count of broiler chickens fed GNC RSC and BSC diets partly substituting soya bean meal

Table 3 showed TBC of birds fed GNC, RSC and BSC diets partly substituted with soya bean meal. The result showed that dietary inclusion of the seed cakes had no significant ($P>0.05$) effect in blood profiles of the bird. However, basophils level across the treatments was significant ($P<0.05$). The packed cell volume (PCV) and haemoglobin (Hb) counts were in accordance with normal PCV and Hb ranges of 7-15 g/dL and 24-40 % respectively [22], this showed that all PVC and Hb values were near upper limits of the range for healthy birds. Most parameters measured fell within normal range reported by Mitruka and Rawnsely [22] for healthy birds. This implied that feed efficiency and oxygen circulation were not impaired. White blood cell (WBC) counts showed that all the birds had a good immune system, and the values fell within normal range of 1.90 - 9.50 × 109/L as reported by Simrak et al. (2004) [23]. Basophil count was low for SBM diet compared to other treatments. They are known to be released in response to seasonal allergies, serious medical conditions, blood disorder, leukemia and fight against infection.

However, the level of immunity in birds can be depicted by higher levels falling within normal range, this clearly explained that the birds on SBM diets had less immunity and were more exposed to high risk of infection [24].

Higher values of white blood cell (WBC) count obtained in this study were similar to the values recorded by Abdulazeez et al. [25] and Muataz [26] in their trials for birds fed BSC at 25%.

Serum biochemical profile of broiler chickens fed GNC RSC and BSC diets partly substituting SBM

Serum biochemical profile of birds fed GNC, RSC and BSC diets are presented in Table 4. Dietary inclusion of the seed cakes had no significant ($P>0.05$) effect in all the tested parameters but a significant ($P<0.05$) difference was observed across the dietary groups for alkaline Phosphatase (ALP). All ALP values across the treatment means except birds fed BSC in their diet were within normal range 10-106 µL [29].

Table 3. Total blood count of broiler chickens fed groundnut roselle and baobab seed cake partly substituting soya bean meal

Parameters	Dietary levels of the seed cakes (kg/100 kg diet)					
	SBM	GNC	RSC	BSC	LSD	Reference Values
PVC (%)	29.32	32.55	31.95	34.60	8.48	24.00-40.00*
Hb(g/dl)	9.15	10.32	10.12	10.72	2.65	7.00-15.00*
RBC ($\times 10^{12}$/L)	2.08	2.29	2.27	2.46	0.64	1.59-4.10*
WBC ($\times 10^{9}$/L)	7.78	8.67	8.02	8.95	24.96	1.90-9.50**
Lymphocytes (%)	88.22	89.40	90.02	89.87	3.70	40.00-100.00**
Monocytes (%)	3.00	2.87	2.17	2.37	1.99	1.007.00****
Eosinophils (%)	4.62	4.57	4.00	4.25	1.73	1.50-6.00**
Basophils (%)	0.10^{b}	0.25^{ab}	0.97^{a}	0.25^{ab}	0.86	0.10-2.00*

[ab] = Means with different superscripts on the same row are significantly different $P < 0.05$, GNC = Groundnut Cake, RSC = Roselle Seed Cake, BSC = Baobab Seed Cake, SBM = Soya Beans Meal, LSD = Least Significant Difference, *Mitruka and Rawnsely, (1997) [22], **Simrak et al., (2004) [23], ***Jain (1986) [27], ****Jain (1993) [28]

Table. 4. Serum biochemical profile of broiler chickens fed groundnut roselle and baobab seed cake diets partly substituting soya bean meal

Parameters	Dietary levels of the seed cakes (kg/100 kg diet)					
	SBM	GNC	RSC	BSC	LSD	Reference ranges
Glucose (g/dL)	98.75	87.92	89.73	91.25	14.07	199.00-348.00**
Blood Urea Nitrogen (mg/100ml)	3.52	4.17	3.67	4.25	1.00	1.50-8.30*
Albumin (g/L)	1.97	2.00	2.13	2.25	0.54	1.10-2.20***
Globulin (g/L)	3.40	3.35	2.83	3.45	0.91	1.20-3.20****
Total Protein(g/L)	5.37	5.35	4.96	5.70	0.86	3.60-5.50***
Creatinine (mg/100ml)	0.82	0.82	0.70	0.80	0.17	$0.10\text{-}0.40^{M}$
Aspartate Aminotransferase (µL)	53.87	51.60	54.96	57.12	11.23	150.00-278.00**
Alkaline Phosphatase (µL)	86.00^{ab}	90.72^{a}	93.70^{a}	79.02^{b}	11.38	10.00-106.00*****
Alanine Aminotransferase (µL)	16.55	15.82	17.70	17.22	2.51	9.50-37.20*

[ab]= Means with different superscripts on the same row are significantly different $P < 0.05$, SBM = Soya Bean Meal, GNC = Groundnut Cake, RSC = Roselle Seed Cake, BSC = Baobab Seed Cake, LSD= Least Significant Difference, *Mitruka and Rawnsley, (1997) [22], **CDD (1990) [35], ***Ross et al. (1976) [36], ****LAVC (2009) [37], ****Bounous and Stedman (2000) [29], [M] Merck (2012) [38].

The result revealed efficient utilization of protein in the diet, with no interference of enzyme activities in the liver to cause damage, confirming that the seed cakes are not toxic and are healthy for feeding. Albumin, globulin and total protein levels were within normal range for healthy birds, indicating good blood clotting ability and protein retention. Fasting the birds before slaughter, levels of tannin and phytic acid in the experimental ingredients and diet, and high temperature during the study could be the reason for low glucose across dietary groups, with least record in GNC and RSC birds. Low blood glucose response to starchy feeds can be tied to high Phytic acid and tannin levels in feed which lower starch digestion [31]. Muscle degeneration to produce ATP, dehydration, and feed restriction before slaughter could be the reason for higher creatinine levels for all the groups. Animals use their reserved energy during feed restriction for a longer period and this could be the reason for the low blood glucose and high creatinine values. Feed and water restriction are amomg the haematological changes that affect domesticated animals [32], this is supported by Etim et al. [2] and Boostani et al. [3]. Sands et al. [33] also reported a decrease in plasma glucose level of broiler chickens under heat stress. Abdalla (2009) [34] reported similar results with a decrease in plasma glucose concentration in broiler chickens during summer as compared to winter.

Feeding Trial 2

Total Blood Count of broiler chickens fed GNC RSC and BSC diets partly substituting soya bean meal

Table 5 showed the total blood count for broiler chickens fed RSC and BSC with and without multienzymes partly substituting SBM.

Multienzymes supplementation significantly (P<0.05) affected PCV and Hb of birds, but dietary inclusion did not affect (P>0.05) their count and they followed the same pattern. Basophils, WBC, lymphocytes, red blood cells and monocytes were not significantly (P>0.05) affected by dietary inclusion across the treatments, except eosinophil level. Muataz [26] reported that Hb and PCV of broiler chickens were not affected neither by dietary inclusion nor the addition of commercial enzymes;

Table 5. Total blood count of broiler chickens fed roselle and baobab seed cakes partly substituting soya bean meal with and without multienyzmes

Parameters	Dietary levels of the seed cakes (kg/100kg diet)					
	SBM	RSC +E	RSC	BSC +E	BSC	LSD
PVC (%)	40.93^{a}	35.40^{b}	36.93^{ab}	35.80^{b}	37.96^{ab}	4.83
Hb(g/dl)	12.06^{a}	10.60^{b}	11.03^{ab}	10.40^{b}	11.06^{ab}	1.30
RBC ($\times10^{12}$/L)	2.93	2.61	2.66	2.68	2.77	0.36
WBC ($\times10^{9}$/L)	8.85	8.41	8.54	8.74	8.20	8.55
Lymphocytes (%)	89.56	90.06	88.86	86.26	91.70	6.40
Monocytes (%)	4.20	3.36	3.56	6.36	3.13	3.74
Eosinophils (%)	3.46^{ab}	3.80^{ab}	4.80^{a}	3.06^{b}	3.13^{b}	1.58
Basophils (%)	0.36	0.23	0.36	0.56	0.10	0.54

^{ab} = Means with different superscripts on the same row are significantly different P < 0.05, RSC= Roselle Seed Cake, BSC = Baobab Seed Cake, SBM = Soya Beans Meal, LSD = Least Significant Difference, E = Multienzymes,*Mitrkuka and Rawnsley, (1997) [22], **Simrak et al., (2004) [23], ***Jain, (1986) [27], ****Jain, (1993) [28]

PCV and Hb means observed in their report were similar with the results in this study. All values obtained were within normal range as reported by Mitrkuka and Rawnsley [22]. Adejumo [39] stated that Hb and PCV correlates with the nutritional status of animals. This showed that nutrient transport was not impaired by feeding the seed cakes to the bird and is an indication for good health. Lymphocytes, monocytes, white blood cells and basophils were within the normal range for healthy birds. Eosinophils values were significant (P<0.05) but within normal range for all the groups. Elevated eosinophil level reveals the presence of certain parasites, viral infection, level of resistance or response of the birds to infection or diseases [24].

Table 6. Serum biochemical profile of broiler chickens fed roselle and baobab seed cake diets partly substituting soya bean meal with and without multienyzmes

Parameters	Dietary Levels of the Seed Cakes (kg/100kg diet)						
	SBM	RSC+E	RSC	BSC+E	BSC	LSD	Normal range
Glucose (g/dL)	89.97	87.49	88.80	94.79	88.43	10.72	199.00-348.00**
Blood Urea Nitrogen (mg/100ml)	4.24	3.88	3.84	3.85	3.70	0.59	1.50-8.30*
Albumin (g/L)	1.05^{ab}	1.13^{ab}	1.43^{a}	1.26^{ab}	0.87^{b}	0.43	1.10-2.20***
Globulin (g/L)	5.53^{ab}	4.43^{b}	4.21^{b}	6.08^{a}	6.11^{a}	1.61	1.20-3.20****
Total Protein (g/L)	6.59^{ab}	5.56^{b}	5.64^{b}	7.44^{a}	7.05^{ab}	1.59	3.60-5.50***
Creatinine (mg/100ml)	0.73	0.78	0.92	0.79	0.91	0.21	0.10-0.40^{M}
Aspartate Amino Transferase(µL)	52.73	51.50	51.56	59.66	58.29	11.19	150.00-278.00**
Alkaline Phosphatase (µL)	70.36^{b}	72.23^{ab}	79.13^{ab}	84.70^{a}	82.33^{ab}	12.72	10.00-106.00*****
Alanine Amino Transferase (µL)	20.50^{b}	20.86^{b}	19.46^{b}	24.63^{a}	21.70^{ab}	3.56	9.50-37.20*

^{ab} = Means with different superscripts on the same row are significantly different P < 0.05 SBM = Soya Bean Meal, RSC = Roselle Seed Cake, BSC = Baobab Seed Meal, E = Multienzyme, LSD = Least Significant Difference, *Mitruka and Rawnsley 1997 [22], **CDD (1990) [35], ***Ross *et al*. (1976) [36], ****LAVC (2009) [37] *****Bounous and Stedman (2000) [29], ^{M}Merck (2012) [38].

Serum Biochemical Profile of broiler chickens fed RSC and BSC with and without multienzymes partly substituting SBM

Biochemical profile of broiler chickens fed RSC and BSC with and without multienzymes partly substituting SBM is presented in Table 6. Globulin, total protein and albumin, ALP and ALT were significant (P<0.05), while creatinine, urea, AST and blood glucose were not significant (P>0.05).

Biochemical profile of birds was not significantly affected by dietary inclusion and multienzymes supplementation. High creatinine and low glucose levels observed were lower than the normal ranges for broiler chickens, elevated levels could be due to fasting and dehydration before slaughter, as a result of muscle degeneration and utilization of stored energy to produce adenosine triphosphate (ATP). This agreed with the findings of Onyishi et al. [40] that age, nutrient conditions and feed restriction, breed, and water restriction are among the factors that affect blood profile of domesticated animals [41]. Alanine aminotransferase and ALP were within normal for all groups except for SBC, RSC + E and RSC, higher level within normal range compared to other treatment means for BSC with and without multienzymes could be indicating lower protein metabolism in blood for the birds fed those diets. Lower level of ALP in birds fed SBC showed that hydrolyses of phytates to organic phosphorus was not impaired due to its presence in the diet. From the result, the liver was in good shape and was not affected by the dietary inclusion and enzyme supplementation.

Conclusions

Partial supplementation of broiler chicken diets with 20% roselle and baobab seed cakes did not affect the total blood count and serum biochemical profile of broiler chickens. Furthermore, the addition of enzymes to BSC and RSC diets has no effect on the blood profile of the broiler chicken.

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