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Research Article

Effect of Phytate Enzyme Supplementation in Cooked Baobab Seed Meal Diets on Broiler Chickens' Health and Nutrient Digestion

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ABSTRACT

Introduction: Phytate poses a significant challenge in poultry nutrition due to its anti-nutritional properties. Phytate is one of the antinutritional factors that is considered harmful to broilers. This study aimed to evaluate the impact of incorporating phytase enzymes on the health of chickens and their ability to digest nutrients from the baobab seed meal.

Materials and methods: A total of 240 broiler chickens of mixed sexes, averaging 980 grams in weight, were allocated to the four dietary treatment groups, each replicated four times, with 15 birds per replicate. Enzyme supplementation was administered at 0 and 200 ppm levels, while cooked baobab seed meal (CBSM) inclusion levels were set at 0 and 20%, respectively. Treatment 1 (T1) served as the negative control, containing zero enzyme and CBSM. Treatment 2 (T2) acted as the positive control, comprising 200 ppm of enzyme without CBSM. Treatment 3 (T3) contained 20% CBSM without enzyme supplementation, and Treatment 4 (T4) comprised 20% CBSM supplemented with 200 ppm of enzymes.

Results: The results indicated that incorporating cooked CBSM into broiler diets at a 20% inclusion level led to an increase in crude protein content from 19.08% to 19.19% in finisher diets. Notably, supplementation with 200 ppm of phytase significantly enhanced total albumin levels (from 21.30 to 25.56 g/dl). Moreover, the interaction between phytase and CBSM resulted in elevated levels of total cholesterol (4.35 mmol/l), total albumin (26.62 g/dl), and Uric acid (295.95 µmol/l). However, the addition of CBSM led to decreased crude fiber digestibility (from 58.82% to 53.42%) and nitrogen-free extract (from 69.74% to 65.64%). The interaction between phytase and CBSM further diminished dry matter, ether extract, crude fiber, and nitrogen-free extract, particularly evident in the treatment group receiving 20% CBSM with 0 ppm of phytase. However, when the diet supplemented with 200 ppm of phytase, the interaction maintained statistically similar results throughout compared to T1 (0% CBSM + 0 ppm). Regarding microbial count, T4 exhibited lower levels of Escherichia coli and no detectable Shigella species.

Conclusion: Twenty percent CBSM plus phytase enzyme supplementation resulted in the improvement of total cholesterol, total albumin, and Uric acid.

1. Introduction

Poultry production stands as a vital component within the livestock industry, offering a rapid avenue to bolster animal protein provision. With its contribution of meat and eggs, this sector holds promise in addressing the prevalent

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animal protein deficiency observed across Nigeria[1]. However, the poultry industry faces significant constraints, primarily revolving around nutrition and disease management. Notably, in Nigeria, commercial poultry operations grapple with substantial expenses, with feed constituting 70-80% of total costs[2]. The challenge is exacerbated by the limited availability of feed resources in developing nations like Nigeria, where competition from both human consumption and the broader livestock sector intensifies[3]. The reason for the high cost of traditional poultry feed is the competition in feed resources among poultry, humans, and ever-expanding intensive livestock production. Researchers and feed manufacturers have been searching for low-cost alternative feed ingredients that are readily available, inexpensive, and have limited nutritional relevance for humans as a way of reducing feed costs and maximizing returns of investment from poultry farming. The use of non-conventional sources of protein such as ground nut cake, and soya bean, to supplement poultry diets and reduce production costs is one alternative solution.

Many non-conventional feedstuffs (NCF) have been studied, and researchers are now focusing on the potential of lesser-known, overlooked, and underexploited trees that are native to Africa as a source of protein and energy. Baobab (*Adansonia digitata*) tree is produced all year round in the savannah and desired savannah area of Nigeria. Baobab is easily found in the Northeastern part of Nigeria, including Borno, Yobe, Bauchi, Gombe, and Adamawa, where it is also widely utilized as food. The baobab fruit contains several seeds embedded in a whitish pulp that can be eaten as a sweetener or made into a refreshing beverage after soaking in water or milk. It is also used to adulterate and curdle milk[4]. The consumption of seeds and their use in the forest and derived savanna region of Nigeria is not common. Baobab seed is a protein-rich food source that provides a significant amount of energy[5] meanwhile, the fruit pulp is an excellent source of Vitamin C[6]. In Nigeria, it is widely distributed in the savannah regions[7]. Therefore, the current study aimed to assess the effectiveness of the dietary incorporation of cooked baobab seed meal (CBSM) and phytase enzyme supplementation.

2. Materials and Methods

2.1. Ethical approval

The study was approved and conducted in line with the instructions of the Animal Care and Use Research Committee of the Nasarawa State University Keffi, Nigeria. All animals were humanly handled during the experiment. The approval number is NSUK-ACUREC/BCH/24/03-36/01/2024

2.2. Experimental site

The experiment was carried out at Ibas Poultry Farm, number 117 Ibrahim Barde Street Keffi, Nasarawa State. Keffi is located in the Guinea Savanna zone of North Central Nigeria. It is found on latitude 08° 35'N and longitude 08° 33'E. The mean monthly maximum and minimum temperatures are 35. 06^{0}C and 20.16^{0}C respectively while the mean monthly relative humidity is 74%. The average rainfall is about 1168. 90mm[8].

2.3. Source of feed ingredients and Processing of baobab

The baobab seeds were procured from two markets, Mafa and Gomboru, in Borno State, Nigeria while other ingredients including phytase enzymes were obtained from Novum Agric Industries Ltd. in Keffi town of Nasarawa State, Nigeria. The baobab seeds were de-husked from the pulp and washed with clean water. After drying, they were added to boiling water at a temperature of 45^{0}C and cooked for 30 minutes. The CBSM was then oven-dried and ground using a grinding machine. Subsample was analysed for proximate composition Table 1.

Table 1. Percent chemical composition of cooked baobab seed meal in broiler chickens' diet

Parameters (%)	Value
Dry matter	94.75
Crude protein	20.93
Ether extract	3.92
Crude fibre	6.44
Ash	5.25
Nitrogen free extract	51.84
Metabolisable Energy (kcal/kg)	2932.27

2.4. Source of experimental birds

A total of 240 four-week-old broiler chickens (COBB 500), consisting of mixed sexes and averaging 980 ± 75.74 grams in weight, was procured from Olam Hatcheries Limited. The hatchery is situated at Km 25, Kaduna-Abuja expressway, Nigeria.

2.5. Experimental design

Two hundred and forty broiler chickens, each with comparable live weights averaging 980 ± 75.74 grams, were randomly allocated to treatment groups using a 2x2 factorial arrangement, implemented within a completely randomized design framework.

2.6. Experimental diets for finisher birds

Four diets named T1, T2, T3, and T4 were formulated to be isonitrogenous (19%) and isocaloric (3000 kcal\kg, ME). The control diet was the T1 which contained no cooked baobab seed meal or any enzymes. The T2 diet had no baobab seed but had 200 ppm enzymes added. The T3 and T4 diets had 20% CBSM with 0 and 200 ppm of enzyme supplementation, respectively. Other ingredients were included to make up the required nutrients for this class of finisher chickens (Table 2).

Table 2. Composition of nutrients in the experimental diets for broiler finisher

Ingredients	(%) inclusion of baobab seed meal			
	T1 (0%cbsn+0ppm)	T2 (0%cbsm+200ppm)	T3 (20%cbsm+0ppm)	T4 (20%cbsm+200ppm)
Soybean (full fat)	10.00	10.00	10.00	10.00
CBSM*	0.00	0.00	20.00	20.00
Rice bran	5.00	5.00	5.95	5.95
Maize bran	25.00	25.00	25.00	25.00
Groundnut cake	10.95	10.95	10.00	10.00
Maize	41.00	41.00	21.00	21.00
Palm oil	4.00	4.00	4.00	4.00
Blood meal	3.00	3.00	3.00	3.00
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
**Premix	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30
Total (kg)	100kg	100kg	100kg	100kg
Phytate enzyme	0ppm	200ppm	0ppm	200ppm
Calculated nutrient and energy composition				
Energy (kcal/kg, ME)	3000.21	3000.21	3000.74	3000.74
Protein (%)	20.13	20.13	20.18	20.18
Lysine (%)	1.16	1.16	1.30	1.30
Methionine (%)	0.54	0.54	0.63	0.63
Ether extract (%)	9.68	9.68	9.70	9.70
Crude fibre (%)	5.67	5.67	5.70	5.70
Calcium (%)	0.71	0.71	0.71	0.71
Phosphorus (%)	0.53	0.53	0.54	0.54
Ash (%)	3.19	3.19	3.28	3.28

*CBSM : Cooked baobab seed meal inclusion levels. **premix supplied the following per 100kg of diet: Vitamin A 15,000 I.U, Vitamin D3 300,000 I.U., Vitamin E 3,000 I.U., Vitamin K 2.50mg, Vitamin B_1 (thiamin) 200mg, Riboflavin (B_2) 600mg, pyridoxine (B_6), Niacin 40.0mg, Vitamin B_{12} 2mg, Pantothenic acid 10.0mg, folic acid 100mg, Biotin 8mg, choline chloride 50mg, anti-oxidant 12.5mg, manganese 96mg, zinc 6mg, Iron 24mg, Copper 0.6mg, Iodine 0.14 mg, Selenium 24 mg, cobalt 214mg.

2.7. Management of birds

The broiler chickens were distributed 16 units (7 *7 square feet). Each unit had feeders and drinkers. Electric bulbs were provided at night to enable the birds to eat both day and night (20-21^{0}C and a relative humidity of 55-60%). The birds were given weighed amounts of the diets and had drinking water available *ad-libitum*. All routine management practices such as daily washing of drinkers and changing water, cleaning of pens when necessary, repairing of pens, and daily inspection were strictly followed.

2.8. Data collection

2.8.1. Nutrient digestibility trial

During the final 7 days of the feeding trials, fecal collection for digestibility studies was conducted over a period of 3 weeks in each of the four units. Prior to fecal collection, the birds underwent a 12-hour fasting period to standardize the process, with fecal collection commencing and concluding at the beginning and end of this fasting period, respectively. The collected poultry droppings were then dried in an oven at a temperature of 1050 ^{0}C for 18 hours and weighed on a daily basis. After the gathering, the daily collected fecal samples from each replicate were combined, ground, and extensively to achieve a uniform mixture, and proximate analysis was carried out based on standard methods[9]. The apparent digestibility was calculated using a predefined formula

$$\text{Apparent digestibility coefficient} = \frac{\text{Nutrients in feed} - \text{Nutrients in faeces}}{\text{Nutrients in feed}} \times \frac{100}{1}$$

2.8.2. Serum biochemical analysis

aminotransferase (ALT) and Aspartate aminotransferase (AST).

Blood samples were collected using anticoagulant-free sample bottles and 5ml sterile syringes from the wing vein, obtaining 2ml of blood for serum biochemical analysis. Commercial kits provided by RANDOX® in Nigeria were employed for the analysis, following the protocol outlined by Aguihe et al.[10]. The serum biochemical parameters assessed included Total protein, Albumin, Globulin, Albumin/Globulin ratio, Glucose, Lipid profile (including Triglycerides and Cholesterol), Creatinine, Electrolytes (Calcium, Phosphorus, and Magnesium), as well as liver enzymes Alanine Aminotransferase (ALT) and Aspartate Aminotransferase (AST).

2.8.4. Apparent digestibility coefficient

Fecal samples were gathered during the last seven days of the feeding trials over a week. Three birds in each of the four units were utilized for digestibility studies. The poultry droppings were collected after 12 12-hour feeding period to ensure the gut was empty. These poultry droppings were used to mark the start and end of the collection period. Every day, the collected poultry droppings were weighed and oven-dried at 105^{0}C for 18

hours. The fecal samples collected at the end of each day's replicate were combined, processed, and mixed thoroughly to obtain a uniform and consistent mixture. Proximate analysis was performed on samples of the poultry droppings using standard methods[9]. The analysis results were utilized for computing the apparent digestibility with the aid of the formula mentioned below[11].

$$\frac{\text{Nutrients in feed} - \text{Nutrients in faeces}}{\text{Nutrients in feed}} \times \frac{100}{1}$$

2.8.6. Microbial assay of the Gastrointestinal tract

Gut contents were collected from the caecum to determine the microbial cell numbers for *Escherichia coli*, *lactobacilli spp*., *clostridium*, *salmonella spp.*, *bacillus spp.*, *shigella*, *pseudomonas*, and *Klebsiella* using microbact 12E kit and conventional biochemical methods[12]. This was conducted at the Department of Microbiology Laboratory, Nasarawa State University, Keffi, Nigeria.

2.9. Statistical analysis

A factorial experiment was conducted, and the resulting data obtained was subjected to a two-way analysis of variance (ANOVA) using the SPSS model 22. Duncan's Multiple Range Test was used to discern mean differences[13].

The model used for statistics was: Yijk = U +Ai +Bk + (AB)ij +eijk, where Yijk represents individual observation, U is the population mean, Ai denotes the effect of cooked baobab seed meal (CBSM), Bk signifies enzymes effect, and ABij determines the effect of the interaction of CBSM and enzymes.

3. Results

3.1. Percent chemical composition of cooked baobab seed meal

The results for the percent chemical composition of cooked baobab seed meal (Table 1) revealed 20.93% crude protein, 3.92% crude fat, 6.44% crude fiber, 5.25% ash, 51.84% nitrogen-free extract, 94.75% dry matter, and 2932.27 kcal/kg of metabolizable energy.

3.2. Serum biochemistry

Table 3 shows the main effect of cooked baobab seed meal on the serum biochemistry of broiler finisher chickens fed for 28 days. Phytase enzyme exhibited no significant impact across serum biochemical parameters of broiler chickens, except for total albumin (21.30 vs. 25.56 g/dl). Birds fed T4 demonstrated higher total albumin levels compared to T2 and T1 ($p < 0.05$), indicating a potential interaction between phytase and CBSM in the diet. Furthermore, this interaction between phytase and CBSM led to increased levels of total cholesterol (4.35 mmol/l), albumin (26.62 g/dl), and uric acid (295.56 µmol/l), respectively.

Table 3. Main effects of cooked baobab seed meal on serum biochemistry of broiler finisher chickens (28 days)

Parameters	Treatment groups				
	T1	T2	T3	T4	LOS
Total cholesterol (mmol/L)	3.47	3.70	4.00	3.77	NS
Aspartate aminotransferase (µ/l)	31.81	30.06	32.58	34.33	NS
Total protein (g/dl)	33.07	32.92	35.58	35.58	NS
Total albumin (g/dl)	22.21^{b}	21.30^{b}	24.65^{ab}	25.56^{a}	NS
Uric acid (µmol/l)	219.15	219.76	243.97	243.36	NS
Globulin (g/dl)	9.31	12.25	12.11	9.17	NS

^{ab} means on the same row having different superscripts differ significantly ($p < 0.05$); NS: Not significantly different ($p > 0.05$); SD: Standard deviation; LOS: Level of significance; CBSM: Cooked baobab seed meal, %: percentage; T1: 0% cbsn+0 ppm, T2: 0% cbsm + 200 ppm, T3: 20%cbsm + 0 ppm, T4: 20%cbsm + 200ppm

Table 4. Interactive effects of phytase enzyme supplementation and cooked baobab seed meal on serum biochemistry of broiler finisher (28 days)

Parameters	CBSM	Phytase Enzymes		SD	LOS
		0 ppm	200 ppm		
Total cholesterol (mmol/L)	0%	3.75^{ab}	3.20^{b}		
	20%	3.65^{ab}	4.35^{a}	3.72	*
Aspartate aminotransferase (µ/l)	0%	30.00	33.62		
	20%	30.12	35.05	36.75	NS
Total protein (g/dl)	0%	31.80	34.35		
	20%	34.05	36.82	42.13	NS
Total albumin g/dl	0%	19.92^{b}	24.50^{a}		
	20%	22.67^{ab}	26.62^{a}	21.38	*
Uric acid (µmol/l)	0%	247.52^{ab}	190.77^{b}		
	20%	192.00^{b}	295.95^{a}	459.74	*
Globulin (g/dl)	0%	10.10	8.52		
	20%	14.40	9.82	52.51	NS

^{ab}means on the same column having different superscripts differ significantly ($p<0.05$); NS: Not significantly different ($p > 0.05$); SD: Standard deviation; LOS: Level of significance; CBSM: Cooked baobab seed meal

Table 5. Effects of cooked baobab seed meal on nutrient digestibility of broiler finisher (28 days)

Parameters (%)	Treatment group		SD	LOS
	T1 (0%CBSM)	T3 (20%CBSM)		
Dry matter	91.96	90.80	5.73	NS
Crude protein	90.52	89.56	9.29	NS
Ether extract	53.10	47.78	30.05	NS
Crude fibre	58.82[a]	53.42[b]	17.04	*
Ash	73.97	70.60	17.04	NS
Nitrogen free extract	69.74[a]	65.64[b]	20.14	*

[ab] means on the same row having different superscripts differ significantly ($p<0.05$); NS: Not significantly different ($p > 0.05$); SD: Standard deviation; LOS: Level of significance; CBSM: Cooked baobab seed meal.

3.3. Apparent nutrient digestibility coefficient

Table 5 presents the effect of cooked baobab seed meal on the apparent nutrient digestibility of broiler chickens fed for 28 days. A significant reduction was observed in crude fiber (58.82% to 53.42%) and nitrogen-free extract (69.74% to 65.64%) only ($p < 0.05$). However, dry matter, crude protein, ether extract, and ash were not statistically significant ($p > 0.05$). Chickens fed 20% CBSM exhibited lower crude fiber (53.42%) and nitrogen-free extract (65.64%) compared to those fed 0% CBSM.

On the other hand, phytase enzyme supplementation had no effect on any of the apparent nutrient digestibility parameters (Table 6). However, the interaction between phytase enzyme and CBSM (Table 7) revealed a significant reduction in dry matter (92.69% to 90.34%), ether extract (56.04% to 50.15%), ash (75.96% to 69.06%), and nitrogen-free extract (72.13% to 63.88%) for chickens fed 20% CBSM + 0 ppm phytase enzyme (T3) only ($p < 0.05$). Nevertheless, chickens fed 20% CBSM + 200 ppm (T4) showed no significant differences compared to the control groups (0% CBSM + 0 ppm, T1, and 0% CBSM + 200 ppm, T2).

Table 6. Effects of phytase enzyme supplementation on nutrient digestibility of broiler finisher (28 days)

Parameters (%)	0ppm	200ppm	SD	LOS
Dry matter	91.51	91.25	5.73	NS
Crude protein	90.02	90.07	9.29	NS
Ether extract	50.60	50.28	30.05	NS
Crude fibre	56.71	55.54	26.02	NS
Ash	72.51	72.06	17.04	NS
Nitrogen free extract	68.00	67.37	20.14	NS

[ab] means on the same column having different superscripts differ significantly ($p < 0.05$); NS: Not significantly different ($p > 0.05$); SD: Standard deviation; LOS: Level of significance; CBSM: Cooked baobab seed meal

3.4. Microbial assay of the gut content (caecum)

The result of the effect of baobab meal and phytase enzyme supplementation on the microbial assay of the gut content (caecum) of broiler chickens is presented in Table 7. The results revealed heavy growth of *Escherichia coli* (+++) across all treatments except in T4, where it was moderate (++) in growth. Additionally, *Klebsiella*, *Salmonella* spp., and *Pseudomonas* were present across all treatments. Notably, *Shigella* showed no growth except in T3, where it was indicated as small in growth (+).

Table 7. Interactive effects of phytase enzyme supplementation and cooked baobab seed meal on nutrient digestibility of broiler finisher (28 days)

Parameters (%)	CBSM	Phytase Enzymes		SD	LOS
		0ppm	200ppm		
Dry matter	0%	92.69[a]	91.24[ab]		
	20%	90.34[b]	91.26[ab]	8.21	*
Crude protein	0%	91.22	89.82		
	20%	88.81	90.32	13.17	NS
Ether extract	0%	56.04[a]	50.15[ab]		
	20%	45.16[b]	50.40[ab]	2.75	*
Crude fibre	0%	62.32[a]	55.33[ab]		
	20%	51.10[b]	55.75[ab]	42.60	*
Ash	0%	75.96[a]	71.98[ab]		
	20%	69.06[b]	72.14[ab]	24.01	*
Nitrogen free extract	0%	72.13[a]	67.35[ab]		
	20%	63.88[b]	67.40[ab]	28.50	*

[ab] means on the same row having different superscripts differ significantly ($p < 0.05$); NS: Not significantly different ($p > 0.05$); SD: Standard deviation; LOS: Level of significance; CBSM: Cooked baobab seed meal

Table 8. Effect of baobab meal and phytase enzyme supplementation on microbial assay of the gut content (caecum) of broiler finisher (28 days)

Treatments	Microbial types	Microbial load along caecum
0%CBSM+0ppm	*Escherichia coli*	+++
	Shigella spp.	-
	Klebsiella spp.	++
	Salmonella spp.	++
	Pseudomonas spp.	++
0% CBSM +200ppm	*Escherichia coli*	+++
	Shigella spp.	-
	Klebsiella spp.	++
	Salmonella spp.	++
	Pseudomonas spp.	++
20% CBSM +0ppm	*Escherichia coli*	+++
	Shigella spp.	+
	Klebsiella spp.	+
	Salmonella spp.	++
	Pseudomonas spp.	++
20% CBSM +200ppm	*Escherichia coli*	++
	Shigella spp.	-
	Klebsiella spp.	++
	Salmonella spp.	++
	Pseudomonas spp.	++

CBSM : Cooked baobab seed meal; Spp: species, +++ heavy growth, ++ moderate growth, + minute growth, – no enteric pathogen isolated

4. Discussion

The significant enhancement in ether extract digestibility (64.74%) observed in broiler starter chicks fed 20% CBSM compared to those fed 0% CBSM suggests that baobab contains more digestible fat, providing birds with increased energy for growth and development. Similarly, the notable increase in the digestibility of crude fiber (37.33%) and ash (30.78%) in birds fed 200 ppm of phytase enzyme can be attributed to enzyme supplementation. This finding aligns with the general understanding that enzyme supplementation aids in

releasing more nutrients for digestion and enhances mineral ion availability. By enhancing thermo-stability and supplying calcium, phosphorus, and other mineral ions, exogenous enzymes facilitate the breakdown of phytate-bound minerals, making them more readily absorbable. These results support the assertions made by previous studies, which highlight the benefits of exogenous enzyme supplementation, including improved nutrient utilization and efficiency, reduction of anti-nutrients, and enhancement of feed digestibility[14,15]. The significant decrease in dry matter digestibility (46.39%) observed in birds fed T4 (20%CBSM + 200ppm) and the improvement in crude fiber (39.17%) and ash (32.21%) digestibility may be attributed to the interaction between baobab and enzymes. Similarly, the enhanced digestibility of crude protein (73.08%) and ether extract (65.27%) in birds fed T3 (20%CBSM + 0ppm) is likely associated with the absence of enzymes in the diet. These observations underscore the interactive effects of both enzymes and baobab in the diets, influencing nutrient digestibility in broiler chickens.

A noticeable decrease in the digestibility of crude protein (53.42%) and nitrogen-free extract (65.64%) was observed in birds fed 20% CBSM. This decline appears to be correlated with the presence of anti-nutrients in baobab seeds. Consequently, the digestion of these nutrients, particularly nitrogen-free extract, which serves as a crucial source of carbohydrates for energy, was significantly hindered. This finding contradicts Aftab et al.[16], who reported significantly higher apparent nutrient digestibility in birds fed diets containing baobab pulp seed meal. However, the lack of significant differences across some measured nutrient digestibility coefficients can be attributed to phytase enzyme supplementation. This finding contrasts with Omole et al.[17], who observed a significant increase in crude protein and crude fiber digestibility in broiler chicks fed diets containing Hamecozyme enzyme.

Additionally, this aligns with Salama et al.[18], who found that crude protein, crude fiber, ether extract, nitrogen-free extract, and nutritive value in terms of digestible crude protein and total digestible nutrients did not significantly differ between control diets and enzyme supplementation. However, a reduction in the digestibility of dry matter (90.34%), ether extract (45.16%), crude fiber (51.10%), ash (69.06%), and nitrogen-free extract (63.88%) for chickens fed T3 (20% BM + 0 ppm) was associated with the higher inclusion of baobab seed meal, which may contain anti-nutritional factors that need to be removed by enzyme supplementation. This finding is in agreement with Agboola et al.[15] who reported that apparent nutrient digestibility in broiler chickens was significantly improved with enzyme supplementation.

The non-significant differences observed in the serum biochemical indices suggest that an increase in baobab seed meal from 0% to 20% in the diet of broilers does not significantly affect serum biochemical parameters. This finding supports previous research by Sola-Ojo et al.[19] when broiler chickens were fed cooked baobab seed meal. However, the significant increase in total albumin (25.56 g/dl) for birds fed 200 ppm of phytase indicates that enzyme supplementation influences certain serum biochemical parameters. The observed increase in albumin values may be attributed to the efficacy of phytase supplementation. This finding aligns with the results of Hajati et al.[20], who reported that enzyme supplementation influenced serum albumin levels in broiler chickens.

Nonetheless, non-significant values indicate nutritional adequacy, which can be determined by reflecting the amount and quality of protein. According to Omoikhoje et al.[21] and Eggum[22], high serum protein and albumin values are indicative of high-quality diets. The increase in total cholesterol (4.35 mmol/l), albumin (26.62 g/dl), and uric acid (295.95 µmol/l) for birds fed T4 (20% CBSM + 200 ppm) may be attributed to the mechanism of action of phytase in the utilization of cooked baobab seed meal in the diets.

5. Conclusion

In conclusion, the inclusion of 20% CBSM with phytase enzyme supplementation resulted in improvements in total cholesterol (4.35 mmol/l), total albumin (26.62 g/dl), and uric acid (295.95 µmol/l). However, it was observed that CBSM alone depressed the digestibility of dry matter, ether extract, crude fiber, and nitrogen-free extract, particularly at the 20% inclusion level. Further research is therefore recommended to explore the potential benefits of baobab on poultry production, especially when subjected to different processing methods. Investigating how various processing techniques affect the nutritional composition and digestibility of baobab seed meal could provide valuable insights into optimizing its use as a feed ingredient in poultry diets. Additionally, examining the potential interactions between baobab and enzyme supplementation in greater detail may help elucidate strategies to mitigate the negative effects observed and maximize the nutritional benefits for poultry.

Declarations

Competing interests

The declaration made by the authors affirm that they do not have any conflicting interests.

Authors' contributions

The study conception and design were contributed by Owie Parmata Abba, Samuel Emmanuel Alu was responsible for the study concept, design, and supervision, Ramalan Hudu Abdullahi to the data collection and analysis, and Muhammad Umar Dogara contributed to the data collection and first draft of the manuscript, Bawa Mohammed was responsible for material preparation and data collection. All the authors read and approved the final revision of the manuscript.

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Availability of data and materials

The datasets generated during the current study are available from the corresponding author upon reasonable request.

Ethical considerations

All authors have approved the publication of this manuscript and confirm that its content will not be copyrighted, submitted, or published elsewhere while it is under consideration for publication by this journal.

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