



Response of Broilers Finisher Chickens to Dietary Boiled Baobab Seeds

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Abstract

One hundred sixty day old Cobb broiler chicks (initial weight: 41.05 ± 0.31 g) used to evaluate the effect of boiled baobab (*Adansonia digitata*) seeds on broiler performance, haematological parameters and economic appraisal. The experiment was arranged in a completely randomized design (CRD) consisting of four treatments replicated four times. Each replicate contains 10 birds, housed in 1 m² pens with wood shavings litter. The inclusion levels of boiled baobab seeds in the finisher diets were 0, 10, 15 and 20%. The results indicated that the higher significant ($P \leq 0.05$) finisher and overall feed intake was observed in birds fed on 15% boiled baobab seeds versus control, however, there were no significant ($P \geq 0.05$) differences compared to the other dietary treatments. Birds fed on 10% boiled baobab seeds achieved significantly ($P \leq 0.05$) improved finisher and overall feed conversion ratio and protein efficiency ratio compared to those fed on 20%. However, there were no significant ($P \geq 0.05$) differences compared to the other dietary treatments. Bird fed 10% baobab yielded the highest finisher and overall weight gain (1805.0 g and 2595.4 g, respectively). Finisher body weight gain of birds fed 10% was significantly ($P \leq 0.05$) higher versus control. Nevertheless, there was no significant ($P \geq 0.05$) difference compared to the other dietary treatments. No significant differences ($P \geq 0.05$) were detected in haematological indices or meat quality among the dietary treatments. The best feed cost per kilogram of meat, economic efficiency index (EEI) and cost index (CI) showed by birds fed 10%, 0%, 15% and 20%. In conclusion, inclusion of boiled baobab seeds up to 15% did not adversely affect broiler performance. Moreover, 10% inclusion optimized growth efficiency and economic appraisal, making it a viable nutritional strategy for broiler production.

Keywords: Baobab seeds, Broiler, Economic appraisal, haematology.

Introduction

Poultry production plays a vital role in meeting the global demand for affordable animal protein, particularly in developing countries where broiler chickens serve as a major source of meat (FAO, 2021). However, the increasing costs and fluctuating availability of conventional feed ingredients such as soybean meal and maize have necessitated to explore alternative, locally available, and cost-effective feed resources (Makkar, 2018). Among such alternatives, the baobab tree (*Adansonia digitata*), native to sub-Saharan Africa, has received growing attention due to its nutritional and medicinal properties. Baobab seeds, a by-product of fruit processing, are rich in protein, fat, and essential amino acids (Osman, 2004). However, their use in poultry diets has been limited due to the presence of anti-nutritional factors such as tannins and phytates (Yagoub and Ahmed, 2015). Heat treatment, particularly boiling, has been shown to effectively reduce these anti-nutritional compounds and enhance the nutritional value of legume and oilseed meals (Akinmutimi, 2004 and Aletor *et al.*, 2007). Incorporating boiled baobab seeds (BBS) into broiler diets may therefore offer a viable nutritional and economic strategy, particularly in regions where baobab is abundant and underutilized. Baobab seeds reported to contain 20–36% crude protein and an energy content of 3000–4500 Kcal/kg (Murray *et al.*, 2001), along with essential vitamins and minerals. It is high vitamin C content, with reports indicating 4.78 ± 1.02 g/kg in baobab fruit (Parkouda *et al.*, 2012). Vitamin C, a powerful antioxidant, plays a critical role in stabilizing unsaturated fatty acids in poultry products, which are particularly susceptible to lipid peroxidation. This oxidative degradation not only affects the sensory



and nutritional quality of the meat but may also pose health risks to consumers (Martens *et al.*, 2013 and Bolu and Olatunde, 2009). Although studies have explored the effects of baobab seed cake and pulp on poultry performance, limited research has focused on baobab seeds effect on broiler performance, carcass characteristics, and lipid oxidation in poultry meat. Given its nutritional density and high vitamin C content, it is hypothesized that processed baobab seeds could enhance broiler performance and improve product quality (Mwale *et al.*, 2008). The objective of this study was to study the effect of feeding different level of boiled baobab seeds on broiler performance, carcass characteristic, internal organs, haematology, meat quality and economic appraisal.

Materials and Methods

Experimental Birds

A total of 160 unsexed, day old Cobb broiler chicks were purchased from a commercial hatchery. Upon arrival, the chicks were individually weighed (average body weight: $42.2 \text{ g} \pm 0.06$) and randomly allocated to four dietary treatment groups, each comprising 40 birds. Each treatment group was further subdivided into four replicates of 10 birds each.

Housing

The experiment was conducted from December 31st, 2022, to February 11th, 2023, at the Poultry Unit of the Department of Animal Production, Faculty of Agricultural Technology and Fish Science, Al Neelain University. Birds were housed in an open-sided poultry house oriented along an east-west axis to optimize natural ventilation. The facility was partitioned into 16 identical pens (1 m² each) constructed using iron posts and wire mesh. The floor consisted of cemented red bricks, and the roof was made of corrugated iron sheets.

Experimental Diets

Baobab seeds used in the study were brought from the local market in Alobid, North Kordofan State. Baobab seeds were cleaned, washed, and boiled at 100° in tap water for 60 minutes, with change of water at 20 minutes interval. In each case, water was brought to boil at 100° and the seeds were poured into it. Boiling continued at 100-105° during the interval (20, 40 and 60 min) starting from the commencement of boiling. Thereafter, boiled seeds were dried in sun for 72 hours and ground. Samples of boiled baobab seeds were taken for chemical analysis according to (AOAC, 1990) method of analysis. Proximate chemical composition of boiled baobab seeds is shown in Table 1. Four isocaloric and isonitrogenous experimental diets were formulated according to NRC (1994) recommendations. Boiled baobab seeds were used to formulate four finisher diets at 0% (A), 10% (B), 15% (C), and 20% (D) inclusion levels, partially replacing sorghum. For the first week, chicks were fed a pre-starter diet, followed by a starter diet for the second and third weeks. The composition of the starter diet and the finisher diets are shown in Table 2. The experiment started in the finisher phase (4-6) weeks.

Management

Prior to the arrival of the chicks, the house was thoroughly cleaned, washed, and disinfected using a phenol-based solution. A 5-inch layer of dry wood shavings was used as bedding material. Each pen was equipped with a tube feeder and a fountain drinker. Continuous lighting was provided for 24 hours daily, serving both as illumination and heat during the brooding period. Feed and water were offered *ad libitum*, and drinkers were cleaned and refilled twice daily. Vaccination protocols included a combined vaccine against Infectious Bronchitis (IB) and Newcastle Disease (Clone) at 5 days of age, followed by Infectious Bursal Disease (Gumboro) at 2 and 3 weeks, and a booster for Newcastle Disease (Clone) at 4 weeks of age.

Experimental Procedures

Weekly feed intake and body weight gain were recorded on a pen basis. Mortality was monitored daily and used to adjust feed intake accordingly. Feed conversion ratio (FCR) was calculated as the ratio of feed consumed to weight gained, while Protein efficiency ratio (PER) was computed as the ratio of weight gain to protein intake. At the end of the trial, birds were fasted overnight with free access to water. One bird per pen (four per treatment) was randomly selected, weighed, and leg-tagged. Birds were slaughtered via jugular vein cut, scalded at 60°C, manually plucked, and eviscerated. The hot carcass weight was recorded, and internal organs (liver, heart, gizzard, intestine, abdominal fat) were individually weighed. Organ and cuts weights (breast, thigh, wing and drumstick) were expressed as percentages of dressed carcass weight. Intestinal length was also measured.

Blood Sample Collection

Blood samples (5 ml) were collected from the wing vein of two birds per treatment group using sterile syringes. A 2 ml aliquot of each sample was transferred into EDTA tubes for hematological analysis.

Hematological parameters including white blood cells (WBC), red blood cells (RBC), hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), red cell distribution width – standard deviation (RDW-SD), red cell distribution width – coefficient of variation (RDW-CV), platelet count (PLT), and lymphocyte percentage (LYM%) were measured using a hematology analyzer as described by Jain (1986).

Sensory evaluation

Sensory evaluation was conducted to assess the color, juiciness, tenderness, and flavor of cooked poultry meat samples. Semi-trained panelists of 10 members were used for the evaluation. Each panelist received coded breast meat samples that had been cooked under standardized conditions (180°C for 35 minutes in a convection oven) and allowed to cool to 40°C before evaluation. The sensory attributes were assessed using a 9-point hedonic scale, where 1 = extremely undesirable and 9 = extremely desirable (Meligaard *et al.*, 2007).

Cooking loss

Breast meat samples were collected from four birds per treatment (approximately 100 g) is trimmed of visible fat and connective tissue and weighed precisely using a digital balance (W_1). The sample is placed in a polyethylene bag or covered container and cooked in a water bath or convection oven at 75–80°C until the internal temperature of the sample reaches 75°C, monitored using a calibrated thermometer. After cooking, the sample is removed and allowed to cool at room temperature (about 25°C) for 30 minutes. Excess surface moisture is gently blotted using absorbent paper. The cooked sample is weighed again to obtain the final weight (W_2). Cooking loss is calculated using the formula:

$$\text{Cooking Loss (\%)} = ((W_1 - W_2) / W_1) \times 100$$

W_1 = Initial weight of raw sample. W_2 = Final weight after cooking (Honikel, 1998).

Economic Appraisal

The total feed cost was calculated for each dietary treatment and compared with the control diet. Economic efficiency index (EEI) and cost index (CI) were computed following the method of Fialho *et al.* (1985) as:

$$\text{EEI} = (\text{MCE} / \text{CTEI}) \times 100, \text{CI} = (\text{CTEI} / \text{MCE}) \times 100,$$

where MCE denotes the lowest cost per kilogram of weight gain, and CTEI represents the total cost of the respective treatment.

Statistical Analysis

The study adopted a completely randomized design (CRD). Data were analysed using one-way analysis of variance (ANOVA) via the General Linear Model procedure of SAS (SAS Institute, 2003). Where significant differences were detected, means were separated using Duncan's multiple range test as described by Steel and Torrie (1980).

Results and Discussion

Chemical composition and anti-nutritional factors of raw and boiled baobab seeds revealed notable changes due to the boiling process. Boiling resulted in a slight reduction in dry matter content from 91.80% to 89.40%. Metabolizable energy (ME) decreased marginally from 2188 to 2149 kcal/kg, which could be attributed to partial leaching or thermal degradation of energy-contributing compounds such as fats and carbohydrates. This trend aligns with the findings of Guluwa *et al.* (2017), who reported a slight decline in ME values in heat-processed oilseeds. Boiling improved crude protein content from 12.30% to 13.70%. This apparent increase may result from a relative concentration effect due to the loss of soluble carbohydrates or anti-nutrients. This observation is inconsistent with Saulawa *et al.* (2014), who reported decreased protein content in boiled baobab seeds. The ether extract content increased slightly from 10.00% to 10.70%, possibly due to the breakdown of cell walls during boiling, which may enhance fat extractability.

Crude fibre decreased from 26.40% to 24.70%, which suggests partial solubilisation or degradation of insoluble fibre components, particularly hemicelluloses and pectins, during boiling. This aligns with findings of Saulawa *et al.* (2014), who reported reduced fibre levels in processed plant seeds. Nitrogen-Free Extract (NFE), which represents the soluble carbohydrate portion, decreased from 38.9% to 36.1%, likely due to water-soluble carbohydrate loss during boiling. Similar reductions were documented by Musa *et al.* (2010) in some processed legumes seed meals. For mineral content, a slight reduction was observed in calcium (1.42% to 1.17%) and total phosphorus (0.86% to 0.82%). Importantly, anti-nutritional factors were significantly reduced. Tannin levels decreased from 0.62 mg/g to 0.38 mg/g, and phytic acid levels dropped from 1.50% to 0.58%. The reduction in tannins and phytates confirms the effectiveness of thermal processing in improving the nutritional quality of plant seeds by reducing their anti-nutritional burden. These findings confirm those of Saulawa *et al.* (2014), who documented significant reductions in tannin and phytic acid contents following moist heat

treatment in baobab seeds. Growth performance as affected by boiled baobab seeds is shown in Table 3. During finisher phase (4-6 week) and the overall period, birds fed 15% boiled baobab seeds showed significantly ($P \leq 0.05$) higher feed intake than those fed the control diet. This may be attributed to the increased fiber content of the diet which typically leads to higher voluntary intake in an attempt to meet energy demands (Akinfala *et al.*, 2002). Birds fed 10% and 20% also had relatively high feed intake, and not significantly different compared to the other dietary treatments.

This agrees with the findings of Chadare *et al.* (2009) who reported that moderate inclusion of baobab products increases palatability and intake due to their slightly sweet flavor and nutrient richness. However, These findings contradicted with Lawan *et al.* (2017) who found no significant ($P \geq 0.05$) difference for bird fed 15% treated baobab seed meal during the finisher phase compared to birds fed 0%. This discrepancy could be attributed to variations in the chemical composition of baobab seeds and processing method used. Likewise, these result inconsistent with the findings of Mwale *et al.* (2008) who reported that Keets fed 15 % baobab seed cake based diets had significantly lower feed intake compared to those fed on the control diet. The current results are also contrary to the work of Sola-Ojo *et al.* (2011) who reported lower feed intake in layers chickens fed baobab seed meal. The differences may due to using raw baobab seed meal. Bird fed 10% baobab yielded the highest finisher and overall weight gain (1805.0 g and 2595.4 g, respectively).

Finisher body weight gain of birds fed 10% was significantly ($P \leq 0.05$) higher versus control. The improved gain in this group indicates that 10% inclusion offers an optimal balance between energy contribution and digestibility. Bird fed 15% also enhanced finisher and overall weight gain but was not significantly ($P \geq 0.05$) different from the other dietary treatments. Likewise, Lawan *et al.* (2017) found no significant ($P \geq 0.05$) body weight gain of birds fed 15 % treated baobab seed meal during the finisher phase compared to control. The best finisher and overall FCR was observed in birds fed 10% (1.62 and 1.55, respectively), followed by the control. These results agreed with Bale *et al.* (2013) who found the best significant ($P \leq 0.05$) feed conversion ratio in birds fed 10% boiled baobab seeds. Likewise, this study is coincided with the finding of Lawan *et al.* (2017) who reported significantly ($P \leq 0.05$) the best feed conversion ratio and body weight gain in birds fed 10% soaked baobab seed meal. However, its disagreed with Mwale *et al.* (2008) who observed a decrease in the weight gain of guinea fowl keet at 10% inclusion level of baobab seed meal. Chimvuramahwe *et al.* (2011) also reported that feed containing baobab seed meal depressed the growth rate of broiler chicken, as raw baobab seed meal being used. Finisher and overall FCR of birds fed 10% were significantly ($P \leq 0.05$) better compared to those fed 20% boiled baobab seeds.

The later showed the poorest FCR, reflecting inefficiency in converting feed into body mass at high inclusion levels. This tendency confirms a non-linear response, whereby performance improves up to a (10–15%), but beyond that further inclusion leads to decreased efficiency. Similar patterns were reported by (Aderibigbe, 2011 and Sidibe and Williams 2002) who found that while baobab seeds can be beneficial at low to moderate levels, their high fibre and residual anti-nutritional content (even after boiling) can interfere with nutrient absorption at higher inclusion levels. Finisher and overall PER followed the same pattern of FCR, as increased in bird fed 10% (3.07 and 3.10, respectively) and decreased with increasing seed levels, reaching the lowest values in bird fed 20% (2.73 and 2.88, respectively). This indicates that although baobab seeds contribute protein, their efficiency in supporting growth reduced with higher inclusion, likely due to reduced bioavailability of amino acids and reduced digestibility. The present findings agree with those of Saulawa *et al.* (2014), who observed a significant ($P \leq 0.05$) reduction in PER with increased baobab seed levels. However, these result disagreed work of Guluwa *et al.*, (2015) who recorded that treated baobab seeds meal (TBSM) had no significant ($P \geq 0.05$) effect on PER of chickens at 28 days old Haematological indices as influenced by boiled baobab seeds are shown in Table 6. Dietary treatments had no significant ($P \geq 0.05$) effect on all hematological parameters. These results disagreed with the findings of Lawan *et al.* (2023), who revealed significant ($P \leq 0.05$) difference in the haematological indices. These disagreements could be due to inclusion of baobab pulp. Likewise, the present findings partially contradict those of Sola-Ojo *et al.* (2016), who observed significant ($P \leq 0.05$) variations in PCV, WBC, Hb, RBC, MCV and MCH, while RBC and MCH showed a non-significant difference ($P > 0.05$) among treatments. These discrepancies may be due to differences in the processing methods of baobab seeds used in these studies. The economic appraisal of broilers fed diets containing boiled baobab seeds is summarized in Table 8. Data on the effect of boiled baobab seeds depicted that total cost of consumed feed was higher for baobab seeds diets compared to control. These result disagreed with Chimvuramahwe *et al.* (2011) documented a decrease in total feed costs with the inclusion of baobab seed oil cake.

The differences might be as a result of baobab seed oil cake being used. The best feed cost per kilogram of meat, (EEI) and (CI) showed by birds fed 10%, 0%, 15% and 20%. Lawan *et al.* (2017) recorded improved economic performance at the 15% level, which contrasts with the current study's findings. Moreover, the present results differ from those of Bale *et al.* (2013), who reported a progressive reduction in cost per unit weight gain with increasing levels of baobab seed-based diets. Similarly, Akintunde *et al.* (2021) observed a lower feed cost per kilogram gain in birds fed a 15% inclusion of soaked and fermented baobab seeds compared to 0%, 7.5%, 22.5% and 30% levels. Additionally, the discrepancies between the current findings and those of previous studies may be attributed to variations in feed ingredients.

Table 1. Chemical composition and anti-nutritional factor of raw and boiled baobab seeds

Item	Raw baobab seeds	Boiled baobab seeds
Dry matter	91.80%	89.4%
ME ¹ kcal/kg	2188	2149
Crude protein	12.30%	13.70%
Ether extract	10.00%	10.70%
Crude fiber	26.40%	24.70%
Ash	4.20%	4.10%
NFE	38.90%	36.20%
Calcium	1.42%	1.17%
Total phosphorous	0.86%	0.82%
Tannin (mg/g)	0.62	0.38
Phytic acid	1.50%	0.58%

¹ME Calculated according to the equation of Lodhi *et al.* (1976).

Table 2. Composition of broiler starter diet and experimental finisher diets containing different levels of boiled baobab seeds%

Ingredients, %	Starter diet	Finisher diets with different levels of boiled baobab seeds, %			
		0 (A)	10 (B)	15 (C)	20 (D)
Sorghum	53.40	64.50	55.52	49.535	43.03
Groundnut cake	31.16	21.00	21.97	22.00	22.40
Boiled baobab seeds	0.00	0.00	10.00	15.00	20.00
Wheat bran	3.18	3.16	0.14	0.14	0.14
Super-concentrate	5.00	5.00	5.00	5.00	5.00
Nacl	0.30	0.30	0.30	0.30	0.30
Dical. Phosphate	0.22	0.00	0.00	0.00	0.00
Limestone	0.90	1.24	1.00	1.00	1.00
Enzymes	0.20	0.20	0.20	0.20	0.20
L-Lysine	0.09	0.09	0.03	0.001	0.01
DL-Methionine	0.05	0.05	0.04	0.024	0.02
Choline chloride	0.20	0.20	0.20	0.20	0.20
Mycotoxin binder	0.20	0.20	0.20	0.20	0.20
Vegetable oil	5.00	3.96	5.20	6.20	7.30
Premix	0.10	0.10	0.20	0.20	0.20

Table 3. Effect of boiled baobab seeds on broiler growth performance

Parameters	Levels of boiled baobab seeds, %				±SEM
	0 (A)	10 (B)	15 (C)	20 (D)	
4-6 weeks					
Feed intake (g/ bird)	2750.7 ^b ±166.1	2924.5 ^{ab} ±140.7	3065.4 ^a ±158.1	2947.0 ^{ab} ±81.0	70.2
Body weight gain (g/ bird)	1604.7 ^b ±116.1	1805.0 ^a ±127.0	1738.4 ^{ab} ±51.1	1609.3 ^{ab} ±105.1	52.0
FCR	1.72 ^{ab} ±0.1	1.62 ^b ±0.1	1.76 ^{ab} ±0.1	1.84 ^a ±0.1	0.04
PER	2.91 ^{ab} ±0.1	3.07 ^a ±0.2	2.84 ^{ab} ±0.2	2.73 ^b ±0.1	0.08
Overall					
Feed intake (g/ bird)	3819.0 ^b ±202.3	4009.5 ^{ab} ±150.7	4131.6 ^a ±162.0	3959.2 ^{ab} ±74.7	77.2
Body weight gain (g/ bird)	2408.5 ^{ab} ±155.6	2595.4 ^a ±129.4	2531.9 ^{ab} ±86.4	2368.1 ^b ±96.4	60.1
FCR	1.59 ^{ab} ±0.06	1.55 ^b ±0.07	1.63 ^{ab} ±0.07	1.67 ^a ±0.04	0.03
PER	3.02 ^{ab} ±0.12	3.10 ^a ±0.14	2.95 ^{ab} ±0.12	2.88 ^b ±0.07	0.06

Values are means of 4 replicates per treatment (10 birds/ replicate).

^{ab} Means ± SD with different superscripts in the same row were significantly different (P ≤ 0.05).

SEM: Standard error of the means from ANOVA d. f 12.

Table 4. Effect of boiled baobab seeds on hematology

Parameters	Levels of boiled baobab seeds %				±SEM
	0 (A)	10 (B)	15 (C)	20 (D)	
WBC	228.4±0.8	226.9±5.9	243.1±2.5	220.3±1.6	9.6
RBC	2.6±0.8	2.7±0.8	2.9±0.8	2.8±0.1	0.1
HGB	8.6±0.0	9.4±0.4	9.6±0.3	8.3±0.4	0.6
HCT	33.9±0.5	34.9±0.4	38.6±1.6	36.6±2.1	2.0
MCV	127.7±2.2	126.1±2.6	129±1.9	128.8±2.4	1.9



MCH	32.4±1.0	34.1±0.5	32.3±0.3	29.5±2.7	1.7
MCHC	25.3±0.3	27.1±0.1	25±0.1	22.9±2.5	1.6
PLT	2.5±0.5	6.5±0.5	3.5±1.5	7.0±3.0	2.1
LYM	93.8±2.2	96.4±0.3	96.5±0.1	96.2±0.2	1.3
RDWSD	31.0±3.2	27.9±0.3	34.3±0.3	32.7±1.9	2.7
RDWCV	10.1±2.0	11.2±0.9	12.0±0.4	12.2±0.4	0.9

Values are means of 4 replicates per treatment (bird/ replicate).

Means ± SD with different superscripts in the same row were significantly different ($P \leq 0.05$).

SEM: Standard error of the means from ANOVA d.f 12.

Table 5 Effect of boiled Baobab seeds on economic appraisal

Ingredients, %	Levels of baobab seeds, %			
	0 (A)	10 (B)	15 (C)	20 (D)
Total cost of consumed feed	1416.0	1476.9	1501.3	1436.7
Cost (SDG) of feed/1kg meat	587.9	569.0	592.9	606.7
Economic efficiency index (EEI)	96.8	100	96.0	93.8
Cost index (CI)	103.3	100	104.2	106.6

Conclusion

The findings of this study suggest that the inclusion of boiled baobab seeds up to 15% in broiler diets do not negatively impact broiler performance. Additionally, 10% inclusion optimized growth efficiency and reduced feeding costs, making it a viable nutritional ingredient for broiler production.



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