Growth Performance and Digestibility of Starter Broiler Chicks Fed Diets Containing Different Duration of Fermented Baobab (*Adansonia digitata*) Seed Meal

I. Y. Gyang, F. B. P. Abang, and D. T. Shaahu

ABSTRACT

A nutrient retention and growth performance study were conducted with broiler chicks to evaluate the effect of different duration of fermented baobab seed meal (FBSM). Fermented baobab (*Adansonia digitata*) seeds were ground and incorporated in the diets at 12% dietary level. Diet 1 (control diet) had no BSM. Diet 2 had unfermented BSM. Diets 3, 4 and 5 had baobab seed meal (BSM) fermented for 48 h, 72 h and 96 h, respectively. Two hundred and forty (240) Arbor Acre chicks at one-week old were weighed and distributed to these dietary treatments. The five (5) treatments were replicated four (4) times in a completely randomized design, with 12 birds per replicate (48 per treatment). The diets did not significantly ($p>0.05$) influenced Feed intake, final body weight, feed conversion ratio and protein intake across treatments. The body weight gain and protein efficiency ratio of the chicks fed 96 h fermented BSM were not significantly ($p>0.05$) different with those fed control diet but were significantly ($p<0.05$) higher than chicks of other treatment groups. Starter broiler chicks fed T4 had significantly ($p<0.05$) higher nutrient digestibility parameters across treatments, except for EE and CF that were highly digested by chicks fed T3 and T1 respectively. In conclusion the performance of broiler chicks fed 96 h FBSM competed favorably with those fed control diet, whereas, chicks placed on 72 h FBSM recorded better result of nutrient digestibility.

Keywords: Broiler Chicks, Fermented Baobab Seeds, Growth Performance, and Nutrient Digestibility.

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I. Y. Gyang *

Department of Animal Health and Production Technology, Plateau State College of Agriculture, Garkawa, Nigeria.

(e-mail:mapakiliya123@gmail.com)

F. B. P. Abang

Department of Animal Production, Federal University Agriculture, Makurdi, Nigeria.

(e-mail:abang.favour2@gmail.com)

D. T. Shaahu

Department of Animal Production, Federal University of Agriculture, Makurdi, Nigeria.

(e-mail: dtshaatu@gmail.com)

***Corresponding Author**

I. INTRODUCTION

Poultry farmers in Nigeria for the past decades have been using the conventional feedstuffs (soybean meal and groundnut cake) in producing poultry feeds. Unfortunately, these feed ingredients have become scarce, oftentimes unavailable, and very expensive [1]. Research emphasis by animal nutritionists is now on the potentials of lesser-known, ignored and underexploited trees and shrubs that are native to Africa as protein and energy sources. Baobab (*Adansonia digitata* L.) belongs to such category [2]. In Nigeria it grows widely in the northern regions [4], [5]. Baobab seeds have been found to be rich in protein (20-36%) and energy (1898-4465 kcal/kg) and also provide some necessary fibre, vitamins, minerals and amino acids, particularly, lysine and methionine which are limiting in most cereals [6], [7] and [8]. However, like many nonconventional feedstuffs, baobab seeds have been found to contain some anti-nutritional factors such as tannins, oxalates, phytate, and saponin which limits its digestion, absorption, and utilization by broiler chickens.

The seeds therefore require some form of processing such as soaking, boiling, toasting and fermentation so as to facilitate the utilization of its nutrients by broiler birds [1], [9]. References [10], [11] have successfully used differently

processed baobab seeds at 10% inclusion levels. Reference [12] recommended 15% for growing rabbits. Reference [13] had reported that dietary levels of toasted baobab seed meal beyond 22.5% resulted in a decline in weight gain and feed to gain ratio of broiler chickens.

Reference [14] stated that the identification and removal of factors that inhibit nutrient utilization are necessary for successful poultry production. Among potential factors reducing nutrient bioavailability are anti-nutritional factors. Reference [15] had reported that feed ingested by broiler birds is not entirely digested and absorbed in the body system, but some are undigested and found their way out as animal faeces. Digestibility is therefore an index of the disappearance of food in the intestine, but not of the efficiency of use of food by animal metabolism. However, food can be highly digestible without providing enough nutrients to make up needs of animal [15]. Diets provided to chickens must undergoes series of physio-chemical actions prior absorption and assimilation, [16], [15].

Feed digestibility indicate how much the body uses feeds and nutrients, this depends on animal species, strain, and age. Not all feed fractions are absorbable, some are voided and found their way out as faeces [15]. *In vivo* digestibility made it possible to better understand the percentage of nutrient utilization (organic matter, amino acid, fat and metabolizable

energy) absorption in the digestive tract and which constitute the fraction that can be used for metabolism [15]. The objective of this study was to evaluate the effect of duration of fermentation of baobab seed on growth performance and nutrient digestibility by broiler chicks.

II. MATERIALS AND METHODS

A. Experimental Site

The experiment was conducted at Dan-Agro Poultry Farm, a subsidiary of Dan-Agro Feeds, Zawan, Jos South Local Government Area of Plateau State, Nigeria. The study was carried from 6th December 2018 – 31st January 2019. Zawan is located on a geographical coordinates of latitude 9°48' 00" North and longitude 8° 52' 00" East. With an altitude of about 1829 meters above sea level. Has an annual rainfall of 1300-1500 mm (55 inches) while the dry season starts from October - March. Temperature range between 12.9-13 °C. An average relative humidity of 65 % [17].

B. Source of Baobab Seeds Experimental Site

Baobab seeds used for the experiment were purchased from Lur village in Kabwir District of Kanke Local Government Area of Plateau State, Nigeria.

C. Processing of Baobab Seed Meal

The seeds were washed to remove the pulp on the seed coat, sun dried, then winnowed to remove particles (debris) of fibrous and broken woody pericarp of the dried baobab fruit. The baobab seeds were divided into four (4) equal parts. The first part was left unprocessed; the 2nd, 3rd and 4th parts were soaked for 24 hours using tap water. The seeds were then drained of the water using a perforated stainless pan for 20 minutes. Each part was then placed and tied in polythene bag and covered in a 300 litre plastic drum (an anaerobic environment) and left to ferment. The 2nd, 3rd and 4th parts of baobab seeds were left to ferment for 48 h, 72 h and 96 h, respectively. After fermentation the seeds were washed again to remove any fungus or leached anti nutrients. They were sun-dried for 5 days until crisp. Each part was ground in a hammer mill and sieved in 2 mm × 2 mm plastic mesh sieve and then incorporated into the starter diets.

D. Experimental Diets

Diet 1, the control diet, had no baobab seed meal. It was a conventional diet containing groundnut cake and toasted soybeans as the protein sources. Diet 2 contained raw or unprocessed baobab seed meal. Diets 3, 4 and 5 contained baobab seeds fermented for 48 h, 72 h and 96 h, respectively. The diets were iso-caloric and iso-nitrogenous. Table I showed the gross composition, calculated, and analyzed nutrient content of starter diets. This fell within the recommended range of 22-24% crude protein and 2900-3000 Kcal/kg metabolizable energy as reported by [18] for broiler chickens.

E. Design and Management of Experimental Birds

A total number of 240 day-old Arbor Acre broiler chicks were purchased from ECWA Farm, Jos, Plateau State, Nigeria were used for the experiment. The chicks were placed on commercial diet (supreme broiler starter) for one week to

acclimatized and enhance the development of their gastrointestinal tract before introducing them to the experimental diets. On the day of arrival, they were administered multivitamins (Anupco Vitalyte Extra and Antibiotics Doxy-gen) to combat any stress and infections. At 7th day old they were weighed and randomly allocated to the five (5) dietary treatments replicated four (4) times, in a completely randomized design. Each replicate had twelve (12) chicks with 48 chicks per treatment. All management practices and vaccination programs against Newcastle and infectious Bursal disease were strictly adhered to. Feed and water were administered *ad libitum*, which lasted for 21 days.

F. Performance of Broiler Chicks

Records of live weight and feed intake were taken weekly, at the beginning of every week a quantity of feed was weighed and allocated to each replicate group; left-over feeds were also weighed at the end of the week and subtracted from the initial feed supplied to obtain feed intake for the week. Weekly weights were taken of the birds in each replicate. The total weight of the birds in each pen was determined by subtracting the initial body weight for the week from the body weight at end of the week. Through these data, feed intake, body weights, weight gain, protein intake and other performance parameters were determined:

1. Feed conversion ratio (FCR) was calculated by dividing the weekly feed intake per bird in grams by weekly body weight gain per bird in grams for each treatment group.

$$FCR = \frac{\text{Feed intake (g)}}{\text{Body weight gain (g)}}$$

2. Protein intake = Total feed consumed per bird (g) × % CP of feed.

3. Protein efficiency ratio (PER) was obtained by dividing the weight gain per bird (g) by its protein intake (g) during the experiment.

$$PER = \frac{\text{Body weight gain (g)}}{\text{Protein intake (g)}}$$

4.

Apparent digestibility =

$$= \frac{\text{Nutrient intake in feed} - \text{Nutrient voided in feces}}{\text{Nutrient intake in feed}} \times 100$$

G. Nutrient Digestibility by Broiler Chicks

At week 3, three (3) birds were taken from each treatment and placed in metabolic cages for collection of faeces (digestibility studies). Fresh excreta were collected in the morning, weighed, and oven dried for a period of four (4) days. The oven-dried excreta were used for analysis and subsequently used for digestibility calculation. Dry matter and nutrient digestibility were calculated according to [19].

TABLE I: GROSS COMPOSITION (%) OF BROILER STARTER DIETS CONTAINING FERMENTED BAOBAB SEED MEAL

Ingredient	Experimental Diets				
	T1 Control	T2 0 h FBSM	T3 48 h FBSMh	T4 72 h FBSM	T5 96 h (FBSM)
Maize	43.36	37.99	36.21	37.58	39.73
Soybeans	25.09	18.46	20.24	18.87	16.72
BSM	0.00	12.00	12.00	12.00	12.00
GNC	21.00	21.00	21.00	21.00	21.00
Fish meal	1.50	1.50	1.50	1.50	1.50
Wheat bran	2.00	2.00	2.00	2.00	2.00
Rice offal	3.00	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00
Common salt	0.30	0.30	0.30	0.30	0.30
Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated nutrients					
Crude protein	24.00	24.00	24.00	24.00	24.00
ME Kcal/Kg	2941.94	2940.81	2937.11	2934.43	2941.90
Crude fibre	3.39	4.20	4.34	4.24	4.22
Ether extract	8.52	8.41	8.81	8.36	8.29
Calcium	1.26	1.26	1.27	1.26	1.26
Phosphorus	0.78	0.52	0.64	0.62	0.64
Lysine	1.15	1.15	1.23	1.29	1.27
Methionine	0.36	0.36	0.38	0.36	0.39
Analyzed Nutrients					
DM	94.37	94.07	93.79	94.38	94.77
CP	23.85	24.70	24.09	24.59	24.07
EE	5.27	5.26	7.55	6.64	6.40
Ash	9.69	10.41	10.80	11.26	10.15
CF	3.61	4.01	3.82	4.40	4.42
NFE	57.58	55.62	53.74	53.11	54.96
ME (kcal/kg)	3353.94	3315.00	3411.41	3333.74	3360.71

T1 = Control diet, T2 = Diet containing unfermented baobab seed meal, T3 = Diet containing 48hours fermented baobab seed meal. T4 = Diet containing 72hours fermented baobab seed meal, T5 = Diet containing 96hours fermented baobab seed meal, FBSM = Fermented baobab seed meal, h = Hours of fermentation, DM = Dry matter, CP = Crude protein, EE = Ether extract, CF = Crude fibre, NFE = Nitrogen free extract, ME = Metabolizable energy, GNC = Groundnut cake FBSM Fermented Baobab Seed Meal; Vitamin-mineral premix (BIOMIX(R)) Will supply per Kg diet: Vit. A 500IU; Vit. D3 888IU; Vit. E12000 mg; Vit. K3 15000 mg; Niacin 12000 mg; Pantothenic acid 2000 mg; Biotin 1000 mg; Vit.B12 3000 mg; Folic acid 15000 mg; Choline 6000 mg; Manganese 1000 mg; Vit-Iron 15000 mg; Zinc 800 mg; Copper 400 mg; Iodine 80 mg; Cobalt 400 mg; Selenium 8000 mg.

H. Proximate Analysis

The experimental diets and faeces were analyzed through the official method of the Association of Official Analytical Chemists [20] were used for determination of dry matter, crude fibre, protein and fat content of the samples.

Nitrogen free extract (NFE) was determined by the difference of the sum of all the proximate fraction from 100%.

$$\text{NFE} = \% \text{DM} - (\% \text{EE} + \% \text{CP} + \% \text{Ash} + \% \text{CF})$$

The metabolizable energy (ME) of the experimental diets and faeces were calculated according to the formula of [21].

$$\text{ME (kcal/kg)} = 37 \times \% \text{CP} + 81.1 \times \% \text{EE} + 35.5 \times \% \text{NFE}$$

where: DM = Dry matter, CP = Crude protein, CF = Crude fibre, EE = Ether extract and NFE = Nitrogen free extract.

I. Statistical Analysis

All data obtained were subjected to analysis of variance procedure of [22] version 22. Means were separated using Duncan's Multiple Range Test of the same package.

III. RESULTS

A. Growth Performance of Starter Broiler Chicks

Data on growth performance of broiler chicks from one (1) week to four (4) weeks of age is presented in Table II. The initial weight of one (1) week old chicks ranged from 103.91 g to 109.69 g. There were no significant ($p > 0.05$) differences in the feed intake (FI), final weight (FW), feed conversion ratio (FCR) of broiler chicks across all treatment groups. The weight gain (WG) of 468.10 g/bird for chicks fed T5 were not significantly ($p < 0.05$) different from (578.38 g/bird) for chicks fed T1, but were significantly ($p < 0.05$) higher than (407.73 g, 377.50 g and 376.84 g/bird) for chicks fed T2, T3 and T4 respectively. The protein efficiency ratio (PER) of 1.48 and 1.59 for chicks fed T2 and T5 respectively were not significantly ($p > 0.05$) different from 1.99 for chicks fed control diet but were statistically similar to 1.22 and 1.35 for chicks fed T3 and T4.

B. Dry Matter and Nutrient Digestibility by Starter broiler chicks

The result on dry matter and nutrient digestibility by starter broiler chicks is presented in Table III. I observed that DM digestibility ranged from 45.57 to 75.52 %, CP (59.28 to 82.65 %), CF (42.74 to 65.41 %), EE (67.03 to 87.19 %) and NFE (37.25 to 70.34 %). The quantity of digestible DM and CP were significantly ($p < 0.05$) higher in T4. Chicks fed T5

had similar quantity of digestible DM and CP with T4. However, chicks fed T2 poorly digested the DM in feed. The result of EE showed that fat and oil in the diets were highly digestible by the birds. I observed that CF was not adequately digested by the birds in T2, T3 and T5. Results of NFE for

T1, T3, T4 and T5 revealed that the birds were able to digest the carbohydrate component of the feed by chicks except chicks fed T2 (37.25 %). Birds placed on T1 were able to digest NFE at (61.72 %).

TABLE II: PERFORMANCE OF STARTER BROILER CHICKS FED DIETS CONTAINING BAOBAB SEED MEAL

Parameters	Experimental Diets					SEM
	T1 CD	T2 0 h FBSM	T3 48 h FBSM	T4 72 h FBSM	T5 96 h FBSM	
IW (g/bird)	103.91	109.69	107.92	106.59	103.91	0.01 ^{ns}
FI (g/bird)	1194.90	1069.53	1148.07	1056.30	1121.82	0.12 ^{ns}
FW (g/bird)	682.29	517.42	485.42	483.43	572.01	0.06 ^{ns}
WG (g/bird)	578.38 ^a	407.73 ^b	377.50 ^b	376.84 ^b	468.10 ^{ab}	0.05 [*]
FCR	2.07	2.62	3.04	2.80	2.40	0.30 ^{ns}
PER	1.99 ^a	1.48 ^{ab}	1.22 ^b	1.35 ^b	1.59 ^{ab}	0.09 [*]

^{a,b,c,d} Means within each row with different superscripts are significantly ($p < 0.05$), * ($p < 0.05$), ns Not significantly different ($p > 0.05$), SEM = Standard error of means, CD = Control diet T1 = Control diet without baobab seed meal, T2 = Diet containing unfermented baobab seed, T3 = Diet containing baobab seeds obtained after 48h fermentation, T4 = Diet containing baobab seeds obtained after 72h fermentation, T5 = Diet containing baobab seeds obtained after 96h fermentation, FBSM = Fermented baobab seed meal, h = Hours, FI = Feed intake, IW = Initial body weight, FW = Final body weight, WG = Weight gain, FCR = Feed conversion ratio, PER = Protein efficiency ratio, SEM = Standard error of means, P = Percentage level of significance.

TABLE III: NUTRIENT DIGESTIBILITY BY STARTER BROILER CHICKS FED FERMENTED BAOBAB SEED MEALS

Parameters (%)	Experimental Diets					SEM
	T1 CD	T2 0 h FBSM	T3 48 h FBSM	T4 72 h FBSM	T5 96 h FBSM	
DM	65.20 ^b	45.57 ^c	67.14 ^b	75.52 ^a	70.78 ^{ab}	2.56 [*]
CP	73.43 ^b	59.28 ^c	74.42 ^b	82.65 ^a	76.64 ^{ab}	1.98 [*]
EE	82.36 ^{ab}	67.03 ^c	87.19 ^a	86.65 ^a	80.13 ^b	1.85 [*]
CF	65.41 ^a	42.74 ^b	48.90 ^b	54.60 ^{ab}	47.92 ^b	2.36 [*]
NFE	61.72 ^a	37.25 ^b	62.40 ^a	70.34 ^a	67.43 ^a	2.95 [*]

^{a,b,c} Means within each row with different superscripts are significantly ($p < 0.05$), * ($p < 0.05$), SEM = Standard error of means, CD = Control diet T1 = Control diet without baobab seed meal, T2 = Diet containing unfermented baobab seed, T3 = Diet containing baobab seeds obtained after 48h fermentation, T4 = Diet containing baobab seeds obtained after 72h fermentation, T5 = Diet containing baobab seeds obtained after 96h fermentation, FBSM = Fermented baobab seed meal, h = Hours, DM = Dry matter, EE = Ether extracts, CF = Crude fibre, NFE = Nitrogen free extract.

IV. DISCUSSION

A. Growth Performance of Starter Broiler Chicks

The performance of starter broiler chicks fed diets containing fermented BSM are presented in Table II. Initial weight (IW), feed intake (FI), final weight (FW) and feed conversion ratio (FCR) showed no significant ($p > 0.05$) difference across treatments. This result agrees with the findings of [23], [24] who reported no significant ($p > 0.05$) difference in IW, FI, FW and FCR of starter broiler chicks fed differently processed roselle and baobab seed meal respectively. This study is contrary to the findings of [25], [26] who reportedly observed significant ($p < 0.05$) difference in FI, FW and FCR of broiler chicks fed diets containing Roselle seeds fermented at varying durations and Baobab seed meal cake fed beyond 10% level of inclusion respectively. However, the variations may occur due to differences in grain legumes, seed processing and levels of inclusion respectively.

Weight gain of broiler chicks fed T5 is similar with those fed T1 and is significantly ($p < 0.05$) higher than those fed T2, T3 and T4. This study agrees with findings of [27] who reported that body weight gain of broiler chicks fed locust bean seed meal fermented for 96 h and beyond were similar to chicks fed control diet. This revealed that a linear increase in fermentation period could enriched some unidentified growth factors in the starter test diet that stimulated growth of specific tissues.

Protein efficiency ratio (PER) in this study followed a similar pattern of levels of significance as body weight gain. The PER of chicks fed T2 and T5 were similar to the value

for those fed T1 but were significantly ($p < 0.05$) higher than those fed T3 and T4. This study showed that protein was efficiently utilized by broiler chicks fed T5 similar to those fed T1. This result agrees with the findings of [28] who reported that the birds with the highest protein efficiency ratio (PER) were those fed fermented kidney bean diet. This study also corroborated the findings of [29] who reported that the higher protein level obtained for 6 days fermentation of BSM was due to hydrolysis of complex compounds that chelate protein. This makes amino acids readily available and efficiently utilized for body weight gain by broiler chicks. This study revealed that broiler chicks fed fermented BSM at 12 % level of inclusion can produce broiler chicks with similar performance as those fed the control diet.

B. Dry Matter and Nutrient Digestibility by Starter Chicks

The dry matter and nutrient digestibility of broiler chicks fed BSM are presented in Table IV. Inclusion of unfermented BSM in the starter diet significant ($p < 0.01$) reduced broiler chick's digestibility of dry matter and all proximate fractions than other treatment groups. The study conformed with the observations of [30], [31] who reported a depressed dry matter and nutrients digestibility of broiler chicks fed raw pigeon pea meal and raw tropical sickle-pod seed meal (*Senna obtusifolia*) than other treatment groups respectively. Consequently, this poor nutrient digestibility could be attributed to the lack of seed processing, which had been reported to contain anti-nutritional factors (tannin, oxalate, phytate, saponin and HCN), that form less digestible complex compounds with protein, mineral, vitamins and endogenous enzymes [32].

The dietary inclusion of fermented BSM on dry matter and nutrient digestibility has no definite pattern (parabolic). However, when digestibility reaching a pick at 72 h of fermentation of dietary BSM, it tends to decrease at 92 h fermentation. The result showed that broiler chicks fed 72 h FBSM consistently recorded the highest apparent nutrient digestibility value among all other treatment groups, except for CF and EE that showed inferiority over T1 and T3, respectively.

The low crude fibre digestibility by broiler starter chicks fed FBSM was similar to those fed unfermented BSM diet. This study disagrees with the observations of [33] who reported that chicks fed T1 consistently recorded the highest apparent nutrient digestibility value than those fed 72 h fermented castor seed meal diets. This study is also not in line with the findings of [34] who reported that diets containing 8 to 12 % CF levels at 2800 and 3000 kcal/kg (ME) without enzyme inclusion resulted in positive growth response. Hence, 3-5 % CF level is generally recommended for broiler chickens [35], [36]. Variations could be attributed to differences in plant species and processing methods.

The low fibre digestion by broiler chicks in this study could be attributed to the under-development of the gastro-intestinal tract, high crude fibre content of BSM and presence of anti-nutritional factors. Reference [37] reported that high CF in poultry diets decreases the surface area, width and height of intestinal villi that are associated with nutrient digestion and absorption. Furthermore, indigestible cellulose and hemicellulose of crude fibre (Oligosaccharide) contain molecules of xylose, galactose, and mannose link by β -glycoside bond all of which are monosaccharide that would have enhanced carbohydrate digestibility [38].

Also, fermentation of grain legume brings about the breakdown of certain constituent, reduction of anti-nutritional factors, the released of vitamins and minerals thereby improving performance [39], [40]. However, the expression of superior dry matter and nutrient digestibility of broiler chicks fed FBSM in this study had resulted to an improved performance of starter broiler chicks similar to chicks fed control diet.

V. CONCLUSION

Baobab seed meal (BSM) Fermented for 96hrs is recommended for inclusion in starter broiler's diets since growth performance of chicks in this study competed favorably with those fed control diet despite the fact that broiler chicks fed 72 hours fermented BSM had better result of nutrient digestibility.

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