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Research Article

Carcass Yield and Internal Organs Weight of Finishing Broiler Chickens Fed Ash-treated African Locust Bean (*Parkia biglobosa*) Hull-Based Diets

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ABSTRACT

Introduction: Carcass yield and meat cuts are traits of meat quality that determine consumers' preferences. The present study investigated the effects of feeding ash-treated African locust bean hull meal partially replacing palm kernel meal on broiler chicken carcass and gut organs.

Materials and methods: One hundred and twenty Arbor Acre broiler chickens were randomly distributed on an equal weight basis into three groups of 40 broilers each, and each group was replicated four times with 10 chickens per replicate in a completely randomized design. Each group was assigned to three experimental diets in which ash-treated African locust bean pulp replaced palm kernel cake at 0 % (T1, Control), 25% (T2), and 50% (T3). At the end of the feeding trial, which lasted for 42 days, a chicken each was randomly selected per replicate per treatment group (twelve in total), and final live weight, final feed intake, and feed conversion ratio were measured before slaughtering.

Results: Carcass primal cuts (back, drumstick, breast, thigh, and wings) and gut weights (crop, gizzard, heart, liver, proventriculus and small intestine) of the broiler chickens were not significantly influenced by the experimental diets except dressed percent, carcass weight and live weight which were statistically higher in control (T1) and T2 diets while, chickens on T3 diets recorded least value.

Conclusion: In conclusion, ash-treated African locust bean hull meal can replace palm kernel cake meal up to 25% in broiler chicken diets without a detrimental effect on carcass characteristics.

1. Introduction

Meat serves as a significant source of animal protein in human nutrition. In Nigeria, the average meat consumption is estimated at eight grams per person per day, which falls short by approximately 27 grams of the minimum intake recommended by the Food and Agriculture Organization[1]. Consequently, the average Nigerian is among the lowest consumers of animal protein globally. The World Health Organization has raised concerns regarding the risks associated with dietary animal protein, constituting only 26% of the total protein intake for Nigerians[2]. Unfortunately, the population primarily depends on large livestock, such as cattle and goats, for their meat supply. These animals have extended production cycles and generational intervals, typically ranging from 365 days to 4.5 years for cattle, and 5-6 months to 2-3 years for goats[3]. Although these larger animals tend to have a higher live weight at slaughter, their actual edible meat yields and dressing percentages are relatively low, ranging between 40% and 50%, influenced by factors such as age at slaughter, sex, and the specific body components considered as edible[4,5]. Bonny et al. [5] noted that the ratio of carcass weight to live weight is a critical factor in determining meat yield. Consequently, the proportion of offal, visceral organs, and gut contents in ruminants is substantial, often accounting

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for nearly half of their total weight, leading to lower carcass yields. Therefore, the meat supply from ruminants is insufficient to meet the growing demand for meat[5].

Kakagida et al.[6] and Sundu et al.[7] suggested that the possible and most appropriate remedy to low animal protein intake lies in the production of rapid-maturing animals with merit for higher carcass weight and ability to thrive on low-cost feedstuffs, such as broiler chickens. Broilers have characteristics for rapid growth as they attain the required weight for slaughter (2-3 kg) between six to eight weeks under proper management[8].

In the tropics, the main product of broiler production is the carcass or chicken meat, which is an excellent source of protein[9]. Under tropical conditions, most of the broiler breeds dressed out satisfactorily[5,9]. Thus, broilers can produce relatively (83%) more edible meat per bone. Hot carcass yield and dressing of 78% was estimated for Nigeria dressed chicken, out of which 30% accounted for the breast, 17% for the thigh, 15% for the drumstick, 15% for the wings, 20% for the back, and 8.5% accounted for the giblets (Neck, heart, liver, gizzard)[5,9]. The meat yield of different parts of eight-week-old broilers also had 85% breast meat, 87% thigh meat, 76 % drumstick meat yield, 60% wing meat, and 54% back meat yield[5,6,9]. Thus, broilers have the prospect of replacing the conventional meat source.

The demand for poultry meat has increased appreciably in recent times in response to health concerns, arising from red meat consumption[10], and also an improvement in carcass yield and meat composition[4]. These improvements are mainly in the production of high-quality meat that has no fat deposition within a short period[11].

The ability of broilers to grow rapidly and have high dressing percent, however, can be influenced by effective nutrition and general management[12]. It has been reported by Obun[13] that broilers fed a high-energy diet produced high carcass yield. At present, the biggest constraint to poultry production in Nigeria is the high cost of quality energy feeds, which account for about 60% and 80% of the recurrent expenditure in intensive management techniques[9]. This is because feedstuffs used in formulating and compounding diets for poultry are in high demand for both human consumption and industrial uses. In an attempt to boost broiler production and cut down the cost of feed, animal nutritionists have tried to harness and utilize agro-industrial byproducts and crop residues that are not utilized by man. A large number of alternative feedstuffs that have the potential of being harnessed as poultry feed ingredients abound in Nigeria. Research into finding the nutritional constituents and chemical profile of these agro-industrial by-products to determine their utilization and the percentage of conventional feed to replace in diets is ongoing. One of such that is receiving attention is the African locust bean pulp (*Parkia biglobosa*).

The ripe fruit of African locust bean (*Parkia biglobosa)* hulls is sweet[14] and a healthy source of dietary fiber and protein[15]. African locust bean seed coat and pulps contain carbohydrate (67.3%), primarily reducing sugars, and other complex carbohydrates (18%)[13]. Although the pulp is low in essential amino acids content, it has rich contents of Vitamin C and Palmitic acids[16,17]. Furthermore, the nutrients composition of *Parkia biglobosa* pulp is 98.4% dry matter, 11.52% crude protein, 12.49% crude fibre, 3.09% ether extract, 4.08% ash, 68.32% nitrogen free extract, 4.56 mg/100g reducing sugar, 24.22 mg/100g ascorbic acid, and 5.84 mg/100g total starch[18]. However, Tamburawa et al.[11] reported that the protein content of *Parkia biglobosa* seeds can vary from 21% to 30% and has the potential to be utilized in livestock feeding. Animashaun et al.[12] also revealed the proximate contents of *Parkia biglobosa* seed pulp as 17.52% Crude protein, 5.62% ether extract, 17.15% crude fiber, and 11.90% ash.

The utilization of African locust beans in Monogastric nutrition as a replacement for a protein source was reported to improve nitrogen retention and feed utilization[13,15]. Similarly, Belem et al.[16] and Lakurbe et al.[14] also recorded better utilization of cooked and toasted African locust bean fruit pulp in broilers' diets at a 20% dietary inclusion level. On the contrary, Alabi et al.[17] observed significant depressed values for carcass weight and dressing percentage, breast muscle, drumstick, and thigh muscles for broilers fed 15% fermented African locust bean seeds meal.

Ayanwale et al.[3] observed no positive influence of toasted *Afzella africana* seed meal against raw *Afzella africana* seed meal, which inhibited broiler growth due to lower protein quality and essential Vitamins. The positive result in feed utilization of toasted or treated *Afzella africana* seed meal-based diets in broilers was attributed to optimum protein and low presence of tannin. African locust bean pulp, similar to most seed-bearing fruits such as mango, cashew, and oranges, possesses anti-nutritional factors (ANF) such as tannins, oxalate, and hydrogen cyanide, which can limit its utilization[17]. Tamburawa et al.[11] and Tamburawa et al.[19] reported 4.71 mg/100 g of phytate, 1.00 mg/100 g of tannin, 2.08 mg/100 g of saponin, 1.78 mg/100g of oxalate, 0.100 mg/ 100 g of Hydrogen cyanide, and 1.90 mg/100 g of trypsin inhibitor for anti-nutritional factors in raw African locust bean seeds. Processing by application of heat, fermentation, cooking, sprouting, ash treating, and enzymatic actions has been reported to reduce or eliminate anti-nutritional factors in grain legumes, thereby improving their nutritive value and digestibility[11,13]. However, the best processing method to adopt in treating leguminous seeds to achieve optimum removal of anti-nutrients remains contradictory.

Information on the use of ash-treated African locust bean hulls as a replacement for palm kernel cake meal in finishing broiler diets is also scant. However, there is a prospect in the use of African locust beans hull in poultry diet as a cheaper and alternative protein source[14]. Therefore, it has the advantage of sustainable broiler production and increased animal protein intake in Nigeria.

The value of feed is its ability to be utilized by animals and converted to weight gain over a relatively short period. Literature has established that most commercial feeds have high value[4,12,13,17]. However, formulated diets did not usually produce desirable results. As such, there is a need to evaluate the carcass merit of chickens on formulated diets towards predicting their meat yields, meat-to-bone ratio, and meat quality. This information is important in planning a breeding program to improve meat production and quality characteristics of the broiler carcass. Moreover, meat yield will also assist retailers of meat in estimating and providing cuts of suitable size for customer requirements[5]. The present study explored the nutritive value of ash-treated African locust beans (*Parkia biglobosa*) hull as a dietary replacement for palm kernel cake meal and assessed the carcass yield and weight of internal organs of broilers fed ash-treated African locust beans fruit hull-based diets.

2. Materials and Methods

2.1. Ethical approval

The current study was conducted based on the principles of laboratory animal care (NIH publication No. 85-23, revised 1985), as well as specific national laws where applicable, as the animals used in research were cared for. Experimental protocols were followed as approved by the institutional animal care and use committee (KSPACUC-2022).

2.2. Study location

The study was conducted at the Poultry unit of the Department of Animal Health and Production Technology Research and Demonstration Farm, Kogi State Polytechnic, Itakpe Campus, Kogi State, Nigeria. The site is located at Latitude 7.0384^{0}N and Longitude 6.335^{0}E, and an altitude of 420 meters above sea level. The temperature throughout the year ranged from 18.87 to 34.4°C, and the average annual rainfall was 1280 mm.

2.3. Collection, preparation, and processing of Parkia biglobosa hull

African locust bean *(Parkia biglobosa)* hulls were collected at different processing sites around the Itakpe community, Nigeria. The hulls were sorted, washed, air-dried, and then treated with wood ash in the ratio of 2 kg *Parkia biglobosa* hull samples*,* 1 kg of wood ash; and allowed to ferment in an air-tight container for 21 days after which the ash-treated *Parkia biglobosa* hull was air-dried, sieved using 2.00 mesh size sieve then crushed in a hammer mill and stored in a transparent polythene bag until when needed for trial. Other ingredients were bought from the open market at Lokoja, Kogi State.

2.4. Experimental diets

Three experimental diets for the finisher phase of broiler chicken were formulated in which ash-treated African locust bean fruit hull replaced palm kernel cake meal at 0% (control), 25%, and 50%, coded as T1, T2, and T3. The proportions of other ingredients were held constant to achieve an isonitrogenous diet of 18% crude protein and metabolizable energy of 2900 Kcal/kg to meet broilers' requirements according to the standard of the National Research Council and as reported by Kakagida et al.[6]. The percentage composition of the experimental diets is presented in Table 1.

Table 1. Ingredients and nutrient compositions of experimental diets for Arbor Acre finisher broilers aged 28 days

Ingredients	T1 (0.00)	T2 (25.00)	T3 (50.00)
Maize	50.00	50.00	50.00
Soybean meal	25.05	25.05	25.05
Palm Kernel meal	12.50	9.37	6.25
ATPBH	0.00	3.13	6.25
Maize offal	9.75	9.75	9.75
Limestone	1.50	1.50	1.50
Bone meal	0.55	0.55	0.55
Lysine	0.15	-	-
Salt	0.15	0.15	0.15
Methionine vitamin premix	0.15	0.15	0.15
Crude protein (%)	18.00	18.07	18.14
Crude fiber (%)	5.02	5.15	5.26
Ether extract (%)	0.70	0.71	0.72
Metabolizable energy (Kcal/Kg)	2936.54	2940.68	2944.47

ATPBH: Ash-treated *Parkia biglobosa* hull. T1: 0% ash-treated *Parkia biglobosa* hull inclusion, T2: 25% ash-treated *Parkia biglobosa* inclusion, T3: 50% ash-treated *Parkia* biglobosa

2.5. Experimental design and chicken management

2.5.1. Starter phase

One-hundred-and-twenty-day-old Arbor Acre broiler chickens, weighing from 178 to 198 g, were purchased from a reputable hatchery in Nigeria. Before their arrival, the brooding house measuring 7m x 7m was cleaned, washed, and disinfected a week ahead with formalin. Litter materials (wood shavings) were spread on the floor two days before the arrival of the chickens. The temperature and light were controlled according to references[16,17]. At arrival, the chickens were provided with water containing glucose and multi-vitamins. The chickens were brooded conventionally on a deep litter floor with a room temperature of 35°C and humidity of 56%[4]. The temperature was reduced to 31°C as the chickens approached the third week. Commercial feed (Olam Ultima feeds, Nigeria) and water were supplied *ad libitum* to the chickens throughout the starter phase. The routine vaccination program, according to local veterinarians, was adhered to LaSota (Volza, Nigeria Poultry vaccine) was administered in the second week of arrival. On day 21, two hundred (200) dose vials of freeze-dried Gumboro vaccine (I.B.D.V, Animal Care Nigeria) were administered.

2.5.2. Finisher phase

At the end of the starter phase, 120 chickens with similar weight (435 ± 10 g) were randomly selected, weighed, and allotted to the three dietary treatments in a completely randomized design with forty chickens per treatment and four replicates of ten chickens per replicate. A period of one week was provided for acclimatization to the feed. The chickens were then fed the experimental diets for three weeks.

2.6. Carcass and internal organ weight

At the end of the feeding trial, a chicken per replicate aged 42 days and weighing an average of 1.051 ± 0.5 g was randomly selected, supplied with only water for eight hours to empty the crops before being euthanized by stunning, thereafter, slaughtered by severing the jugular vein and bled[4]. The chickens were scalded, plucked, and dressed, and the internal organs of the chickens (gizzard, heart, liver, kidney, crop, and small intestine) were removed and weighed using an electronic scale (Shimadzu model 115c). Plucked weights were determined and calculated as the proportion of the ratio of carcass weight to live weight. The carcass was cut into retail primal parts (back, drumstick, breast, thigh, and wings) and weighed[20].

2.7. Statistical analysis

Data collected were subjected to one-way analysis of variance (ANOVA) using the Statistical Package for the Social Sciences (SPSS) version 23, and significant means were compared and separated using Fisher's Least Squares Difference (LSD) test at a significance level of p-value less than 5% ($p < 0.05$)[21].

3. Results

3.1. Carcass characteristics

The result of carcass yield of finisher broiler chicken fed Ash-treated African locust bean hulls-based diets is presented in Table 2. Live weight was significantly influenced by the experimental diets ($p < 0.05$). The results were statistically similar ($p > 0.05$) for the diet containing 0% ash-treated *Parkia Biglobosa* hull level of inclusion (1440.0 g) and the 25% inclusion diet (1402.0 g), while the lowest ($p < 0.05$) value (1358.3 g) was recorded for chickens fed 50% ash-treated *Parkia biglobosa* hull level of inclusion. Similarly, the dressing percentage was significantly different among the treatments ($p < 0.05$). Chickens on diets T2 and T3 diets had similar values ($p > 0.05$) of 65% and 66.19%, respectively, while the best dressing percentage was obtained from chickens on the control diet (70.61%). Thus, the dressing percentage of chickens fed varying inclusion levels of ash-treated *Parkia biglobosa* hull increased ($p < 0.05$) with the quantity of weight gain. Carcass weight, however, ranged from 1012.0 g to 896.0 g, with chickens fed 0% of ash-treated *Parkia Biglobosa* hull level of inclusion recording the ($p < 0.05$) heaviest weight (1012.0 g) and the least (870 g) recorded in chickens on 50% of ash-treated *Parkia Biglobosa* hull inclusion level.

Table 2. Carcass characteristics of broiler chickens fed ash-treated African locust bean hull diets for 42 days

Parameters	T1 (0.00)	T2 (25.00)	T3 (50.00)	SD	P-value
Live weight (kg)	1.44^{a}	1.40^{a}	1.36^{b}	2.89	0.033
Carcass weight (kg)	1.01^{a}	0.91^{ab}	0.87^{b}	3.26	0.025
Dressing (%)	70.60^{a}	65.00^{b}	66.20^{b}	1.61	0.037
Head (%)	2.88	2.86	2.77	0.15	0.541
Neck (%)	4.03	3.97	4.38	0.11	0.271
Breast (%)	29.70	29.30	27.70	0.56	0.339
Back (%)	11.70	11.45	11.21	0.43	1.13
Drumstick (%)	13.45	13.25	12.63	0.33	2.51
Thigh (%)	15.08	15.15	14.53	0.33	1.09
Shank (%)	6.89	6.59	6.61	0.18	0.810
Wings (%)	1.45	1.44	1.45	0.24	0.264

T1: 0% ash-treated *Parkia biglobosa* hull inclusion, T2: 25% ash-treated *Parkia biglobosa* inclusion, T3: 50% ash-treated *Parkia biglobosa*, SD: Standard deviation. ^{a,b} Mean different superscript letters across the row are significant at $p < 0.05$.

3.2. Carcass primal cuts

The weight of primal cuts (back, drumstick, breast, thigh, and wings) of the carcass was not significantly influenced by diets, as they recorded similar values across the treatments ($p > 0.05$; Table 2).

3.3. Internal organ weights

The results of the internal organ weights for chickens fed ash-treated African locust bean seed hull-based diets are presented in Table 3. All parameters, such as crop, gizzard, heart, liver, proventriculus, and small intestine, assessed as internal organ characteristics, were not significantly affected by the diets; thus, they recorded similar values across the dietary treatments ($p < 0.05$).

Table 3. Internal organ characteristics of broiler chickens fed African locust bean hull diets for 42 days

Parameters	TI (0.00)	T2(25.00)	T3(50.00)	P-value
Gizzard (empty)	35.00	32.00	32.3	1.16
Heart	7.67	7.00	7.56	0.88
Liver	5.18	5.16	3.20	1.34
Small intestine	2.88	2.86	2.68	6.87
Crop	3.90	4.07	5.91	1.35
Proventriculus	9.33	9.67	9.01	0.65

T1: 0% ash-treated *Parkia biglobosa* hull inclusion, T2: 25% ash-treated *Parkia biglobosa* hull inclusion, T3: 50% ash-treated *Parkia biglobosa* hull inclusion

4. Discussion

4.1. Carcass characteristics

In congruence with the present findings, Bot et al.[18] reported a significant decrease in carcass weight and dressing percent of finisher broilers in response to African locust bean pulp meal supplementation at 25%, 50%, 75%, and 100%, dose-dependent depression in carcass weight and dressing percent. Similarly, the observed decrease in carcass traits across the dietary treatments in the present study was a reflection of the final weight of the chickens at slaughter. The current results agreed with the findings of Obun[13] that lower carcass weight and dressed percentages of broilers are a result of their live weight.

Tumburawa et al.[19] opined that the nutritional profile of chickens influences muscular growth, as an increase in protein levels of diets often leads to better muscle deposition and the production of leaner meat that translates to improved live weight. Thus, the low carcass weight observed in diets stuffed with ash-treated African locust bean hull may be attributed to low utilization of protein and the presence of tannin in diets, which depressed nutrient digestion and utilization[6].

Sundu[7] had attributed the low performance of chickens fed palm kernel cake meal diets to an imbalance of amino acids, especially methionine and lysine. These amino acids (lysine and methionine) are low in palm kernel cake, due to the high proportion of its nitrogen and protein being situated and locked up inside the plant cell wall. Thus, the application of enzymes to unlock the bound nutrients was being advocated. Palm kernel-based diets, as such, might not provide the necessary protein to enhance growth.

In agreement with present findings, Kakagida et al.[6] reported comparable values for carcass weight and liver weight in dried African locust beans supplemented broilers during the finishing phase. Similarly, Obun[13] affirmed that heavier chickens with higher live weight at slaughter produced greater eviscerated yield. In the present study, the values recorded for dressing percent across treatments, however, were similar to 71% reported for tropical broiler chicken by Bonny et al.[5]. On the contrary, Belem et al.[16] observed significantly higher values for carcass yield and live weight in chicken broilers fed supplemented *Parkia biglobosa* fruit flour meal-based diets compared to the control batch. The variations observed in values for carcass weight and dressing percent in these studies may be a result of differences in strain of chickens, meat handling techniques, and processing methods.

The present study and those of Bot et al.[18], Obun[13], and Belem et al.[16] were conducted under the same tropical conditions, but the strains of chickens differed, as Bot et al.[18] and Obun[13] studied broiler chickens while Belem et al.[16] researched local chickens. The processing methods for African locust bean fruit hull also differed, as the present study employed ash treatment while Obun[13] used fermented African locust bean seed meal. Bot et al.[18] replaced maize in broiler diets with untreated *Parkia biglobosa* seed meal. Processing has been reported to destroy natural toxins in legumes, thereby improving the nutritive value and digestibility of feedstuffs[23].

Therefore, the significant increase in performance, carcass yield, and live weight of chickens on processed African locust beans hull-based diets was in line with the report of Obun[13], who reported that processing improves energy content of feed availability and utilization of protein. Thus, leading to better performance, which also agreed with the report of Bot et al.[18], who opined that some levels of processing are necessary to reduce the anti-nutritional content of *Parkia biglobosa* pulp before being incorporated into poultry diets.

4.2. Carcass primal cuts

The primal cuts recorded non-significant values across treatment groups, indicating that the inclusion of 25% and 50% ash-treated *Parkia biglobosa* fruit hull in the diets of finishing broilers had no negative influence on the chickens. This observation disagreed with that reported by Bot et al.[18], who noticed a significant decrease in prime cuts (breast, wings, and drumsticks) of chickens as the level of *Parkia* pulp increased across the dietary treatments. This observation was in cognizance of the live weight of the chickens, which also reduces with increased supplementation levels. On the contrary, Muazu et al.[15] recorded a significant improvement in breast muscle (21.97%), drumstick (10.74%), and thigh muscles (11.65%) weights of broiler finishers fed soaked and fermented African locust bean seed meal. The discrepancies in observed values could be a result of effective processing, as Ayanwale et al.[3] and Oguche et al.[22] found a positive attribute for toasted *Afzella africana* seed meal as against the raw *Afzella africana* seed meal-based diet, which inhibited broiler growth due to lower protein quality and a lower level of essential vitamins.

4.3. Internal organ weight

The weight of internal organs that recorded similar values across supplemented treatment groups may suggest that the nutrient density of the ash-treated diets needs to be increased to the level that was obtained in the control diet to meet the demand for maximum flesh lay down[21]. The result of the present study agreed with the findings of Bot et al.[18], who observed no significant differences in the weight of liver, heart, gizzard, and spleen among dietary supplementations of African locust bean hull.

5. Conclusion

The present study demonstrated that ash-treated *Parkia biglobosa hull* could replace palm kernel cake meal at 25% inclusion levels in the diets of broiler chicken without any adverse effect on carcass characteristics. Inclusion of *Parkia biglobosa* hull in the diets of broiler chicken did not have a detrimental effect on carcass yield (back, drumstick, breast, thigh, and wings) of chickens. Ash-treated African locust bean hulls could also be used in livestock feeding by poultry nutritionists, feed millers, and livestock farmers. Employing ash-treated locust bean hulls in livestock feeding will therefore be an additional source of energy and amino acids not competed for as food when compared with other conventional food sources eaten by humans. Further research is needed to assess the effect of ash-treated *Parkia biglobosa* hull meal on growth performance, bone matrix, and egg quality traits of laying hens.

Declarations

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Authors' contributions

Agbana Jude Abayomi conceptualized, wrote the original draft, validated, visualized, collected data, analyzed data, reviewed, edited the manuscript, and read and agreed to the last edition of the article.

Availability of data and materials

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Competing interests

The author declares no competing interests.

Ethical considerations

Ethical issues, including plagiarism, consent to publish, misconduct, data fabrication and/or falsifications, double publication and/or submission, and redundancy, have been checked by the author.

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