Performance, Serum Biochemical Indices and Cost Effectiveness of Broiler Chicks Fed Varying Levels of *Prosopis Africana* Pod Meal Fermented With Rumen Fluid

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Abstract:
Issues: Cereal grains form the basis of livestock/ poultry feed and as such there is stiff competition between man, industries and animal for these grains as food; hence hike in prices of cereal grains which translate into high cost of finished animal products. The use of alternative feedstuff that is less competed for and with similar nutritional value will bridge this gap. **Methods:** A study was conducted to investigate the effect of fermented *Prosopis africana*pod meal (FPAPM) on performance, cost effectiveness and serum biochemical indices of broiler chicks. A four week feeding trial was conducted using 150 day old Ambor acre strain of broiler chicks. Five experimental diets containing 0, 25, 50, 75 and 100% *Prosopis africana* pod fermented with rumen fluid were used to replace maize in a completely randomized design (CRD). Each treatment was replicated five times with thirty (30) birds per treatment. All standard and management practices were strictly observed. Data was collected on performance, cost effectiveness and serum biochemical indices. **Findings:** Results revealed that mean weekly feed intake, body weight, body weight gain and, feed conversion ratio were significantly ($p<0.05$) affected. Performance indices depreciate with increased levels of supplementation across treatment groups; the birds fed TI and T2 performed better. Serum indices were not affected by the treatments. Result revealed a progressive decrease in cost of feed (g) and cost of feed intake/bird (g) across treatments as the level of supplementation increased. The cost of feed/g weight gain was least with birds fed 25% FPAPM. Negative values were observed with feed cost savings per gram of meat, for 50%, 75% and 100% of FPAPM, thereby revealing that no savings accrued with supplementation of FPAPM at these levels. **Conclusion:** The study concluded that *Prosopis africana* pod fermented with rumen fluid could replace maize at 25% level in broiler chicks' diets without compromising optimum productivity.
Keywords: Maize, Prosopis africana pod, rumen fluid, performance, serum biochemistry and cost analysis.

Introduction

The major item of cost in poultry production is feed (feed constitutes about 70 – 75% of the total cost of production); this is due to the stiff competition for cereal grains between man and animal as well as the issue of seasonal availability of these feedstuffs (Abang et al., 2015). In order to ameliorate this problem, alternative feedstuffs that are less competitive or not competed for at all by a human is been sort for. Examples of such feedstuffs are; cocoyam (Abang et al., 2013), mango kernel (Abang et al., 2018),

Prosopisseed coats (Abang et al., 2016; Odey et al., 2019; Bishop et al., 2021), sweet orange peel (Odunlade et al., 2020), baobab seed (Gyang et al., 2021), cocoa husk (Ogana et al., 2020). However, it has been observed that these non - conventional feedstuffs are rich in anti- nutritional factors like tannins, saponins, oxalates, glycogenic glycosides, protease inhibitors, prosopine and, toxic amino acids which are capable of inducing adverse effects on simple stomached animals when consumed without adequate processing (Bishop et al., 2021). Processing methods such as; boiling, drying, autoclaving, fermentation have been reported to reduce these anti-nutrients to a more tolerable level; the presence of these anti-nutritional factor informed the need for serum biochemical assay. Serum biochemistry is a useful tool in clinical diagnosis as it serves as an indicator of various systems states, particularly serum enzyme level determination can provide information on the integrity of the liver and muscular tissues. Moreover, there is a dearth of information on the use of Prosopispod meal in the nutrition of non- ruminants.

2. Literature Review

The major item of cost in poultry production is feed; one of the first manifestation of the problem for feeding animal is competition for feedstuff that are commonly used by human and livestock like; maize, soya, sorghum and groundnut (Iyeghe *etal*., 1992). Therefore, there is a worldwide interest in the search for new plant species capable of supplementing traditional crops and staples (Jurgen *etal*., 1998). Droper(1944) used *prosopisjuliflora* pod flour to replace maize and wheat in nutrient of pigs and chickens and reported positive result.Ausol *et al*. (2001) conducted a study on effect ofsoaked prosopis seed on broiler chicks using replacement levels of 25%, 50%, 75% and 100%, and reported better performance with birds served 25% replacement in terms of live body weight gain and feed conversion ratio (FCR).It is in the light of this that *Prosopisafricana* pod meal is considered as potential feedstuff for broiler chickens.

3. Objective of the study

This study was designed to examine the growth performance, serum biochemical indices and cost effectiveness of producing broiler chicks fed varying levels of *Prosopis africana* pod (PAP) fermented with rumen content (fluid).

4. Methods of the Study

Experimental Site (Location)

The study was conducted at the poultry unit of the Livestock Teaching and Research Farm University of Agriculture, Makurdi. Makurdi is located on latitude 7^0 14 N^1 and longitude 8^0 31^1 and a height of 90 meters above sea level in the Southern Guinea Savannah ecological zone of Nigeria. The rainy season spans from May to October, while dry season spans from November to April. Mean annual rainfall ranges from 1270 to 1397 mm. Mean temperature ranges from 22.3°C to 33.41°C; the mean relative humidity is 64.58% (FGN Visitation Report, 2011). The University is located on a land mass of 7,986.22 hectares out of which less than half is occupied by buildings and crop farms, the rest is natural grassland on which cattle are grazed (FGN Visitation Report, 2011).

Preparation of Experimental Material

Prosopis africana pods (pod) were obtained within Makurdi local government area of Benue State in the month of March. Each 68kg of pod was mixed with 48kg of rumen content collected from the abattoir in Wurukum market, Makurdi until a homogenous mixture was achieved. This was later packed into black cellophane bagsand tied properly to allow for fermentation. The product was allowed to undergo fermentation for four days.Fermented *Prosopis africana* pod (FPAP) was sundried for seven days so as to reduce the moisture content to less than 10% for prolonged keeping before bagging. Full fat soybean was toasted on fire; the grain was toasted until it became crispy and brownish in color. Fermented *Prosopis africana* pod, soybeans and yellow maize were milled separately using hammer mill. The proximate composition the pod was analyzed using the gravimetric methods (AOAC official methods 967.08).

Animal Grouping /Design

One hundred and fifty (150) day old broiler chicks (Ambor Acre broilers) purchased from Amos farm; Sieberer hatchery limited in Ifed Odon road, Awe Ibadan, Nigeria was used for this study. On arrival the birds were randomly allotted to five dietary treatments. Each treatment comprised of five (5) replicates and each replicate contained six (6) birds in a completely randomized design (CRD).

Formulation of Diets

The feed was formulated to meet the nutritional requirements for broiler starter. *Prosopis africana* pod (PAP) meal replaced maize at 0%, 25%, 50%, 75%, and 100% representing – T1, T2, T3, T4 and T5 respectively (Table 1).

Table1. Composition of broiler starter diet with varying levels of *prosopisafricana* pod meal fermented with rumen content

Ingredients	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	T_5 (100%)
Maize	52.00	39.00	26.00	13.00	0.00
Prosopis africana pod	0.00	13.00	26.00	39.00	52.00
Full fat soybean	34.50	35.50	35.25	35.50	36.50
Fish meal	5.00	5.00	5.00	5.00	5.00
Maize offal.	6.00	5.50	5.25	5.00	4.00
Bone meal	1.50	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50	0.50
Premix	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00

Analyzed Nutrients:

ME(Kcal)	2862.94	2820.93	2789.28	2784.84	2782.94
CP	23.20	22.68	22.33	22.00	21.80
Lysine	1.01	0.98	0.94	0.91	1.80
Methionine	0.53	0.52	0.52	0.51	0.51
EE	4.14	3.69	3.21	2.76	2.30
CF	3.74	4.72	5.70	6.69	7.67
Ca	1.37	1.40	1.42	1.43	1.44
P	0.91	0.91	0.92	0.91	0.87

**Vitamin/mineral premix from Bio-mix Broiler starter supplied per kg of diet: Vit. A,10,000 i.u; Vit. D_3, 2000 i.u; Vit. E 3mg; Vit. K, 2 mg; Vit. B_1 (Thiamine), 1.8mg; Vit B_2(Riboflavin), 5.5mg; Vit. B_6 (Pyridoxine), 3mg; Vit. B_{12} 0.015mg; Pantothenic acid 7.5mg; Folic acid 0.75mg; Niacin 27.5mg; Biotin 0.6mg; Choline chloride 300mg; Cobalt 0.2mg; Copper 3mg;Iodine 1mg; Iron 20mg; Manganese 40mg; Selenium 0.2mg*
Zinc 30mg; Antioxidant 1.25mg; ME= Metabolisable Energy.

Routine Management

Birds were fed with fermented Prosopis africana pod basal diets at different levels of inclusions; 0%, 25%, 50%, 75% and 100% for treatments I, ii, iii, iv and, v respectively, throughout the duration of

four weeks. A known quantity of feed was given to each replicate and the left over was measured and recorded every morning before commencement of another day's feeding. The equipment used was shallow feeders, shallow drinkers and weighing scale. Light was provided all day to enable chicks feed ad libitum. Bio sanitary and security measures were strictly adhered. During the experiment, mortality rate were recorded.

5. Data used

The performance indices were measured following the methods of Abang *et al.*, 2023

Blood Indices

Blood collection

At the end of the experiment (4th week) blood samples were collected from one broiler per replicate. Bleeding was done by puncturing of the vein located at the wing web with the aid of 5ml scalp vein needle set. About 2ml of blood was collected from each bird into bottles without EDTA which was centrifuged in a macro centrifuge to generate serum for biochemical analysis following procedures described by Duwa *et al.* (2014). The serum samples were analyzed for total protein, albumin, globulin, alkaline phosphates, alanine aminotransferase (ALT) and aspartate aminotransferase (AST) using sigma assay kits. These tests were carried out at the Physiology and Biochemistry laboratory, College of Veterinary Medicine, Federal University of Agriculture, Makurdi.

Data for cost analysis were collected and computed using the methods of Abang *et al.* (2018)

6. Data Analysis

Data collected were subjected to one way analysis of variance (ANOVA) and means that differed significantly were separated using the Duncan Multiple Range Text (DMRT) as outlined by Steel and Torrie (1980). Results were presented in mean ± standard error mean (X± SEM).

Table2: Proximate composition of *Prosopis africana* pod meal fermented with rumen fluid,

PARAMETERS	% COMPOSITION
Dry matter	91.00
Moisture	10.94
Crude fiber(CF)	20.55
Ether extract(EE)	10.50
Nitrogen free extract (NFE)	47.23

Table3: Performance Characteristics of Broiler Chicks Fed Varying Levels of *Prosopis africana* Pod Meal Fermented with Rumen Fluid (g)

	Replacement Levels (%)				
PARAMETER	**0%**	**25%**	**50%**	**75%**	**100%**
AWFI	422.25±5.75[a]	348.50±17.5[b]	344.75±9.74[b]	327.25±12.25[b]	285.50±7.00[c]
AWBW	307.5±12.5[a]	237.25±7.75[b]	182.5±22.5[c]	177.50±2.5[c]	126.75±2.75[d]
AWWG	137±2.5[a]	103.13±13.5[b]	74.50±4.0[c]	69.00±10.5[cd]	47.75±0.75[d]
FCR	3.08±0.38[a]	3.38±0.32[b]	4.39±0.21[c]	5.00±0.57[cd]	5.98±0.41[d]

[a,b,c,d]: Means in the same row with different superscripts are significantly ($P < 0.05$) different
AWFI= average weekly feed intake, AWBW= average weekly bodyweight,
AWWG= average weekly weight gain, FCR= feed conversion ratio

Table 4: Serum Biochemical composition of broiler chicks fed varying levels of *Prosopis africana* pod fermented with rumen fluid

Parameters	**0%**	**25%**	**50%**	**75%**	**100%**
Total Protein (g/dl)	3.0±0.30	3.00±0.10	3.00±0.40	3.35±0.25	3.15±0.25
Albumin (g/dl)	1.95±0.15	1.75±0.05	1.90±0.20	2.15±0.15	2.10±0.30
Globulin (g/dl)	1.05±0.05	1.25±0.05	1.10±0.20	1.20±0.10	1.05±0.05
AST (IU/L)	106.00±14.00	99.00±1.00	95.50±6.50	107.50±2.50	110.00±10.00
ALP(IU/L)	80.00±4.00	73.00±6.00	79.50±2.50	75.00±1.00	80.00±9.00

AST- Aspartate aminotransferase
ALP- Alkaline phosphate

Table5: Cost effectiveness of broiler chick fed varying levels of *Prosopis africana* pod fermented with rumen fluid

	Replacement Levels (%)				
Parameters	**0%**	**25%**	**50%**	**75%**	**100%**
Cost of feed (#/g)	0.20	0.19	0.18	0.17	0.16
Ave. cost of feed intake/bird (#/g)	84.45	66.52	62.06	55.63	45.68
Cost of feed/g weight gain	260.11	224.84	272.44	278.15	273.16
Cost of saving/g of meat			-12.33	-18.04	-13.05

Results

Result of proximate composition of*Prosopis africana* pod meal (PAPM) fermented with rumen fluid is shown in Table 2. The proximate fractions were: 9.00, 10.94, 20.55, 10.50 and 47.23 for moisture, CP, CF,

EE, ash and NFE, respectively. The moisture was higher than 9.8% reported by Gammanial (2015) who fermented *Prosopis africana* pod in table water for 24 hours at room temperature. The increase in crude protein of PAPM could be associated with the microbes which degrades the sample by secreting cellular enzymes which subsequently increased the protein content (during protein hydrolysis) as well as microbial biomass (Odetokun, 2000). Ash equally increased as a result of microbes that are able to synthesize vitamin B complex. Crude fiber increased because of the roughages in the rumen fluid may not have been properly winnowed prior to milling. However, NFE was lower due to high value of CF, which serves as energy diluent; in addition, fermentation reduces carbohydrate content of a feed. (Odetakun, 2000)

Performance characteristics of broiler chicks

The results of mean weekly feed intake, mean weekly body weight, mean weekly weight gain, feed conversion ratio are presented in Table 3 . The result of mean weekly feed intake of broilersfed*Prosopis africana* pod meal ranged from 422.25±5.75 to 285.5±7.00 (g). Chicks fed 100% *Prosopis africana* pod meal consumed significantly least feed; highest consumption was recorded with chicks fed control diets. Odey *et al*. (2019) reported similar trend when *Prosopis africana* seed coat treated with multi enzymes was fed to chicks (layers). Adeyemi *et al*. (2021) on the other hand, recorded a non- significant effect when *Prosopis africana* seed coat treated with multi enzymes was fed to finisher broiler; probably because of the age of the birds. The reduced intake across the treatments could be due to the presence of anti-nutritional factors such as tannins, saponin, hydrogen cyanides, which render the feed unpalatable. In other words, increased supplementation with FPAP leads to increased level of anti -nutritional factors in the feed which resultant effect is reduced palatability. The results showed that mean weekly body weight decreased across treatments with heavy supplementation of *Prosopis africana* pod meal with maize. It was observed that chicks fed control diets had significantly heavier weights than others probably because they consumed significantly more feed than chicks of other treatments due to feed palatability and absence of anti -nutrients. Anti-nutritional factors like trypsin inhibitors and tannins can cause a decrease in voluntary feed intake, and digestibility of protein and impair the absorption of nutrients in the ingesta which results in depressed body weight (Abang *et al.*, 2013). This result compares with the reports of Odey *et al*. (2019) and Adeyi *et al*. (2021) who recorded decreased body weights across treatments with increased supplementation of PASCM(*Prosopis africana* seed coat meal) in layer chicks' and, finisher broiler diets. The results revealed that weight gain decreased across the treatment groups. Chicks fed control diet (0%) recorded the highest amount of body weight. This result was not in line with the findings of Mariam *et al*. (2013) who placed broiler chicks on*Prosopis pod* flour supplemented with combination of micro xylem and phytase enzymes. Feed conversion ratio ranged from 3.02±0.38 to 5.23±0.41. Chicks fed 0% and 25% diets had least values followed by 50%, 75% and 100% respectively. A progressive increase in the value of FCR across treatments indicates a poor feed conversion with an increased level of supplementation. Anti-nutritional factors present in *Prosopis* such as tannins and phytates would have influenced these results

Serum Biochemical Indices

The result of the serum biochemical analysis is presented in Table4. Result of total protein showed no significant (P>0.05) differences across treatments. The mean values of total protein (3.0-3.35mg/dl) across the treatments were within the normal reference ranges of 3.0-4.9mg/dl for poultry reported by Mezzuli *et al*. (1992). This implies that protein was adequate for both control diet and diets containing FPAP (fermented *Prosopis africana* pod). The anti-nutrients (tannins/ trypsin inhibitors) did not interfere with availability of nutrients such as protein. This report contradicts the observations of Hassan et al., 2014 who recorded values (8.12-8.50mg/dl) above the upper limit of normal reference range when broilers were fed *Prosopis africana*, but was in consonant with the findings of Bishop *et al.* (2021) who fed *Prosopis africana* pod meal to broilers. Serum albumin ranged from 1.75-2.15g/dl and falls within normal reference range of 1.17-2.74g/dl by Mezzuli *et al*. (1992). There were no significant (P>0.05) differences in treatments. Hassan *et al*. (2014) had similar normal ranges (1.51-2.10g/dl) but Bishop *et al*. (2021) and Chile (2014) recorded most values below/ above the normal reference ranges; 1.45-1.75g/dl and 1.73-3.57g/dl for broilers fed *Prosopis africana,* respectively. Results revealed that anti -nutrients present in the

diets such as tannins, phytates, protease/ trypsin inhibitors were reduced to a tolerable limit; resulting in adequate protein utilization across treatments. High levels depict liver damage, kidney disease, etc.
The values of globulin (1.05-1.25g/dl) were below the lower limit of normal range by Mezzuli *et al.*, 2014 (1.83-2.16g/dl) in all the treatments. These results were not different (P>0.05) across treatment groups. Bishop *et al*. (2021) reported similar low ranges (0.43- 1.88g/dl). The low values recorded in this study does not portray liver/kidney damage, since serum total protein, serum albumin and liver enzymes were within normal ranges. Abnormal results may also be caused by certain medicines, dehydration. The findings could be attributed to medicine; antibiotics were given intermittently to the birds as prophylaxis. The mean range (95.50-110.00IU/L) of aspartate aminotransferase (AST) was within normal ranges (70 - 220IU/L) by Mezzuli *et al*. (2014). There were no significant differences (P>0.05) among the diets. Abdel-fattah *et al*. (2008) reported similar normal ranges of 101.34-107.85IU/L for broilers. This implies that the liver and kidney of birds were normal and healthy; high values usually signify liver/kidney damage. Serum alkaline phosphate (ALP) ranged from 75-80IU/L and this fell within normal ranges by Mezzuli *et al.* (2014). There were no significant (P>0.05) differences among the treatment groups. These ranges contradict the assertion of Suchrint *et al*. (2004) for normal range (167-305IU/L). Abnormal levels of ALP an indication of malnutrition caused by a deficiency in vitamins and minerals which sometimes could be attributed to anti-nutritional factors like phytate, oxalates which bind and prevent mineral absorption; especially phosphorus, zinc, calcium and magnesium. Flagib *et al*. (2002) reported lower ranges of 28.23-62.16IU/L indicating malnutrition or renal damage thereby revealing that serum P was inadequate in the diet containing various levels of FPAPM.

Cost Analysis of Broiler Chick

Result showed a progressive decrease in cost of feed (g) and the cost of feed intake/bird (g) across treatments as the level of supplementation increased. Anti-nutrients present in PAP would have reduced the palatability of the feed thereby, resulting in less consumption and subsequently reduced cost of feed intake by the broiler chick. Similar observations were made by Odey et al. (2019) when PASCM (*Prosopis africana* seed coat meal) was served to layers. Cost of feed/g weight gain was least in birds fed 25% FPAPM. Negative values were observed with feed cost savings per gram meat, for 50%, 75% and 10% inclusions, thereby revealing that no savings accrued with supplementation of FPAPM at these levels; probably because of the poor conversion ratio. However, savings accrued (35.25) when birds were fed 25% FPAPM

6. Conclusions

The study concluded that *Prosopis africana* pod (PAP) could be used in broiler chicks' diets up to 25%, beyond, risks optimum productivity

Declarations

Authors' contribution

F. B. P. Abang performed conceptualization, writing, original draft preparation, review and editing. E. E. Nsa performed conceptualization and evaluation of manuscript before submission. E. E. Archibong performed conceptualization and evaluation of manuscript before submission. P. O. Ozung performed conceptualization and evaluation of manuscript before submission. P. Aondoyila performed conceptualization and evaluation of manuscript before submission

Ethical Approval

All authors hereby declared that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

Conflict of Interests

The authors declare that there is no conflict of interest.

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