

Evaluation of diets containing varying levels of cassava root – African locust bean seed meal blend on growth response and nutrient digestibility of starter broiler chicks

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ABSTRACT: The prevailing high cost of conventional feed ingredients, especially energy sources such as maize, necessitated the use of cheap, readily available and nutritionally comparable alternatives, which could be found in cassava root meal. Efficacy of varying levels of cassava root meal – African locust bean seed meal (CRM-ALBSM) blend on growth response and nutrient digestibility of starter broiler chicks was evaluated. A total of two hundred and forty (240) one-day-old broiler chicks were used in four weeks feeding trial. Six experimental diets were formulated using cassava root meal and African locust bean seed blend at a ratio of 20:1 such that diet T1 (Control) contains no CRM-ALBSM while diets T2, T3, T4, T5 and T6 contained varying levels of CRM-ALBSM at 10, 20, 30, 40 and 50%, respectively. The broiler chicks were weighed and allotted to six dietary treatments of 40 birds each. The groups were replicated four times in a completely randomised design of 10 birds per replicate. The parameters determined for growth performance include: Final weight (g), Weight gain (g/bird), Daily weight gain (g/bird), Feed intake (g/bird), Daily feed intake (g/bird) and Feed conversion ratio (FCR). For the nutrient digestibility, dry matter, crude protein, crude fibre, ether extract and ash were determined. Final body weight did not follow a specific trend. The least ($p < 0.05$) value of 1355.00 g was recorded for final weight in birds fed a diet containing 30% CRM-ALBSM. Birds fed a maize-based control diet revealed a higher value of 1500 g for final weight. Highest feed intake of 2301.00 g and 2311.33g were obtained for birds fed diets containing 40 and 50% CRM-ALBSM. Slightly low ($p < 0.05$) dry matter digestibility values of 63.14% and 63.31 % were recorded for birds fed 40 and 50% CRM-ALBSM. Cost per kg feed decreased with increasing level of CRM-ALBSM. In conclusion, CRM-ALBSM up to 30% replacement level for maize improved growth response, nutrient digestibility and economics of production of starter broiler chicks.

Keywords: Cassava, locust bean, growth response, nutrient digestibility, chicks.

INTRODUCTION

Nigerian poultry farmers continue to experience a rise in cost of production as a result of the increasing cost of feeds. Prices of conventional energy sources in Nigeria for feeding chickens keep on increasing. Of these energy sources, maize is the most widely used, and its price in the market has been the most unpredictable. This is partly because it has so many alternative uses and its production has not been able to meet the demands of both man and animals. Feed cost constitutes approximately 65–70% of total poultry production expenses in sub-Saharan Africa

(Osei-Adjei *et al.*, 2025), and maize remains the primary energy source, comprising 55–65% of most poultry diets.

Alternatives to conventional energy and protein feed ingredients for poultry must be cheap or cost-effective, readily available, have suitable nutrient composition and should have minimal negative effects on birds. Bearing this in mind, researchers, animal feed industries and poultry producers have over the years directed their attention towards finding alternative energy sources that meet the aforementioned requirements (Okereke, 2012). One such

alternative is cassava root.

Cassava root meal (CRM) is an important potential energy substitute for maize in tropical poultry diets because of its wide availability, high starch content (65–75% DM), and lower cost relative to maize (Ogbuewu and Mbajorgu, 2022; Yang *et al.*, 2024). However, its sole use as a maize replacement is limited by its low crude protein content (< 3.0%), poor amino acid profile, and the presence of cyanogenic glycosides (linamarin and lotaustralin) that yield hydrocyanic acid (HCN) on hydrolysis (Ogbuewu *et al.*, 2023; Wang *et al.*, 2023). Appropriate processing techniques such as sun-drying, soaking, and fermentation have been demonstrated to reduce HCN concentrations to safe levels for poultry consumption (Tirmidhi *et al.*, 2022; Yang *et al.*, 2024).

A meta-analysis by Ogbuewu and Mbajorgu (2022) confirmed that cassava can partially replace maize in broiler diets, though outcomes depend on inclusion level, processing method, and dietary supplementation. Similarly, studies on roselle seed meal–CRM blends (Tirmidhi *et al.*, 2022) and cassava starch residue (Osei-Adjei *et al.*, 2025) suggest that pairing CRM with a protein-rich complement improves productive performance at moderate inclusion levels.

Legumes generally are good supplements to cereals, which are limiting in essential amino acids such as lysine. African locust bean (*Parkia biglobosa*) seed meal (ALBSM) is a plant-based protein source that has attracted growing interest in poultry nutrition. Rich in crude protein (25–35%), energy, essential amino acids, and minerals, it has been explored as a cost-effective supplement to energy-dense but protein-poor ingredients in monogastric diets (Animashahun *et al.*, 2024). Blending CRM with ALBSM may therefore address the protein and amino acid limitations of CRM while simultaneously reducing reliance on maize.

The inclusion of cassava root as alternative energy feed resources in the poultry industry to cushion the effect of the high cost of production is a veritable tool toward profitability. Fortification of cassava root with African locust bean seed can add value to the blend product by enriching the paucity of crude protein in cassava root meal. Despite the individual assessment of these two ingredients, their combined use as a blend to replace maize in starter broiler diets has received limited scientific documentation. The present study therefore evaluated the potency of varying levels of cassava root meal – African locust bean seed meal (CRM-ALBSM) blend on growth response, nutrient digestibility and cost-benefit analysis of starter broiler chicks.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Poultry Unit of the

Teaching and Research Farm of Taraba State University, Jalingo, at Universal Transverse Mercator (UTM) coordinates of 765089 m E and 985268 m N (WGS 84, ZONE 32N).

Source and processing of test ingredient

The cassava roots used for this study were obtained in Mutunbiu town, Gassol Local Government Area of Taraba State, Nigeria. The fresh cassava roots were peeled, washed and sliced. The sliced cassava roots were sun-dried for 4 days, after which they were packed in bags and milled. African locust bean seeds were purchased from Jalingo market in Jalingo Local Government Area of Taraba State. The seeds were sorted and cleaned.

Boiled African locust bean flour was prepared according to the method of Esenwah and Ikenebomeh (2008). During preparation, African locust bean seeds, which were free from dirt and extraneous materials, were thoroughly cleaned with water. The cleaned seeds were boiled with water at 100 °C for 8 hours with occasional addition of water to avoid drying up. After that, the boiled seeds were drained, rinsed and dehulled manually by pressing out the seeds. The dehulled seeds were rinsed, spread on the trays and dried in a hot air oven (Model DHG 9101 ISA) at 60 °C for 10 h with occasional stirring of the seeds at intervals of 30 minutes to ensure uniform drying. The dried seeds were milled in a hammer mill and sieved through a 500 micron mesh sieve. The flour produced was packaged in an airtight plastic container, labelled, and stored until needed for further use.

Experimental diets

Cassava root - African locust beans seed meal blend was mixed at a ratio of 20 kg cassava root meal (CRM) to 1kg African locust beans seed meal (ALBSM). The prepared CRM- ALBSM blend was used to formulate six diets such that maize was replaced by CRM- ALBSM blend at 0, 10, 20, 30, 40 and 50%, which represent T1 (Control), T2, T3, T4, T5 and T6, respectively. The composition of the six formulated diets is presented in Table 1.

Experimental birds and management

A total number of 240 day-old unsexed broiler chicks of commercial strain (Cobb 500) were purchased from a reputable hatchery. The chicks were weighed and allotted to six dietary treatment groups of four replicates each in a Completely Randomised Experimental Design. Each replicate consisted of 10 chicks, for a total of 40 birds per treatment group.

The chickens were housed in deep litter pens measuring 1 square meter, whose floors were thoroughly cleaned and

Table 1. Percentage composition of broilers starter diets (0 – 28th day).

Ingredients	CRM – ALBSM Blend levels					
	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)
Maize	51.50	46.35	41.2	36.05	30.90	25.75
CRM-ALBSM	0.00	5.15	10.30	15.45	20.60	25.75
Soy bean meal	30.00	30.00	30.00	30.00	30.00	30.00
Groundnut cake	6.70	6.70	6.70	6.70	6.70	6.70
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00
Maize offal	5.00	5.00	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00
Lime stone	1.00	1.00	1.00	1.00	1.00	1.00
DL-Methionine	0.2	0.2	0.2	0.2	0.2	0.2
L-Lysine	0.1	0.1	0.1	0.1	0.1	0.1
Salt	0.25	0.25	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis						
ME (kcal/kg)	2921.31	2919.83	2919.11	2918.52	2916.71	2915.02
Crude protein (%)	22.56	22.63	22.72	22.98	23.21	23.42
Crude fibre (%)	4.01	4.01	4.01	4.01	10.33	10.33
Ether extract (%)	3.74	3.74	3.74	3.74	4.34	4.34
Calcium (%)	1.07	1.07	1.07	1.07	1.07	1.07
Phosphorus (%)	0.55	0.55	0.55	0.55	0.55	0.55
L-Lysine (%)	1.26	1.26	1.26	1.26	0.99	0.99
DL-Methionine (%)	0.54	0.54	0.54	0.54	0.46	0.45

*Premix to supply kg/diet; 9,000,000IU of Vit A; 2,135,000IU of Vit D3; 20,000mg of Vit E; 1,340mg of Vit B1; 5,340mg of Vit B2; 1,670mg of Vit K3; 12,000mg of Pantothenate; 2,670mg of Vit B6; 13.4mg of Vit B12; 30,000mg of Niacin; 100mg of Biotin; 100mg of Folic acid; 0mg of Copper; 63,340mg of Iron; 78,000 of Zinc; 1,17340mg of Manganese; 775mg of Iodine; 180mg of Selenium. **Keys:** CRM = Cassava root meal, ALBSM = African locust bean seed meal.

disinfected before being filled with a 10cm deep layer of wood shavings. The birds were brooded for fourteen days. The brooder temperature was maintained at 35°C in week 1, declining progressively in subsequent weeks. A commercial multivitamin was administered in clean water starting on day two of the experiment at a rate of 1g per 5 litres of water, following the manufacturer's instructions. Birds were vaccinated against Newcastle disease (Lasota strain, days 7 and 21) and Infectious Bursal Disease (Gumboro) on day 14 according to the standard vaccination programme recommended by the Federal Department of Animal Production and Husbandry Services, Nigeria. Feed and water were provided *ad libitum* throughout the period of the study.

Data collection

Performance characteristics

The initial weights of the birds were taken on arrival. The live weights of the birds as well as the feed consumption of each replicate were measured weekly. Feed conversion

ratio for each replicate was determined by dividing the feed intake by the weight gain.

$$\text{Feed intake/bird (g)} = \frac{\text{Quantity of feed fed} - \text{Quantity of feed left over}}{\text{Number of birds} \times 28 \text{ days}}$$

$$\text{Daily weight gain (g)} = \frac{\text{Final live weight} - \text{Initial weight}}{\text{Number of birds} \times 28 \text{ days}}$$

$$\text{Feed conversion ratio} = \frac{\text{Quantity of feed consumed}}{\text{Weight gain}}$$

Nutrient digestibility

A metabolic trial was conducted on the 28th day of the study. A bird per replicate was randomly selected and housed separately in an appropriate metabolic cage fitted with a feeder and drinker. The birds were allowed to acclimatise for 2 days before the commencement of 4 days of feeding and excreta collection. A known weight of feed was given, and excreta collected per bird per day was oven-dried at 60°C and used for analyses. Proximate composition of the feed and dried excreta was analysed

for dry matter, crude protein, ether extract, crude fibre and ash using standard methods of AOAC (2000). The formulae for calculation are as follows:

$$DM = \frac{\text{Feed intake g} \times \% DM(f) - \text{Excreta Output g} \times \% DM(Ex)}{\text{Feed intake g} \times \% DM(f)} \times \frac{100}{1}$$

$$CP = \frac{\text{Feed intake g} \times \% CP(f) - \text{Excreta Output g} \times \% CP(Ex)}{\text{Feed intake g} \times \% CP(f)} \times \frac{100}{1}$$

$$CF = \frac{\text{Feed intake g} \times \% CF(f) - \text{Excreta Output g} \times \% CF(Ex)}{\text{Feed intake g} \times \% CF(f)} \times \frac{100}{1}$$

$$EE = \frac{\text{Feed intake g} \times \% EE(f) - \text{Excreta Output g} \times \% EE(Ex)}{\text{Feed intake g} \times \% DM(f) \times \% EE(f)} \times \frac{100}{1}$$

$$Ash = \frac{\text{Feed intake g} \times \% Ash(f) - \text{Excreta Output g} \times \% Ash(Ex)}{\text{Feed intake g} \times \% Ash(f)} \times \frac{100}{1}$$

Where: DM = Dry matter digestibility, CP = Crude protein digestibility, CF = Crude fibre digestibility, EE = Ether extract digestibility, Ash = Ash digestibility

Statistical analysis

Data collected will be subjected to One-way Analysis of Variance (ANOVA) in a Completely Randomised Design using SAS (2000), while significant means will be separated using Duncan's Multiple Range Test at 5% level of significance.

RESULTS AND DISCUSSION

The result of growth response of starter broiler chicks fed varying levels of cassava root meal and locust bean seed meal (CRM-ALBSM) blend is presented in Table 2. Varying levels of CRM- ALBSM had a significant ($p < 0.05$) influence on parameters measured. Body weight, feed intake and feed conversion ratio (FCR) were significantly ($P < 0.05$) affected. With the exception of birds fed a diet containing 30% CRM-ALBSM, similar statistical values were recorded for final weight across dietary treatments. The least ($p < 0.05$) value of 1355.00 g was recorded for final weight in birds fed the diet containing 30% CRM- ALBSM.

Numerically, birds fed the control diet revealed a higher value of 1500 g for final weight at the comparative level. Observations in this study could be attributed to the increased bioavailability of essential amino acids, such as lysine and methionine, which are poorly available in cassava diets. The superior performance of T1 is attributable to high starch digestibility of maize, favourable amino acid profile, and consistent energy value, which support maximum productive potential in broiler chickens (Osei-Adjei *et al.*, 2025). The CRM-ALBSM blend, while complementary in protein and energy, may not fully replicate the nutritional matrix of maize, particularly in rapidly growing starter-phase birds.

Total weight gain and daily weight gain follow a similar trend with the final body weight. Birds fed 30% CRM-ALBSM showed least ($p < 0.05$) values of 1155.86 g and 55.03g for total weight gain and daily weight gain. Though not statistically different, improved numerical values were recorded for birds fed the control diet at a comparative level to cassava-based diets. This reduced growth rate could be attributed to the low CP and methionine content of the cassava-based diet, lower energy density and residual anti-nutritional factors associated with high cassava substitution.

Similarly, Ogbuewu and Mbajorgu (2022) documented in a meta-analysis that cassava substitution beyond 30% negatively influences average daily gain and final body weight in broiler chickens. Tirmidhi *et al.* (2022) also reported that a CRM-roselle seed meal blend up to 30% did not compromise final weight in starter broilers, corroborating the present finding that up to 30% substitution is acceptable.

Body weight gain recorded in this current study is in contrast with the linear reduction in body weight of starter chicks fed up to 50% cassava root meal reported by Yadav *et al.*, 2019. A similar significant statistical value of 61.94 g and 57.61g recorded for daily weight gain in birds fed control diet (T1) and 50% CRM- ALBSM (T6) aligns with findings (Tang *et al.*, 2012) who reported retarded weight gain in broiler chickens fed a high level of cassava root meal. This was due to the low conversion efficiency, low digestibility, and poor nutrient balance in the feed, resulting in low body weight gain despite high feed intake.

Birds fed diets containing 40% (T5) and 50% (T6) CRM-ALBSM revealed higher ($p < 0.05$) values for feed intake. Higher statistical ($p < 0.05$) values of 2301.00g and 2311.33g were recorded for feed intake in birds fed 40% and 50% CRM- ALBSM at comparative level across dietary treatments. This hyperphagia at high blend inclusion levels is a compensatory feeding response consistent with the lower energy density of cassava-based diets (Ogbuewu and Mbajorgu, 2022; Wang *et al.*, 2023). Broilers characteristically regulate feed intake to maintain a target energy intake; when dietary energy density declines, as occurs with progressive replacement of energy-dense maize by CRM – ALBSM, birds consume more feed to compensate (Osei-Adjei *et al.*, 2025).

Increased feed intake of birds fed a high inclusion level of CRM- ALBSM compared to a maize-based diet (T1) is in agreement with literature (Oladunjoye *et al.*, 2016). The result of this current study supported the observation of Ogbuewu *et al.*, 2023 who reported high feed intake in broiler chickens fed a 20% inclusion level of CRM- ALBSM compared to the control. The observation in this study may be attributed to the low energy density of cassava-based diets. This resulted in the chickens consuming more to meet their nutrient requirements, resulting in a higher total intake in diets containing cassava-based diets

Improved feed conversion ratio (FCR) of 1.72 was recorded for birds fed control diet (T1) at a comparative

Table 2. Growth response of starter broiler chicks fed graded levels of cassava root meal – African Locust Bean Seed Meal Mixture (1 – 28th day).

Parameters	CRM – ALBSM blend levels						SEM
	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	
Initial weight (g)	199.10	199.17	199.14	199.14	199.16	199.00	0.02
Final weight (g)	1500.00 ^a	1447.00 ^{ab}	1416.67 ^{ab}	1355.00 ^b	1375.00 ^{ab}	1409.00 ^{ab}	17.27
Weight gain (g)	1300.90 ^a	1248.16 ^{ab}	1217.53 ^{ab}	1155.86 ^b	1175.83 ^{ab}	1210.00 ^{ab}	17.27
Daily weight gain (g)	61.94 ^a	59.43 ^{ab}	57.97 ^{ab}	55.03 ^b	55.98 ^{ab}	57.61 ^{ab}	0.82
Feed intake (g)	2242.67 ^b	2223.67 ^b	2225.00 ^b	2246.67 ^b	2301.00 ^a	2311.33 ^a	9.87
Daily feed intake (g)	106.79 ^b	105.88 ^b	105.95 ^b	106.98 ^b	109.57 ^a	110.06 ^a	0.47
Feed conversion ratio	1.72 ^b	1.78 ^{ab}	1.82 ^{ab}	1.94 ^a	1.96 ^a	1.91 ^{ab}	0.02
Mortality (number)	1.00	1.00	3.00	1.00	2.00	2.00	-

Keys: CRM = Cassava root meal, ALBSM = African locust bean seed meal, SEM = Standard error of mean.

Table 3. Nutrient digestibility of starter broiler chicks fed graded levels of cassava root meal – African Locust Bean Seed Meal Mixture (1 – 28th day).

Parameters	CRM – ALBSM blend levels						SEM
	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	
Dry matter (%)	66.70 ^a	66.58 ^a	66.75 ^a	65.26 ^a	63.14 ^b	63.31 ^b	0.40
Crude protein (%)	67.53 ^{ab}	68.35 ^a	66.88 ^{ab}	65.95 ^{bc}	64.53 ^c	63.94 ^c	0.44
Crude fibre (%)	57.53	54.82	50.55	56.48	51.83	51.46	1.07
Ether extract (%)	78.56	81.87	82.37	82.29	81.09	80.28	0.57
Ash (%)	69.29 ^a	65.97 ^{ab}	65.10 ^{ab}	62.45 ^b	68.03 ^a	61.22 ^b	0.85

Keys: CRM = Cassava root meal, ALBSM = African locust bean seed meal, SEM = Standard error of mean.

level to birds fed diets with CRM- ALBSM inclusion. Similar statistical values were recorded for birds fed diets containing CRM- ALBSM (T2-T6). Feed conversion ratio (FCR) was significantly ($p < 0.5$) influenced. The poor feed conversion ratio recorded for birds fed cassava-based diets reflects reduced feed utilisation efficiency, likely due to the higher fibre content and lower amino acid availability of the CRM-ALBSM blend compared with maize, as well as possible residual HCN interference with metabolic processes at higher inclusion levels (Ogbuewu *et al.*, 2023).

The result of nutrient digestibility of starter broiler chicks fed diets containing graded inclusion levels of CRM-LBSM blend is shown in Table 3. Graded levels of CRM-LBSM blend had a significant ($p < 0.05$) effect on the parameters determined. Dry matter, crude protein and ash were significantly influenced by the inclusion of graded levels of CRM-LBSM.

Birds fed diets containing 40% (T4) and 50% (T5) CRM-LBSM showed the least ($p < 0.05$) value of 63.14% and 63.31% for dry matter digestibility. The reduction in DM digestibility at high inclusion levels in CRM-ALBSM likely reflects the higher fibre and lower starch digestibility compared with maize, since cassava starch, while readily fermentable, may be limited by its intrinsic granule structure and residual anti-nutritional factors at high

concentrations (Wang *et al.*, 2023). Yang *et al.* (2024) similarly reported a linear decline in apparent DM digestibility with increasing CRM levels in broiler chickens, attributing the effect to the lower energy and starch utilisation efficiency of cassava-based diets.

Similar statistical values, 66.70, 66.58, 66.75 and 66.26%, were recorded for dry matter in birds fed 0%, 10%, 20%, and 30% CRM-LBSM. The observed trend in this study supported the literature (Khempaka *et al.*, 2016) who reported reduced apparent digestibility when corn was substituted with more than 30% cassava root meal. Birds fed diets containing 40% (T4) and 50% (T5) CRM-LBSM recorded least ($p < 0.05$) values of 64.53 and 63.94% for crude protein digestibility. The slight decline in CP digestibility beyond 20% inclusion may reflect anti-nutritional factors present in higher concentrations of ALBSM, including tannins and phytates, which are known to form complexes with dietary proteins and reduce their bioavailability in poultry (Tamburawa *et al.*, 2017). Additionally, the higher fibre content of the blend at elevated inclusion levels could physically impede proteolytic enzyme access to dietary protein substrates, further reducing CP digestibility (Ogbuewu and Mbajorgu, 2022).

Similar statistical ($p < 0.05$) values of 67.53, 68.35 and 66.88% were obtained for crude protein in birds fed 0%,

Table 4. Cost benefit analysis of starter broiler chicks fed graded levels of cassava root meal – African locust seed meal mixture (1 – 28th day).

Parameters	CRM – ALBSM blend levels						SEM
	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	
Cost of diet per kg (₦)	812.00 ^a	790.00 ^b	768.00 ^c	746.00 ^d	724.00 ^e	702.00 ^f	9.11
Cost of feed consumed (₦/bird)	1821.05 ^a	1756.70 ^b	1708.80 ^c	1676.01 ^{dc}	1665.92 ^d	1622.56 ^e	16.19
Cost per kg gain (₦/kg)	1399.89	1411.47	1405.18	1452.71	1422.90	1340.82	17.12
Production cost (₦/bird)	2244.05 ^a	2179.70 ^b	2131.80 ^c	2099.01 ^{cd}	2088.92 ^d	2045.56 ^e	16.19
Feed cost percentage (%)	81.14 ^a	80.58 ^b	80.13 ^c	79.84 ^{cd}	79.74 ^d	79.31 ^e	0.14
Total variable cost (₦/bird)	3294.05 ^a	3229.70 ^b	3181.80 ^c	3149.01 ^{cd}	3138.92 ^d	3095.56 ^e	16.19
Revenue (₦/bird)	6000.00 ^a	5789.30 ^{ab}	5666.70 ^{ab}	5420.00 ^b	5500.00 ^{ab}	5636.00 ^{ab}	69.10
Gross margin (₦/bird)	2706.00	2559.60	2484.90	2271.00	2361.10	2540.40	61.52
Benefit cost ratio	1.81	1.79	1.78	1.71	1.75	1.82	0.02
Profit index	0.45	0.44	0.43	0.41	0.42	0.44	0.01

Keys: CRM = Cassava root meal, ALBSM = African locust bean seed meal, SEM = Standard error of mean.

10% and 20% CRM-LBSM. Decreased value with high inclusion levels of CRM-LBSM, as observed in this study, corroborating findings of Khempaka *et al.* (2016), who reported decreased values for crude protein with cassava inclusion up to 30%. Ash digestibility did not follow any specific pattern. Birds fed 30% and 50% inclusion levels of CRM-LBSM revealed the least ($p < 0.05$) values of 62.45% and 61.22% for ash digestibility. Decreases in nutrient digestibility with high inclusion levels of CRM-LBSM, as shown in this current study, could be attributed to a low level of non-starch polysaccharide (NSP). Water-soluble non-starch polysaccharide (NSP) is lower (0.078% - 1.64%) in cassava compared to maize (8.4%) (Uthumporn *et al.*, 2017; Chauynaron *et al.*, 2015) and could be responsible for low digestibility in cassava-fed chicks. Insoluble NSP reduces the efficient digestion of nutrients by interfering with amylase and protease (Morgan *et al.*, 2016).

Cost-benefit analysis of starter broiler chicks fed graded levels of cassava root meal – African locust bean seed meal mixture is presented in Table 4. Dietary treatment showed significant ($p < 0.05$) effect on parameters evaluated. Cost of diet per kg, cost of feed consumed, production cost, feed cost percentage, total variable and revenue were significantly ($p < 0.05$) influenced. There was a progressive decline in cost of diets per kg from ₦812.00/kg in the control diet to ₦702.00/kg in birds fed 50% CRM – ALBSM blend, reflecting the lower market price of CRM relative to maize. This economic advantage is consistent with the reports of Nsa *et al.* (2019), who reported that the cost of feed decreased significantly as cassava root meal replaced maize in broiler finisher diets. The cost of feed consumed followed a similar trend with cost of diet per kg, with birds fed 50 % CRM – ALBSM blend recorded the least cost of ₦1622.56 against ₦1821.05 obtained for birds on maize-based diet. The saving in cost of feed consumed per bird represents a reduction of approximately ₦198.49/kg (10.89%) between the maize-based diet, Control and 50% cassava-based

diet, which, when scaled to commercial production volumes, brings about huge returns. No significant effect ($p > 0.05$) of dietary treatments on cost per kg gain. Birds fed cassava-based diets recorded the least production cost at a comparative level to maize based diet. A similar trend was observed for variable cost and revenue, with birds fed cassava-based diets recording the least cost. Gross margin, benefit cost and profit index were not statistically influenced.

Conclusion

The study showed that graded inclusion levels of cassava root meal–African locust bean seed meal (CRM-ALBSM) blend up to 30% do not significantly compromise nutrient digestibility and growth performance in starter broiler chicks. The findings further indicate that the CRM-ALBSM blend can successfully be utilised in starter broiler chick diets for improved revenue and profitability.

CONFLICT OF INTERESTS

The authors declare that they have no conflicts of interest.

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REFERENCES

- Animashahun, R. A., Idowu, A., Oluwafemi, P., Odhe, P., Edozie, N., Animashahun, A. P., Akintola, O., & Adegboye, O. (2024). Assessment of *Parkia biglobosa* leaf meal as a partial

- replacement for soybean meal in broiler chicken diets. *Journal of Liaoning Technical University*, 18(3), 32-42.
- Chauynaron, N., Bhuiyan, M. M., Kanto, U., & Iji, P. A. (2015). Variation in nutrient composition of cassava pulp and its effects on in vitro digestibility. *Asian Journal of Poultry Science*, 9(4), 203-212.
- Esenwah, C. N., & Ikenebomeh, M. J. (2008). Processing effects on the nutritional and anti-nutritional contents of African locust bean (*Parkia biglobosa* Benth.) seed. *Pakistan Journal of Nutrition*, 7(2), 214-217.
- Khempaka, S., Hokking, L., & Molee, W. (2016). Potential of dried cassava pulp as an alternative energy source for laying hens. *Journal of Applied Poultry Research*, 25(3), 359-369.
- Morgan, N. K., & Choct, M. (2016). Cassava: Nutrient composition and nutritive value in poultry diets. *Animal Nutrition*, 2(4), 253-261.
- Nsa, E. E., Ukoha, O. A., & Agida, C. A. (2019). Bio-economics of feeding cassava root meal based diets to broiler finisher chickens. *Nigerian Journal of Animal Production*, 46(4), 110-116.
- Ogbuwu, I. P., & Mbajorgu, C. A. (2022). Meta-analysis of substitution value of maize with cassava (*Manihot esculenta* Cratz) on growth performance of broiler chickens. *Frontiers in Veterinary Science*, 9, 997128.
- Ogbuwu, I. P., Mabelebele, M., & Mbajorgu, C. A. (2023). Meta-analysis of blood indices and production physiology of broiler chickens on dietary fermented cassava intervention. *Tropical Animal Health and Production*, 55(6), 368.
- Okereke, C. O. (2012). Utilisation of cassava, sweet potato, and cocoyam meals as dietary sources for poultry. *World Journal of Engineering and Pure & Applied Sciences*, 2(2), 63.
- Oladunjoye, I. O., Ojebiyi, O., & Amao, O. A. (2010). Effect of feeding processed cassava peel meal based diet on the performance characteristics, egg quality and blood profile of laying chicken. *Agricultura Tropica et Subtropica*, 43(2), 119-126.
- Osei-Adjei, A., Hamidu, J. A., Adjei-Mensah, B., Hanson, P. N. A., Sarfo, G. K., & Donkoh, A. (2025). Evaluating Cassava Starch Residue as a Maize Substitute in Broiler Chicken Diets. *Food Science & Nutrition*, 13(6), e70360.
- Tamburawa, M. S., Ogundipe, S. O., Tegbe, T. S. B., Olugbemi, T. S., & Makinde, O. J. (2017). Effect of soaked and fermented African locust bean (*Parkia biglobosa*) seed meal on growth performance, haematological profile and nutrient digestibility of broiler chickens. *Tropical and Subtropical Agroecosystems*, 20(1), 155-163.
- Tang, D. F., Ru, Y. J., Song, S. Y., Choct, M., & Iji, P. A. (2012). The effect of cassava chips, pellets, pulp and maize based diets on performance, digestion and metabolism of nutrients for broilers. *Journal of Animal and Veterinary Advances*, 11(9), 1332-1337.
- Tirmidhi, A. B., Oguntoye, M. A., Ardo, B. A., Akintunde, A. R., & Joshua, I. M. (2022). Nutritional evaluation of cassava root meal fortified with roselle seed meal as a replacement for maize on growth response and blood profile of broiler chicks. *Nigerian Journal of Animal Science*, 24(2), 192-200.
- Uthumporn, U., Nadiyah, I., Izzuddin, I., Cheng, L., & Aida, H. J. S. M. (2017). Physicochemical characteristics of non-starch polysaccharides extracted from cassava tubers. *Sains Malaysiana*, 46(2), 223-229.
- Wang, X., Du, B., Nian, F., Ru, Y., Sun, L., Qin, S., & Tang, D. (2023). Effects of processing methods and conditioning temperatures on the cassava starch digestibility and growth performance of broilers. *Animals*, 13(8), 1373.
- Yadav, S., Mishra, B., & Jha, R. (2019). Cassava (*Manihot esculenta*) root chips inclusion in the diets of broiler chickens: effects on growth performance, ileal histomorphology, and cecal volatile fatty acid production. *Poultry Science*, 98(9), 4008-4015.
- Yang, Y., Lei, F., Zhang, Z., Liu, L., Li, Q., & Guo, A. (2024). Effects of cassava root meal on the growth performance, apparent nutrient digestibility, organ and intestinal indices, and slaughter performance of yellow-feathered broiler chickens. *Tropical Animal Health and Production*, 56(8), 274.