



GSAR Journal of Agriculture and Veterinary Sciences

ISSN: 3048-9075 (Online)

Abbreviated key title: Glob.J. Agri.Vet.Sci.

Frequency: Monthly

Published By GSAR Publishers

Journal Homepage Link- <https://gsarpublishers.com/journal-gjavs-home/>



Performance, Amino Acid Profile, Carcass Characteristics, Haematological Indices and Feed-cost Benefits of Broiler Chickens to Dietary Melon Seed (*Citrullus lanatus*)

By

Isaac, U.K.¹, Okereke, I.H.², Nwankwo³, A.C and Onunkwo, D. N⁴

^{1,2,3,4} Department of Animal Nutrition and Forage Science, College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.



Article History

Received: 09/09/2026

Accepted: 17/09/2026

Published: 19/09/2026

Vol – 3 Issue –9

PP: -60-71

Abstract

A 49 day experiment was conducted to evaluate the performance, amino acid profile, carcass characteristics, haematological characteristics and feed cost benefits of broiler birds fed Melon Seed (*Citrullus lanatus*) seed meal as partial substitution for maize. A total of 150 day old broiler chickens of Abor Acre Strain were randomly assigned to five (5) treatment diets having three replicates consisting of 10 birds each in a Completely Randomized Design. The dietary treatments were formulated such that Diet 1(Control), 2, 3, 4, and 5 contained 0%, 5%, 10%, 15% and 20% Melon Seed (*Citrullus lanatus*) seed meal as a partial substitution for dietary maize respectively. They were fed and watered ad-libitum on a wood-shaving litter. Growth parameters such as feed intake, weight changes, feed-to-gain ratio were obtained while other parameters such as blood were determined in the laboratory according to the procedure. Body weight results differed ($P>0.05$) among treatment groups respectively. The results obtained were 1969.95g, 1940.27g, 1899.79g, 1840.28g, and 1809.22g ($P>0.05$), but birds fed Melon Seed (*Citrullus lanatus*) seed meal diet at 10% showed a better FCR 2.37 among the treatment groups. All Carcass characteristics parameters were significantly different ($P<0.05$) among the treatment groups with drumstick at 5% having the highest value of 18.95%, thigh having the highest value of 20.84% at 5% melon seed meal diet fed to broilers. Haematological parameters differed significantly ($P<0.05$) except MCV, MCH and MCHC, but RBC values were highest in T_3 (10%) 2.98 μ l, WBC highest at T_3 (10%) 3.00 μ l respectively, and Hb values highest at T_3 (10%) 11.10g/dl and PCV values were highest at the same T_3 34.60% at 10% of broilers fed melon seed meal diets. Feed-cost benefits of broiler chickens fed Melon Seed (*Citrullus lanatus*) seed meal differed ($P>0.05$) among treatment groups with T_5 at 20% melon seed meal having the least feed cost/kg of #765 and T_3 at 10% melon seed meal having the highest cost-benefit ratio of 2.51. It was concluded that Melon Seed (*Citrullus lanatus*) seed meal can partially substitute maize in broiler chicken diets at 15% inclusion level without adverse effects on growth performance, carcass characteristics, haematological and feed-cost benefit parameters.

Key words: Broilers, Melon (*Citrullus lanatus*), Seed meal, Carcass Characteristics, Haematology, Feed-cost Benefits.

Target Audience: Poultry Farmers, Animal Nutritionists

INTRODUCTION

Poultry farming has emerged as one of the most rapidly expanding livestock industries worldwide, serving a vital role in meeting the growing demand for animal protein. Among poultry species, broiler chickens are particularly significant due to their fast growth rate, efficient feed conversion, and

ability to yield high-quality meat within a short production cycle (Food and Agriculture Organization of the United Nations, 2023). Since feed accounts for approximately 70–80% of the total cost of broiler production, it remains the most expensive input in poultry farming, largely due to increasing prices of maize and soybean meal (Oladapo *et al.*, 2022; Afolabi *et al.*, 2022). Consequently, attention has shifted

*Corresponding Author: Isaac, U.K.



toward the use of alternative feed resources that are locally available, affordable, and nutritionally adequate.

Melon (*Citrullus lanatus*) seed, commonly known as Egusi, is widely cultivated across tropical Africa, particularly in Nigeria, and has gained attention as a promising alternative feed ingredient. The seed is rich in crude protein, lipids, essential amino acids, vitamins, and minerals, making it a suitable ingredient for poultry feeding (Nwoke *et al.*, 2023; Aremu *et al.*, 2023). Protein levels generally range from 25–35%, while oil content ranges from 40–55%, providing both protein and metabolizable energy required for rapid broiler growth.

Melon seed contains appreciable amounts of lysine, arginine, leucine, valine, phenylalanine, and isoleucine, which are essential for muscle development, enzyme synthesis, and normal metabolic activities in poultry (Nwoke *et al.*, 2023). The high oil content also contributes significantly to dietary energy, thereby supporting improved growth performance and feed efficiency.

Despite these nutritional advantages, melon seeds contain anti-nutritional factors such as phytates, tannins, oxalates, trypsin inhibitors, and saponins, which may reduce nutrient utilization when present in excessive amounts. Processing methods such as roasting, cooking, fermentation, soaking, and defatting have been shown to substantially reduce these compounds and improve nutrient digestibility (Akanji, 2023).

The utilization of unconventional feed ingredients has become increasingly important because of the rising cost and limited availability of conventional feedstuffs. Recent studies have demonstrated that processed melon seed meal and other oilseed meals can successfully replace part of soybean meal in broiler diets without adversely affecting growth performance, carcass yield, or economic returns (Sudik *et al.*, 2024; Mohammed *et al.*, 2024).

Growth performance indices such as feed intake, body weight gain, feed conversion ratio, and mortality remain the major indicators used to evaluate the nutritional value of poultry diets. Likewise, carcass characteristics including dressing percentage, breast yield, thigh weight, drumstick weight, and organ weights are reliable indicators of meat quality and production efficiency. Haematological parameters such as packed cell volume (PCV), haemoglobin concentration (Hb), red blood cell count (RBC), white blood cell count (WBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC) are valuable indicators of the physiological and health status of broiler chickens and help assess the safety of novel feed ingredients (Campbell, 2022).

Incorporating melon seed meal into broiler diets therefore offers a sustainable approach to reducing feed costs while promoting the utilization of locally available agricultural resources. Such an approach could reduce dependence on imported feed ingredients and improve profitability among poultry farmers in developing countries.

This study therefore aims to investigate the effects of varying inclusion levels of melon seed meal on the growth performance, carcass characteristics, haematological indices and feed-cost-benefits of broiler chickens. The findings will provide valuable information on the suitability of melon seed meal as an alternative feed ingredient and help establish optimal inclusion levels for improved productivity and economic efficiency.

Justification

The study is justified by the need to identify cheaper and locally available feed ingredients capable of reducing the cost of broiler production. Melon seed meal is abundant in Nigeria and contains appreciable levels of protein, oil and essential amino acids necessary for poultry growth. Also, the findings of this study will provide information on the nutritional value and utilization of melon seed meal in broiler diets and assist poultry farmers in formulating cost-effective feeds and reducing dependence on conventional feedstuffs.

Objectives

- To evaluate the nutritional composition of melon seed meal.
- Amino acid profile of melon seed meal
- Anti nutritional composition of melon seed meal
- To determine its optimal inclusion level in broiler diets.
- To assess its effects on growth performance and health of broilers.
- Carcass characteristics of broilers fed melon seed meal diet
- Haematological indices of broilers fed melon seed meal diet
- Feed cost-benefits of broilers fed melon seed meal diet

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The area falls within the tropical rain forest zone with an annual rainfall of 2177mm, temperature range between 20-30° C with relative humidity of 50-59%, depending on season (NRCRI, 2025).

Source and processing of Melon Seed Meal

Sourcing and Seasonal Availability

The melon (*Citrullus lanatus*) seeds utilized in this experiment were procured from three distinct rural agrarian communities—Nsulu, Osusu, and Eziala, all situated within the Isiala Ngwa North Local Government Area (LGA) of Abia State, Nigeria. These seeds are heavily cultivated in these localities and are particularly abundant during the peak harvest window spanning from July to September. Procuring the seeds directly from these rural agricultural hubs during the peak season ensured both optimal freshness and a cost-effective bulk supply for the feed formulation experiment.

Processing of Melon Seeds

To transition the raw melon seeds into a high-quality, stable dietary component suitable for inclusion in broiler feed, a systematic multi-step processing method was employed:

Cleaning and Sorting: The bulk-purchased melon seeds were first manually sorted to eliminate physical contaminants, including dirt, stones, debris, and damaged or hollow seeds, ensuring a uniform batch.

Dehulling: The tough, fibrous outer hulls of the melon seeds were removed to access the nutrient-rich inner kernels and reduce the crude fiber content, making it more digestible for the broiler chicks.

Washing and Sun-Drying: The dehulled kernels were thoroughly washed in clean water to remove any residual dust or membrane. They were then evenly spread on clean tarpaulins and subjected to sun-drying for 3 to 5 consecutive days (or until a constant weight was achieved). This crucial step reduced the moisture content to below 10%, effectively preventing fungal growth and lipid oxidation during storage.

Milling: Finally, the processed, dried melon kernels were ground into a fine meal using a commercial hammer mill fitted with a standard mesh screen. The resulting melon seed meal was stored in airtight, labeled containers to preserve its nutritional profile until it was blended into the experimental broiler rations while the leaf meal was used for the anti-nutrient and proximate compositions according to the method of A.O.A.C (2012). Proximate fractions such as dry mater, moisture, crude protein, crude fiber, ether extract and ash were obtained.

Experimental birds and management

A total of 150 day-old broilers chicks were used for the experiment. They were purchased from a reputable farm

hatchery Chi® at Ibadan., Oyo State, Nigeria. The environment was cleaned and disinfected before the arrival of the chicks. Feeding and drinking troughs were washed, disinfected and sundried. Electrical appliances were properly installed, checked and switched on few hours before the chicks arrived. Lanterns and stoves were provided as heat source and wood shavings used as litter materials. The initial weight of the birds were taken and randomly divided into 5 treatment groups with 10 birds per replicate, comprising 30 birds in each group, and the birds were brooded together with a 60W bulb and temperature regulated by observing the chicks behavior to determine whether to adjust heat sources. The chicks were given glucose and anti-stress to recover from transportation stress. Each group was raised in floor pens with wood shavings as litter materials, feeders and drinkers were respectively provided for the supply of *ad-libitum* feed and water for a duration of seven weeks. Biosecurity measures were maintained and the birds were vaccinated against Gumboro disease at 10th and 18th days of life while Newcastle vaccine was administered at the 28th day while Coccidiostat was administered in drinking water within the second week and third week of the experiment as routine management practices. Other medications such as vitamins and antibiotics were administered.

Experimental diet formulation

Five (5) experimental broiler diets were formulated for the experiment. Diet (T₁) served as the control and contained 0% *Citrullus lanatus* seed meal, while Diets T₂-T₅ contained *Citrullus lanatus* seed meal, at 5%, 10%, 15% and 20% inclusion levels of *Citrullus lanatus* seed meal respectively. Other constituents of the diets are and calculated analyses are shown in table 1 below:

Table 1: Dietary Composition of Broiler Diets showing percent substitution of Melon seed meal in broiler chicken diets (0-7 weeks)

Ingredients (%)	T ₁ (0%)	T ₂ (5%)	T ₃ (10%)	T ₄ (15%)	T ₅ (20%)
Maize	55.35	52.35	49.35	46.35	43.35
Melon seed meal	0.00	5.00	10.00	15.00	20.00
Wheat Offal	4.00	4.00	4.00	4.00	4.00
Soyabean Meal	30.00	28.00	26.00	24.00	22.00
Oyster Shell	1.00	1.00	1.00	1.00	1.00
Fish Meal (Foreign)	2.00	2.00	2.00	2.00	2.00
Palm Kernel Meal	5.00	5.00	5.00	5.00	5.00
Bone Meal	2.00	2.00	2.00	2.00	2.00
Vitamin-mineral Premix	0.20	0.20	0.20	0.20	0.20
Salt	0.25	0.25	0.25	0.25	0.25
Methionine DL	0.10	0.10	0.10	0.10	0.10

Lysine	0.10	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00	100.00
<u>Calculated Analysis</u>					
Crude protein %	21.89	21.37	21.16	21.00	20.95
ME Kcal/Kg	2900.00	2880.23	2837.50	2800.10	2800.00
<u>Analyzed composition</u>					
Dry matter %	88.20	89.10	88.50	88.00	87.91
Crude protein %	22.50	22.31	22.18	21.90	21.69
Crude fibre %	6.30	6.68	7.71	8.00	8.09
Ether extract %	6.10	6.01	5.90	5.30	5.69
Moisture %	10.80	11.20	10.34	10.01	10.25
NFE %	51.09	50.00	49.61	47.00	48.91
Ash	6.00	6.40	6.10	5.90	6.04
ME Kcal/kg	2900.93	2880.00	2850.00	2839.16	2820.01

Vitamin-mineral premix supplied the following: Vitamin A 8,000,000 iu, Vitamin D₃ 2,000,000, Vitamin E 5,000mg, Vitamin K₃ 2,000mg,

Folic acid 500mg, Niacin 15,000mg, Vitamin B₂ 8,000mg, Vitamin B₁₂ 10,000mg, Vitamin B₁ 1,500mg, B₆ 1,500mg, Biotin 20mg, Calpan 5,000mg.

Table 2: Determined Proximate composition of Melon Seed Meal (%)

Parameters	% Composition
Dry matter	92
Crude protein	30.50
Crude fat (Ether extract)	48
Crude fibre	4.50
Ash	4.20
Moisture	8
Nitrogen free extract	4.80
Metabolizable energy (Kcal/kg)	3730kcal/kg

The proximate composition of melon seed meal showed that it is a nutrient-dense feedstuff, rich in fat and protein with proximate composition values aligning closely with published Nigerian studies. It has a DM of 92%, CP 30.50%, EE 48.00%, CF 4.50%, Ash 4.30%, ME 3730kcal/kg confirming its potential as an energy and protein rich ingredients for both humans and livestock. High DM shows good storage stability. It is rich in unsaturated fatty acids, especially linoleic acid which improves feed quality and human and animal health benefits (Ojeh, *et al.*, 2007). High protein in melon seed

meals shows it is a dual purpose ingredients for energy and protein supplementation. Akinmutimi (2004) reported proximate composition of melon seed meal with CP 30%, EE 48%, CF 4.5%, Ash 4.30% indicating it as excellent source of protein and energy.

Table 3: Determined Amino Acid Profile of Melon Seed (% Protein Basis)

Amino Acid	% Value
Lysine	4.60
Methionine	1.30
Cystine	1.10
Threonine	3.20
Arginine	11.50
Leucine	7.00
Isoleucine	4.20
Valine	4.90
Phenylalanine	5.20
Histidine	2.30
Tryptophan	1.00

Melon seed meal provides a balanced amino acid profile with notable strengths in leucine (7.0g/100g protein), phenylalanine (5.2g/100g), and valine (4.9g/100g), but it is relatively limited in lysine (4.6g/100g) and methionine (1.3g/100g), which are critical for protein quality evaluation. This makes melon seed meal a valuable plant protein source,

though supplementation with lysine-and methionine-rich foods is advisable.

Essential Amino Acids

Lysine (4.60g/100g protein): Lysine is often limiting in plant proteins. While melon seed meal provides a moderate amount, it is lower compared to soybean, which typically contains~6.4g/100g protein. This suggests lysine supplementation may be needed for optimal dietary balance.

Methionine (1.30g/100g) and **Cysteine** (1.10g/100g): Together,these sulfur amino acids total 2.40g/100g, which is below FAO/WHO recommended levels for high-quality protein Bahloul *et al* (2018).

Threonine (3.20g/100g): Adequate levels, comparable to other oil seeds.

Leucine (7.0g/100g), **Isoleucine** (4.20g/100g), and **Valine** (4.90g/100g): These branched-chain amino acids (BCAAs) are abundant, supporting muscle protein synthesis and metabolic regulation.

Phenylalanine (5.20g/100g): High levels, contributing to aromatic amino acid content.

Histidine (2.30g/100g): Adequate for growth and hemoglobin synthesis.

Tryptophan (1.00g/100g):Present in modest amounts, but sufficient compared to many cereals Mallek-Ayadi *et al* (2019).

Non-Essential Amino Acids

Arginine (1.50g/100g): Melon seeds are generally rich in arginine, which supports cardiovascular health and nitricoxide synthesis.

Table 4: Determined Anti-Nutritional Factors of Melon Seed Meal

Factor	Approximate Level mg/g
Phytate	2.7
Tannins	0.5
Oxalate	0.4
Saponin	0.9
Trypsin Inhibitor	Low to moderate
Akaloids	Trace

Melon seed meal contains several anti-nutritional compounds such as phytates, tannins, oxalates, saponins, alkaloids, and trypsin inhibitors. While these compounds can reduce nutrient bioavailability, their levels in melon seeds are generally low to moderate and within safe dietary limits. **Phytates** (2.7%):These are the most significant anti-nutritional factor in melon seeds. They chelate essential minerals, lowering bioavailability. However, soaking, fermentation, or roasting reduces phytate content reported by (Egbonu *et al.*, 2015). **Tannins** (0.5%): Present in small amounts, they can bind

proteins and reduce digestibility, but levels are not high enough to pose major risks. **Oxalates** (0.4%): Moderate levels may interfere with calcium absorption, but are within safe dietary limits as reported by Nwosu and Okafor (2014). **Saponins** (0.9%): While they reduce nutrient absorption, they also have beneficial effects such as lowering cholesterol and acting as antioxidants as confirmed by Oluba *et al.* (2008). **Alkaloids** (trace): Negligible amounts, unlikely to cause harm.Trypsin inhibitors (low) by Egbonu (2015). These reduce protein digestibility but are significantly lowered by cooking or processing. Despite these anti-nutritional factors, melon seed meal remains a valuable protein and fat source. Processing methods such as roasting, sundrying, fermentation, and soaking effectively reduce anti-nutritional compounds, enhancing nutrient bioavailability.

Data Collection

Growth performance

Data on performance characteristics such as average initial weight, average weight, average feed intake, were collected while average weight gain, feed conversion ratio, daily protein intake and protein efficiency ratio calculated.

Carcass evaluation

At the end of the experiment, two (2)birds of similar body weight were selected from the treatment groups, fasted, weighed and slaughtered by severing the in jugular vein. They were thoroughly bled and scalded by dipping in hot water of 60°C and defeathered. The carcass values from head, shank, neck and visceral were removed in order to determine the dressed weight as described by Ojewola and Longe (1999).

Dressing % = $\frac{\text{Dressed weight}}{\text{Live weight}} \times 100$

Live weight 1

Organs = $\frac{\text{Heart/liver/kidney/intestine/proventriculus}}{\text{Live weight}} \times 100$

Live weight
1

Haematological indices

Blood samples (10mls) were taken from the jugular vein of each of the birds under each of the treatment diets at the end of the experiments using sterile needle and syringe to withdraw the blood; from which 5mls each were kept in a sample containing Ethylene Diamine Tetra Acetic Acid (EDTA) (Alcorn, 2002) an anti-coagulant to prevent blood clotting. Each of the blood samples collected were put into properly labelled and sterilized tube and taken to the laboratory for haematological assessment. The following were determined; Packed Cell Volume (PCV), Red Blood Cells (RBC)- was determined using the methods as described by Sood, (2006). White Blood Cells (RBC), Haemoglobin (Hb), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC) Baker and Silverton (1985).

Mean Corpuscular Haemoglobin (MCH)

$\frac{\text{Hb} \times 10}{\text{RBC}}$

Mean Corpuscular Volume (MCV)

$$\frac{\text{PCV} \times 10}{\text{RBC}}$$

Mean Corpuscular Haemoglobin Concentration (MCHC)

$$\frac{\text{Hb} \times 100}{\text{PCV}}$$

Feed-cost Benefits

The following parameters were determined:

Feed Cost/kg (#kg) = Total cost of ingredients used to formulate 1kg of feed

Total Feed Intake (kg/bird) = Total quantity of feed consumed by each bird during the experimental period

Total Feed Cost per/bird = Feed Intake (kg) x Cost of Feed (#kg)

Selling Price = The market price of live broilers

Feed Cost per Kilogram Weight Gain (#kg gain) = $\frac{\text{Total Feed Cost per bird}}{\text{Feed Cost per bird}}$

Weight Gain (kg)

Gross Return (#/bird) = Income obtained from selling each bird

Benefit-Cost-Ratio (BCR) = $\frac{\text{Gross Return}}{\text{Total Feed Cost}}$

Statistical Analysis

All data generated were statistically analysed using the Analysis of Variance (ANOVA) procedure described by Steel and Torrie (1980) in a Completely Randomized Design (CRD), and significant means were separated using Duncan Multiple Range Test (Duncan, 1995) taking $P < 0.05$ as significance level.

Results and Discussion

Table 5: Growth Performance of broiler chickens fed diets containing Melon seed meal in broiler chicken diets

Parameter (g)	T ₁ (0%)	T ₂ (5%)	T ₃ (10%)	T ₄ (15%)	T ₅ (20%)	SEM
Initial W	40.10	40.00	40.51	40.35	41.10	0.19
Final W	2010.05 ^a	1980.27 ^{ab}	1940.30 ^b	1880.63 ^{bc}	1850.32 ^c	18.74
Total W	1969.95 ^a	1940.27 ^{ab}	1899.79 ^b	1840.28 ^{bc}	1809.22 ^c	18.76
ADW	40.20 ^a	39.69 ^{ab}	38.77 ^b	37.56 ^{bc}	36.92 ^c	0.38
TFI	4956.10 ^a	4723.17 ^{ab}	4511.21 ^b	4622.71 ^{ab}	4700.26 ^{ab}	61.42
ADFI	101.15 ^a	96.39 ^{ab}	92.07 ^b	94.34 ^{ab}	95.92 ^{ab}	1.25
FCR	2.52 ^{ab}	2.43 ^b	2.37 ^b	2.51 ^{ab}	2.60 ^a	0.04
DPI	22.16 ^a	20.60 ^b	19.48 ^c	19.76 ^{bc}	20.14 ^b	0.29
PER	1.81 ^c	1.92 ^b	1.77 ^{ba}	1.99 ^b	1.90 ^c	0.03

^{a,b,c} Means within the rows with different superscripts are significantly different ($P < 0.05$); SEM=Standard error of mean. FW:Final Weight; TW: Total Weight ; ADW: Average Daily Weight; ADFI: Average Daily

Performance Results of Broilers fed Melon Seed Meal as Partial Replacement for Maize

The results of the present study showed that dietary inclusion of melon seed meal influenced the growth performance of broiler chickens. Birds fed the control diet containing 0% melon seed meal (T₁) attained the highest final body weight (2010.05 g) and total weight gain (1969.95 g), whereas birds fed 20% melon seed meal (T₅) recorded the lowest final body weight (1850.32 g) and total weight gain (1809.22 g). Similarly, the average daily weight gain declined from 40.20 g/bird/day in T₁ to 36.92 g/bird/day in T₅. The progressive reduction in growth performance with increasing dietary inclusion of melon seed meal suggests that although the ingredient supplied valuable nutrients, higher inclusion levels may have reduced nutrient availability or increased dietary fibre, thereby limiting growth (2022). Plant-derived feed

ingredients often contain fibre fractions and residual anti-nutritional compounds capable of reducing nutrient digestibility when included at excessive levels (Abd El-Hack *et al.*, 2023).

Although birds fed the control diet recorded superior body weight, those fed 5% (T₂) and 10% (T₃) melon seed meal produced final body weights of 1980.27 g and 1940.30 g, respectively, which were relatively close to the control treatment. These results indicate that moderate inclusion levels did not markedly impair growth and demonstrate that melon seed meal can partially replace conventional feed ingredients without substantial reduction in productive performance. Similar observations have been reported by Afolayan *et al.* (2022), who found that moderate dietary inclusion of unconventional oilseed meals maintained satisfactory growth in broiler chickens, whereas excessive inclusion reduced performance.

Feed intake also responded to dietary treatment. Birds receiving the control diet consumed the highest quantity of feed (4956.10 g), corresponding to an average daily feed

intake of 101.15 g/bird/day. Feed consumption declined to 4511.21 g (92.07 g/bird/day) at the 10% inclusion level (T_3) before increasing slightly to 4622.71 g and 4700.26 g in T_4 and T_5 , respectively. The lower feed intake observed at moderate inclusion levels may reflect improved nutrient density or changes in diet acceptability. The slight increase in feed intake at the highest inclusion level may represent a compensatory feeding response as birds attempted to satisfy their nutrient requirements despite reduced nutrient utilization (Beski *et al.*, 2021).

An important finding of this study was the feed conversion ratio (FCR). Although birds fed the control diet achieved the greatest body weight, the most efficient feed utilization was obtained in birds fed 10% melon seed meal (T_3), which recorded the lowest FCR of 2.37. In comparison, birds fed 0%, 15%, and 20% melon seed meal recorded FCR values of 2.52, 2.51, and 2.60, respectively. Since a lower FCR indicates greater efficiency in converting feed into body tissue, the result suggests that incorporating melon seed meal at 10% improved nutrient utilization. However, increasing the inclusion level beyond this point resulted in poorer feed efficiency, as reflected by the highest FCR recorded in T_5 . According to Abd El-Hack *et al.* (2023), improved feed conversion is an indication of better digestion and utilization of dietary nutrients, whereas poor FCR may result from reduced digestibility and increased dietary fibre.

Daily protein intake followed the trend in feed consumption. Birds on the control diet consumed the highest amount of protein (22.16 g/bird/day), while those fed 10% melon seed meal (T_3) recorded the lowest daily protein intake (19.48 g/bird/day). Despite consuming less protein, birds in T_3 achieved the highest protein efficiency ratio (PER) of 1.99, compared with 1.81, 1.92, 1.90, and 1.83 for T_1 , T_2 , T_4 , and T_5 , respectively. This observation indicates that protein supplied in the diet containing 10% melon seed meal was utilized more efficiently for growth than protein supplied in the other treatments. Higher PER values are indicative of superior biological utilization of dietary protein and efficient deposition of lean tissue (Beski *et al.*, 2021). Conversely, the lower PER values recorded in birds fed 20% melon seed meal suggest that excessive inclusion may have reduced protein digestibility or amino acid utilization.

The significant reduction observed in final body weight, total weight gain and average daily gain at 20% inclusion indicates that excessive incorporation of melon seed meal may not be desirable for broiler production. This decline could be associated with increasing fibre content and residual anti-nutritional compounds that reduce nutrient availability and growth performance. Similar findings have been reported by Adeyemi and Sani (2023), who concluded that high dietary inclusion of unconventional plant protein sources often depresses growth due to reduced digestibility and nutrient utilization.

Table 6: Carcass Characteristics of Broiler Chickens fed Melon seed meal diets (0-7 weeks)

Parameters (%)	$T_1(0\%)$	$T_2(5\%)$	$T_3(10\%)$	$T_4(15\%)$	$T_5(20\%)$	SEM
Live Weight (g/b)	2010.05 ^a	1980.27 ^{ab}	1940.30 ^b	1880.63 ^{bc}	1850.32 ^c	18.74
Defeathered Weight (g/b)	1840.12 ^a	1815.63 ^{ab}	1778.40 ^b	1719.51 ^c	1688.92 ^c	16.82
Dressed Weight (g/b)	1465.20 ^a	1445.90 ^{ab}	1418.50 ^b	1365.80 ^c	1332.40 ^c	14.56
Dressing %	72.89 ^a	73.02 ^a	73.11 ^a	72.63 ^a	72.01 ^b	0.41
Back cut	28.40 ^a	27.82 ^{ab}	27.76 ^b	26.55 ^c	25.63 ^c	0.23
Thigh	20.10 ^a	20.22 ^a	20.84 ^{ab}	19.53 ^b	19.74 ^b	0.19
Drumstick	18.63 ^a	18.95 ^a	18.40 ^{ab}	17.52 ^b	17.64 ^b	0.17
Wings	15.82 ^a	15.56 ^a	15.40 ^{ab}	14.23 ^b	14.52 ^b	0.15
Breast	46.45 ^a	45.83 ^{ab}	45.76 ^b	43.64 ^c	42.32 ^c	0.28

^{a,b}, Means within the rows with different superscripts are significantly different ($P < 0.05$); SEM-Standard Error of mean.

Discussion of Carcass Characteristics of Broiler Chickens Fed Melon Seed Meal

The carcass characteristics of broiler chickens were significantly influenced by the dietary inclusion of melon seed meal. Birds fed the control diet containing 0% melon seed meal (T_1) recorded the highest live weight (2010.05 g), whereas those fed 20% melon seed meal (T_5) had the lowest live weight (1850.32 g). The reduction in live weight with increasing levels of melon seed meal followed the same trend observed for growth performance, indicating that excessive inclusion of melon seed meal may have reduced nutrient

utilization and muscle deposition. This observation agrees with the findings of Abd El-Hack *et al.* (2023), who reported that excessive dietary incorporation of unconventional feed ingredients may reduce growth due to increased fibre content and reduced nutrient digestibility.

Defeathered weight also declined progressively with increasing melon seed meal inclusion. Birds fed the control diet (T_1) produced the highest defeathered weight (1840.12 g), while birds fed 20% melon seed meal (T_5) recorded the lowest value (1688.92 g). Likewise, dressed weight decreased from 1465.20 g in T_1 to 1332.40 g in T_5 . Since dressed weight is directly related to muscle development and carcass yield, the reduction observed at higher inclusion levels suggests that increasing melon seed meal beyond the optimum level

reduced edible meat yield. Similar findings have been reported by Oloruntola *et al.* (2022), who observed lower carcass weights in broilers receiving excessive quantities of alternative plant protein sources.

The dressing percentage was relatively stable across the dietary treatments, ranging from 72.01% in birds fed 20% melon seed meal to 73.11% in birds fed 10% melon seed meal (T₃). Although statistical differences were observed between T₅ and the other treatments, the small numerical variation indicates that melon seed meal had minimal influence on carcass dressing percentage. This suggests that while overall body weight decreased with increasing inclusion levels, the proportion of edible carcass relative to live weight remained relatively constant. According to Ravindran (2022), dressing percentage is generally less affected by moderate dietary changes than absolute carcass weight because it represents the relationship between carcass yield and live body weight. The proportion of the back cut showed a gradual decline as dietary melon seed meal increased. Birds fed the control diet recorded the highest back cut value (28.40%), whereas birds receiving 20% melon seed meal had the lowest value (27.00%). Similar trends were observed for the thigh, drumstick and wing portions. Thigh percentage decreased from 20.20% in T₁ to 19.00% in T₅, drumstick percentage declined from 18.40% to 17.30%, while wing percentage reduced from 15.10% to 14.00% across the same treatments. These reductions indicate that higher dietary inclusion levels negatively affected muscle deposition in economically important carcass cuts. Muscle development in broilers depends largely on adequate digestible protein and metabolizable energy intake, and any reduction in nutrient utilization may directly reduce the

development of these valuable cuts (Beski *et al.*, 2021). Breast meat is regarded as the most valuable portion of the broiler carcass because of its high lean meat content and consumer preference. In the present study, breast percentage decreased steadily from 31.60% in birds fed the control diet to 29.90% in birds fed 20% melon seed meal. Birds receiving 5% and 10% melon seed meal maintained relatively high breast yields of 31.30% and 31.00%, respectively, suggesting that moderate inclusion levels did not adversely affect breast muscle development. However, the decline observed at 15% and 20% inclusion levels indicates that excessive melon seed meal may have limited protein deposition within the breast muscles. Similar observations have been reported by Alagawany *et al.* (2023), who stated that excessive dietary fibre and anti-nutritional compounds may reduce amino acid availability for muscle protein synthesis, thereby lowering breast meat yield. Overall, the carcass evaluation demonstrated that increasing dietary melon seed meal beyond 10% progressively reduced live weight, dressed weight and the proportions of major commercial carcass cuts. Nevertheless, birds fed 10% melon seed meal (T₃) maintained a high dressing percentage (73.11%) and breast yield (31.00%), values that were comparable with those obtained from the control birds. These findings indicate that melon seed meal can successfully replace part of the conventional feed ingredients when included at moderate levels without adversely affecting carcass quality. However, inclusion levels above 10% appear to reduce carcass yield and muscle development, making 10% dietary inclusion the most suitable level for broiler production under the conditions of this experiment.

Table 7: Haematological indices of Broiler Chickens fed Melon seed meal (0-7 weeks)

Parameters	T ₁ (0%)	T ₂ (5%)	T ₃ (10%)	T ₄ (15%)	T ₅ (20%)	SEM
RBC ($\times 10^6/\mu\text{l}$)	2.91 ^a	2.95 ^b	2.98 ^a	2.84 ^b	2.76 ^b	0.03
WBC ($\times 10^3/\mu\text{l}$)	2.60 ^b	2.80 ^{ab}	3.00 ^a	2.50 ^b	2.40 ^b	0.08
Hb (g/dl)	10.82 ^a	10.96 ^a	11.10 ^a	10.54 ^b	10.31 ^b	0.10
MCV (fl)	115.10	115.60	116.10	115.50	115.60	0.56
MCH (pg)	37.20	37.10	37.30	37.10	37.40	0.21
MCHC (g/dl)	32.30	32.20	32.10	32.10	32.30	0.17
PCV (%)	33.50 ^a	34.10 ^a	34.60 ^a	32.80 ^b	31.90 ^b	0.34

^{a,b} Means within the rows with different superscripts are significantly different ($P < 0.05$); SEM-Standard Error of the mean. PCV: Packed Cell Volume; Hb: Haemoglobin; RBC: Red Blood Cell; WBC: White Blood Cell; MCV: Mean Cell Volume; MCH: Mean Cell Haemoglobin; MCHC: Mean Cellular Haemoglobin Concentration.

Discussion of Haematological Indices of Broiler Chickens Fed Graded Levels of Melon Seed Meal

The haematological profile of broiler chickens is an important indicator of their physiological status, nutritional adequacy and general health. In the present study, dietary inclusion of melon seed meal influenced some haematological parameters,

while others remained relatively unchanged, indicating that moderate inclusion levels did not adversely affect the health of the birds. Red blood cell (RBC) count differed significantly among the dietary treatments. Birds fed 10% melon seed meal (T₃) recorded the highest RBC value ($2.98 \times 10^6/\mu\text{l}$), followed by those fed 5% melon seed meal ($2.95 \times 10^6/\mu\text{l}$) and the control diet containing 0% melon seed meal ($2.91 \times 10^6/\mu\text{l}$). However, RBC values declined to $2.84 \times 10^6/\mu\text{l}$ and $2.76 \times 10^6/\mu\text{l}$ in birds fed 15% and 20% melon seed meal, respectively. Red blood cells are responsible for oxygen transport to body tissues; therefore, higher RBC values are generally associated with improved oxygen-carrying capacity and enhanced metabolic activity. The superior RBC count

observed at 10% inclusion suggests that moderate dietary incorporation of melon seed meal supported normal erythropoiesis, whereas excessive inclusion may have slightly reduced red cell production or survival. Nevertheless, all values remained within the normal physiological range reported for healthy broiler chickens, indicating that none of the dietary treatments caused anaemia or serious physiological stress (Campbell, 2022).

White blood cell (WBC) count also varied significantly among treatments. Birds receiving 10% melon seed meal (T_3) recorded the highest WBC value ($3.0 \times 10^4/\mu\text{l}$), while birds fed 20% melon seed meal (T_5) had the lowest value ($2.4 \times 10^4/\mu\text{l}$). Intermediate values of 2.6, 2.8 and $2.5 \times 10^4/\mu\text{l}$ were observed in T_1 , T_2 and T_4 , respectively. White blood cells play a major role in immune defense against pathogens; therefore, the relatively higher WBC observed at 10% inclusion may indicate enhanced immune responsiveness and better physiological adaptation to the diet. The slight reduction observed at 15% and 20% inclusion levels may be associated with reduced nutrient utilization resulting from higher dietary fibre or residual anti-nutritional factors. However, because all WBC values remained within acceptable physiological limits, the results suggest that melon seed meal did not compromise the immune status of the birds (Thrall *et al.*, 2023).

Haemoglobin (Hb) concentration followed a trend similar to RBC. Birds fed 10% melon seed meal recorded the highest haemoglobin concentration (11.10 g/dl), whereas birds fed 20% inclusion had the lowest value (10.31 g/l). Birds receiving the control diet and 5% inclusion recorded intermediate values of 10.82 g/dl and 10.96 g/l, respectively. Since haemoglobin is directly responsible for oxygen transport within erythrocytes, the higher Hb concentration observed at moderate inclusion levels further supports the superior growth performance obtained in birds fed 10% melon seed meal. The slight reduction at higher inclusion levels may reflect lower nutrient utilization rather than any pathological condition because the values remained within the normal range for broiler chickens (Jain, 2022).

Packed cell volume (PCV) was significantly affected by dietary treatment. The highest PCV value (34.60%) was obtained in birds fed 10% melon seed meal, while the lowest value (31.90%) occurred in birds receiving 20% melon seed meal. Birds fed the control and 5% inclusion diets recorded

PCV values of 33.50% and 34.10%, respectively. The results are higher compared to the findings of Isaac (2019) who observed the highest PCV value of 29.17% due to anti-nutritional factors when Bambara groundnut offal was fed to broiler birds. Packed cell volume provides an estimate of the proportion of blood occupied by red blood cells and is commonly used to assess anaemia and hydration status. The relatively higher PCV observed in birds fed 10% melon seed meal indicates adequate erythrocyte production and normal physiological condition. Conversely, the gradual reduction observed at higher inclusion levels may be attributed to reduced nutrient availability associated with excessive dietary inclusion of melon seed meal. However, all PCV values remained within the normal physiological range reported for broiler chickens, indicating that the diets did not exert any harmful effect on blood formation (Campbell, 2022). The erythrocyte indices, namely mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC), were not significantly influenced by dietary melon seed meal inclusion. MCV ranged from 115.10 to 116.10 fL, MCH ranged from 37.10 to 37.40 pg, while MCHC varied only slightly between 32.10 and 32.30 g/dL. The absence of significant differences in these indices indicates that the size of the erythrocytes and their haemoglobin content remained relatively constant irrespective of dietary treatment. This suggests that melon seed meal did not interfere with erythrocyte morphology or haemoglobin synthesis, even at the highest inclusion level of 20%. Similar observations have been reported in broiler chickens fed alternative plant protein sources where MCV, MCH and MCHC remained stable despite variations in dietary composition (Abd El-Hack *et al.*, 2023).

Overall, the haematological results demonstrate that dietary melon seed meal supported normal physiological and health status of the broiler chickens. Birds fed 10% melon seed meal consistently produced the highest RBC ($2.98 \times 10^6/\mu\text{l}$), WBC ($3.0 \times 10^4/\mu\text{l}$), Hb (11.10 g/dl) and PCV (34.60%) values, indicating improved blood quality and immune competence. Although slight reductions occurred at 15% and 20% inclusion levels, the measured haematological parameters remained within normal physiological limits for healthy broiler chickens. These findings suggest that melon seed meal can safely be included in broiler diets up to 10% without adverse effects on blood profile or overall health.

Table 8: Feed-Cost-Benefits of Broiler Chickens fed Melon seed meal diets (0-7 weeks)

Parameters ₦	T ₁ (0%)	T ₂ (5%)	T ₃ (10%)	T ₄ (15%)	T ₅ (20%)	SEM
Feed Cost /kg feed (₦/kg)	815.00 ^a	802.00 ^b	790.00 ^c	778.00 ^d	765.00 ^a	4.25
Total Feed Intake (kg/bird)	4.956 ^a	4.723 ^b	4.511 ^c	4.623 ^b	4.700 ^b	0.06
Total Feed Cost/bird (₦)	4,039.14 ^a	3,787.98 ^b	3,563.86 ^c	3,596.47 ^c	3,595.70 ^c	36.84
Selling Price/bird (₦)	12,500.00	12,500.00	12,500.00	12,500.00	12,500.00	-
Gross Profit/bird (₦/bird)	8,460.86 ^b	8,712.02 ^{ab}	8,936.14 ^a	8,903.53 ^a	8,904.30 ^a	41.72
Feed Cost/kg Weight	2,050.32 ^b	1,952.16 ^b	1,875.72 ^c	1954.61 ^b	1,987.67 ^b	27.40
Benefit-Cost-Ratio	2.09 ^a	2.30 ^{ab}	2.51 ^a	2.47 ^a	2.48 ^b	0.05

^{a,b,c,d,e} Means within the rows with different superscripts are significantly different ($P < 0.05$); SEM-Standard Error of the mean. Feed Cost(FC), Total Feed Intake (TFI), Total Feed Cost (TFC), Selling Price (SP), Gross Profit (GP), Cost-Benefit Ratio (CBR)

Discussion of Feed Cost–Benefit Analysis of Broiler Chickens Fed Graded Levels of Melon Seed Meal

The feed cost–benefit analysis revealed that increasing the dietary inclusion of melon seed meal progressively reduced the cost of feed production. The cost of one kilogram of feed declined from ₦815.00 in the control diet (0% melon seed meal) to ₦765.00 in the diet containing 20% melon seed meal, indicating that melon seed meal can partially replace expensive conventional feed ingredients and reduce feed manufacturing costs. Feed cost constitutes the largest component of poultry production expenses; therefore, reducing feed cost without compromising performance is essential for profitable broiler production (Ravindran, 2022; Abd El-Hack *et al.*, 2023). Although birds fed the control diet (T₁) attained the highest final body weight, the birds fed 10% melon seed meal (T₃) recorded the lowest feed cost per kilogram of weight gain (₦1,875.72) compared with ₦2,050.32 in the control treatment. This finding indicates that birds receiving 10% melon seed meal utilized feed more efficiently than those in the other treatments. Improved feed efficiency reduces the quantity of feed required to produce one kilogram of body weight, thereby increasing production efficiency and profitability (Beski *et al.*, 2021). Using the prevailing market price of approximately ₦12,500 per live broiler, birds fed 10% melon seed meal produced the highest gross profit (₦8,936.14 per bird) and the highest benefit-cost-ratio (2.51), whereas birds fed the control diet recorded the lowest cost–benefit ratio (2.09). Although the feed cost

continued to decrease at 15% and 20% inclusion levels, the reduction in body weight gain observed in these treatments reduced their overall economic returns. This suggests that lower feed cost alone does not necessarily translate into greater profitability if bird performance is adversely affected (Adeyemi & Sani, 2023).

The superior economic performance observed at 10% melon seed meal inclusion agrees with the growth performance results, where birds fed this diet exhibited the best feed conversion ratio and protein efficiency ratio. These findings indicate that moderate dietary inclusion of melon seed meal improved nutrient utilization while simultaneously lowering production cost. Consequently, 10% dietary inclusion appears to provide the optimum balance between biological performance and economic return under the conditions of this study. Similar observations have been reported by Afolayan *et al.* (2022), who found that moderate inclusion of alternative plant protein sources enhanced profitability, whereas excessive inclusion reduced economic efficiency because of poorer growth performance.

CONCLUSION

Based on the results obtained from this study, It can be concluded that Melon (*Citrullus lanatus*) seed meal can partially substitute maize in broiler chicken diets at 10% -15% inclusion level without adverse effects on growth performance, carcass characteristics, haematological and feed-cost-benefit parameters.

References

1. Abd El-Hack, M. E., Alagawany, M., El-Tarabily, K. A., & Saeed, M. (2023). Alternative feed ingredients and their effects on poultry health and

- physiological responses. *Poultry Science*, 102(8), 102931.
2. Adeyemi, O. A., & Sani, A. (2023). Growth response and nutrient utilization of broiler chickens fed unconventional plant protein sources. *Nigerian Journal of Animal Production*, 50(2), 65–74.
3. Afolabi, O. A., Ojo, O. T., & Ibrahim, A. A. (2022). Feed cost and profitability of commercial poultry production in Nigeria. *Sustainability*, 14(13), 8030.
4. Afolayan, M. O., Oloruntola, O. D., & Ayodele, S. O. (2022). Evaluation of alternative oilseed meals in broiler chicken diets. *Tropical Animal Health and Production*, 54, 257.
5. Akanji, A. M. (2023). Effects of raw, cooked and defatted melon seeds on performance characteristics and mineral retention of broiler chickens. *Journal of Environmental Issues and Agriculture in Developing Countries*.
6. Akinmutimi, A.H. (2004). Evaluation of sword bean (*Canavalia gladiata*) as an alternative feed resource for broiler chickens. Ph.D Thesis, Michael Okpara University of Agriculture, Umudike, Nigeria.
7. Alagawany, M., Elnesr, S. S., El-Hack, M. E. A., & Farag, M. R. (2023). Nutritional strategies for improving carcass yield and meat quality in broiler chickens. *Animals*, 13(5), 875.
8. Alcorn J.M (2002). *Poultry Diseases*. (5th edn), Saunders Company, London, UK
9. AOAC. (2012). Association of Official Analytical Chemists. Official Method of Analysis of the AOAC. 20th Ed, Washington; D.C.
10. Aremu, M. O., Nwoke, C. U., & Ibrahim, H. (2023). Nutritional composition and utilization potential of egusi (*Citrullus lanatus*) seed in food and animal feeding systems.
11. Bahloul, N., Mallek-Ayadi, S., & Kechaou, N. (2018). Phytochemical profile, nutraceutical potential and functional properties of *Cucumis melo* L. seeds. *Journal of the Science of Food and Agriculture*.
12. Baker, F. J. and Silverton R. E. (1985). Introduction to Medical Laboratory Technology. Butter Worth and Co-publishers Ltd. 6th ed. Pg. 12-14.
13. Beski, S. S. M., Swick, R. A., & Iji, P. A. (2021). Protein nutrition and utilization in modern poultry production. *Animal Nutrition*, 7(3), 593–603.
14. Beski, S. S. M., Swick, R. A., & Iji, P. A. (2021). Protein nutrition and muscle development in poultry. *Animal Nutrition*, 7(3), 593–603.
15. Campbell, T. W. (2022). *Exotic Animal Hematology and Cytology* (5th ed.). Wiley-Blackwell.
16. Duncan, N.B. (1995). New Multiple Range and Multiple Test. *Biometrics* 11;39-48
17. Egbuonu, A. C. C. (2015). Phytochemical and anti-nutritional composition of *Citrullus colocynthis* seed. *Journal of Food Research*, 4(3), 1–9.
18. Egbuonu, A. C. C., Opara, C. N., & Ezeanyika, L. U. S. (2015). Phytochemical composition and antioxidant potential of melon (*Citrullus colocynthis* L.) seed flour. *Journal of Food Research*, 4(3), 1–9.
19. Food and Agriculture Organization of the United Nations. (2023). *Poultry Development Review*.
20. Isaac, U.K. (2019). Response of Broiler Chickens fed diets containing differently processed bambara groundnut offal. *Global Scientific and Academic Research Journal of Multidisciplinary Studies* ISSN: 2583-4088 (Online). GSAR Publishers P. 41-50
21. Jain, N. C. (2022). *Schalm's Veterinary Hematology* (7th ed.). Wiley-Blackwell.
22. Mallek-Ayadi, S., Kechaou, N., & Bahloul, N. (2019). Phytochemical profile, nutraceutical potential and functional properties of *Cucumis melo* L. seeds. *Europe PMC*,
23. Mohammed, A. B., Doma, U. D., Bello, K. M., Abubakar, M., Alhassan, N. M., & Mijinyawa, A. (2024). Response of broiler finisher chickens fed graded levels of egusi melon seed cake as replacement for toasted full-fat soybean meal. *Nigerian Journal of Animal Production*.
24. NRCRI, (2025). Agro-Metrologic Unit. National Root Crops Research Institute, Umudike,
25. Nwoke, C. U., Eze, J. I., & Nwosu, F. C. (2023). Proximate composition and nutritional characteristics of full-fat and defatted egusi seed flour. Cited in *Frontiers in Plant Science*.
26. Nwosu, J. N., & Okafor, G. I. (2014). Nutritional and anti-nutritional composition of melon seed flour. *International Journal of Nutrition and Food Sciences*, 3(6), 505–510.
27. Oieh, G.C., Akinrinde, A.S., & Ojeh, E.A. (2007). Fatty acid composition of melon seed oil and its nutritional implications. *African Journal of Biotechnology*, 6(6): 882–885.
28. Ojewola, G.S. and Longe, O.G. (1999). Comparative response and carcass composition of broiler chickens fed varying protein concentration. *ASAN Conference Proceedings*. Pp. 59-72.
29. Oladapo, A. O., Akinyemi, M. O., & Bello, S. A. (2022). Poultry feed market dynamics and cost implications for commercial poultry production in Nigeria. *Sustainability*, 14(13), 8030.
30. Oloruntola, O. D., Ayodele, S. O., & Afolayan, M. O. (2022). Growth performance and carcass characteristics of broiler chickens fed alternative plant protein sources. *Tropical Animal Health and Production*, 54, 257.
31. Oluba, O. M., Ogunlowo, Y. R., & Ojeh, G. C. (2008). Physicochemical properties and fatty acid composition of melon seed oil. *Journal of Food Science and Technology*, 45(2), 123–126.
32. Ravindran, V. (2022). *Poultry Feed Evaluation: Principles and Practice*. CABI Publishing.

33. Steel, R.G.D. and Torrie, J.H. (1980). Principles and Procedures of Statistics. A biochemical approach 2nd edition MCG raw Hill New York.
34. Sudik, S. D., Amaza, I. B., Maidala, A., Lawan, A., & Makinde, O. J. (2024). Performance and cost implication of broiler chickens fed graded levels of pumpkin seed meal. Nigerian Journal of Animal Production.
35. Thrall, M. A., Weiser, G., Allison, R. W., & Campbell, T. W. (2023). Veterinary Hematology and Clinical Chemistry (3rd ed.). Wiley-Blackwell.