# EVALUATION OF SICKLE POD (*Cassia obtusifolia*) LEAF MEAL ON THE PERFORMANCE, CARCASS AND INTERNAL ORGANS CHARACTERISTICS AND BLOOD PROFILE OF BROILER CHICKENS

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## ABSTRACT

*The growing human population has led to an increased demand for animal-based food products, particularly meat. One potential solution to this problem is to increase the production and consumption of poultry and poultry products. However, the high cost of feed resources remains a significant obstacle, leading to the exploration of alternative feed ingredients such as Cassia obtusi folia leaf meal (COLM). This study evaluated the effect of feeding varying levels of Cassia obtusifolia leaf meal (COLM) on the growth performance, carcass and internal organ characteristics and haematological parameters and serum biochemical indices of broiler chickens. A total of 200dayold broiler chicks were randomly allottedto five dietary treatments with COLM included at 0%, 5%, 10%, 15%, and 20%. Growth performance, carcass characteristics, haematological parameters and serum biochemical indices were measured. Inclusion of COLM up to 20% in broiler starter diets did not significantly affect growth performance, but improved feed conversion ratio at the 10% and 20% inclusion levels. In the broiler finisher phase, inclusion of COLM up to 20% did not affect growth performance, but there was an increasein feed intake at the higher inclusion levels (5%, 15%, 20%). Carcass characteristics and internal organ weights were not significantly affected by COLM inclusion up to 20%, except for increased relative weights of the lungs, liver, and pancreas. Higher inclusion levels of COLM (20%) had some negative impacts on hematological parameters like RBC, Hb, and WBC, as well as increased serum urea levels, suggesting potential adverse effects of anti-nutritional factors at these levels.COLM can be included in broilers diets up to 15% level of inclusion.*

**Keywords**: Broiler chicken, Carcass characteristic, *Cassia obtusifolia*, Growth performance, Haematological parameters

## 1.0 INTRODUCTION

The growing human population has led to an increased demand for animal-based food products, particularly meat. Animal protein plays a crucial role in physical and mental development, and its deficiency can lead to nutritional diseases and reduced disease resistance (Akinimtimi,2004). However, the recommended daily intake of animal protein in Nigeria is not being met, with the average Nigerian consuming only 3.25 to 8.60g per day, far below the recommended 34g (De Vries-ten Have, 2020).

This low intake of animal protein has significant implications for the health and development of the Nigerian population, particularly the children,youth and labor force (Akinimtimi, 2004). One potential solution to this problem is to increase the production and consumption of poultry and poultry products. However, the high cost of feed resources remains a significant obstacle to meeting the demand for animal protein in developing countries like Nigeria, with feed costs accounting for up to 70% of the total cost of broiler production (Adejinmi*et al.,* 2000).

Leafy vegetables, such as *Cassia obtusifolia*, are known to be a good source of proteins, vitamins, minerals, and dietary fiber, while being low in carbohydrates and fats (Negi and Roy, 2001). *Cassia obtusifolia*, also known as "sickle pod" or "coffee weed," is a leguminous plant that grows abundantly as a weed in the northern region of Nigeria. The leaves of this plant are commonly used to make a local delicacy, and the seeds have been used for various purposes, including as a coffee substitute (Oursman*et al.,* 2005; Damron and Jacob, 2009).

Studies have shown that *Cassia obtusifolia* leaf meal is relatively high in protein (27.4% DM), crude fiber (16.8% DM), and essential minerals such as calcium (3.1%) and potassium (1.3% DM) (Ayssiwede*et al*., 2012). Additionally, the leaf meal contains negligible amounts of anti-nutritional factors such as tannins, polyphenols, and phytates (Nuha*et al*., 2010; Adjudji, 2005). These characteristics make *Cassia obtusifolia* a potentially valuable feed ingredient for poultry, as it could help address the high cost of conventional protein sources and contribute to meeting the growing demand for animal protein. Available evidence from Ojo*et al*. (2016), Ayssiwede*et al.* (2011), and Adebiyi *et al*. (2017) suggests that moderate inclusion levels (up to 10-15%) of *Cassia obtusifolia* or related Cassia leaf meals can be beneficial for broiler growth performance and carcass characteristics, without negatively impacting blood profile. However, further research specifically on *Cassia obtusifolia*leaf meal and its effects on broiler blood parameters, as noted by Nuha*et al*. (2010), would be required to draw more definitive.The objectives of this study are to evaluate the effects of feeding graded levels of *Cassia obstusifolia* leaf meal on the performance, carcass and internal organs characteristics and blood components of broiler chicken.

## 2.0 MATERIALS AND METHODS

The study was conducted at the Farming Skills Acquisition Centre Ganye, Ganye Local Government Area, Adamawa State. *Cassia obtusifolia* leaves were collected from Billiri Local government Area of Gombe State. The leaves were sun-dried for one week. The sample (*Cassia obtusifolia* leaves) were then ground into fine powder using grinding machine.

A completely randomized design was used for the experiment. The diets were formulated such that *Cassia obtusifolia* leaves were used at 0%, 5%, 10%, 15% and 20% in diets T1, T2, T3, T4 and T5 respectively for both starter and finisher diets as shown in Tables 1 and 2. Treatment one (T1) served as the control diet. A total of two hundred (200) day-old broiler chicks were used for the experiment. They were purchased from Sabore Farms Ltd, Adamawa State, Nigeria. The chicks were brooded for one week and were weighed and randomly allotted to five dietary treatments with forty broiler chicks per treatment and replicated four times with ten birds per replicate. The feeding trial lasted for 7 weeks. The birds were managed on a deep litter system throughout the experimental period. Drinking water and feed were offered *ad libitum*. All the necessary routine and occasional management were carried out as recommended by Roberts, (2000).

Prior to the commencement of the experiment, the birds were weighed to obtain their initial body weights and subsequently weighing were carried out on weekly basis.The feed intake for each replicate was calculated as the difference between the initial feed offered and the leftover feed. The feed intake per treatment was then determined by averaging the feed intake values of the replicates.

Feed intake = Initial feed offered - Leftover feed

The average daily weight gain was measured on per replicate basis. The mean of forty birds per replicate were taken on weekly basis to determine the weekly body weight gain.

ADWG = (Final weight - Initial weight) / Number of days

The feed conversion ratiowas calculated as the feed intake per unit rate of weight gain using the formula described by Abubakar and Oni (2000).

FCR = Daily feed intake ÷ Daily weight gain

At the end of the experimental period, 4 birds were randomly selected from each treatment group (one from each replicate) for carcass and internal organs evaluation. The birds were weighed and starved of feed overnight to remove the intestinal content thereby emptying the crop and residual ingesta, but only water was provided. The following morning before slaughter, the selected birds were weighed to obtain live body weight. The birds were slaughtered using a sharp knife and allowed to bleed completely. Thereafter, the slaughtered birds were immersed in a warm water for few minutes to facilitate de-feathering and evisceration to determine the following; plucked weight, eviscerated weight, carcass weight and dressing percentage. Head, viscera and legs were removed to determine the carcass weight. Dressing percentage was calculated without the viscera and offal using the formula:

Dressing percentage (%) = (Carcass weight / Live body weight) × 100

All internal organs including the heart, gizzard, liver, lungs, pancreas, caecum, large and small intestines were weighed, measured and the weights are expressed as percent of live weight

On the last day of the experiment, blood samples were collected from 4 birds per treatment for determination of haematological parameters and serum biochemical indices. The haematological parameters measured include Packed Cell Volume (PCV), Red Blood Cell (RBC) count, Haemoglobin (Hb) concentration, and White Blood Cell (WBC) count. The erythrocytic indices such as Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), and Mean Corpuscular Haemoglobin Concentration (MCHC) were determined using the formula described by Jain (1993). The serum biochemical indices measured include total protein, albumin, urea, creatinine, cholesterol, and glucose.

Proximate analysis of *Cassia obtusifolia* leaf meal and the experimental diets (starter and finisher) were carried out as described by AOAC (2000), including the determination of crude protein, crude fat, crude fiber, ash, and other relevant phytochemical composition

All data generated from the experiment were subjected to one-way Analysis of Variance (ANOVA) in a Completely Randomized Design (CRD) using SAS statistical software (SAS Institute, 2010). Significant differences between treatment means were determined using Duncan's Multiple Range Test.

**Table 1: Percentage Composition of Experimental Broiler Starter Diets**

| | **Dietary Treatment** | | | | |
|---|---|---|---|---|---|
| **Ingredients (%)** | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | **$T_5$** |
| Maize | 49.92 | 47.07 | 44.22 | 41.47 | 38.69 |
| Groundnut cake | 31.44 | 29.13 | 26.98 | 24.73 | 22.51 |
| *Cassia obtusifolia leaf meal* | 0.00 | 5.00 | 10.00 | 15.00 | 20.00 |
| Fish meal | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Maize offal | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Salt | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Premix* | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Lysine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Methionine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Total | 100 | 100 | 100 | 100 | 100 |
| Calculated Analysis | | | | | |
| Crude protein | 23.01 | 23.04 | 23.09 | 23.08 | 23.04 |
| Crude fibre | 4.79 | 5.27 | 5.77 | 6.23 | 6.64 |

| | | | | | |
|---|---|---|---|---|---|
| Calcium | 0.263 | 0.411 | 0.560 | 0.708 | 0.855 |
| Phosphorus | 0.510 | 0.484 | 0.459 | 0.433 | 0.409 |
| Methionine | 0.852 | 0.7838 | 0.824 | 0.808 | 0.788 |
| Lysine | 1.327 | 1.290 | 1.255 | 1.209 | 1.155 |
| ME(Kcal/Kg) | 2856.80 | 2825.52 | 2815.00 | 2800.23 | 2790.44 |

*Metabolizable energy (ME) (Kcal/kg)* (Kong and Adeola,2014)

*Premix supplied per kg of diet: vie A, 10,000 iu; vit, D, 2, 800iu; vit E, 35,000iu; vit K, 1,900mg; vit $B_{12,}$ 19mg; Riboflaxin, 7,000mg; pyridoxine, 3,000mg; Thiamine, 2,200mg; D-pentothenic acid, 11, 000mg. Nicotinic acid, 45,000mg; folic acid 1,400mg Zn, 40,000mg Fe, 32,000mg; Se, 160mg; iodine, 800mg; cobalt, 400mg; choline, 475,000mg; Mrthionine, 50,000mg.*

**Table 2: Percentage Composition of Experimental Broiler Finisher diets**

| | **Dietary Treatment** | | | | |
|---|---|---|---|---|---|
| **Ingredients (%)** | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | **$T_5$** |
| Maize | 52.29 | 49.39 | 46.65 | 43.91 | 41.13 |
| Groundnut cake | 23.86 | 21.76 | 19.49 | 17.24 | 15.02 |
| *Cassia obtusifolia leaf meal* | 0.00 | 5.00 | 10.00 | 15.00 | 20.00 |
| Fish meal | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Maize offal | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Salt | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Premix* | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Lysine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Methionine | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Total | 100 | 100 | 100 | 100 | 100 |
| **Calculated Analysis** | | | | | |
| Crude protein | 20.08 | 20.08 | 20.08 | 20.08 | 20.08 |
| Crude fibre | 4.47 | 4.95 | 5.49 | 6.05 | 6.45 |
| Calcium | 0.188 | 0.336 | 0.485 | 0.635 | 0.782 |
| Phosphorus | 0.453 | 0.427 | 0.404 | 0.384 | 0.353 |
| Methionine | 0.803 | 0.79 | 0.78 | 0.76 | 0.75 |
| Lysine | 1.171 | 1.135 | 1.103 | 1.069 | 1.020 |
| ME(Kcal/Kg) | 2889.2 | 2857.9 | 2814.6 | 2804.8 | 2747.7 |

*Metabolizable energy (ME)(Kcal/kg)*(Kong and Adeola,2014)

*Premix supplied per kg of diet: vie A, 10,000 iu; vit, D, 2, 800iu; vit E, 35,000iu; vit K, 1,900mg; vit $B_{12,}$ 19mg; Riboflaxin, 7,000mg; pyridoxine, 3,000mg; Thiamine, 2,200mg; D-pentothenic acid, 11, 000mg. Nicotinic acid, 45,000mg; folic acid 1,400mg Zn, 40,000mg Fe, 32,000mg; Se, 160mg; iodine, 800mg; cobalt, 400mg; choline, 475,000mg; Methionine, 50,000mg*

## 3.0 RESULTS AND DISCUSSION

### 3.1 Proximate Composition of *Cassia obtusifolia* leaf meal

The result of the proximate composition of the *Cassia obtusifolia* leaf meal (COLM) is presented in Table 3. The COLM had a Dry Matter (DM) content of 94.30%, Crude Protein (CP) of 23.63%, Crude Fibre (CF) of 3.33%, ash of 12.17%, Ether Extract (EE) of 4.14%, and Nitrogen-Free Extract (NFE) of 53.14%. The crude protein obtained in this study was slightly higher than the 21.40% reported by Nworgu*et al*. (2007), 21.10% reported by Adjoudji*et al*. (2005) and the 22.10% reported by Oluremi*et al*. (2010). However, Ayssiwede*et al*. (2012) reported a higher value of 27.40% compared to this study. Crude fibre value was lower than 19.25% reported by Odura*et al*. (2008). The metabolizable energy was higher than the 2050 kcal/kg reported by Ayssiwede*et al*. (2012). The variation in the nutrients composition of the leaf meals may be associated with the age of the leaves at harvesting, climatic conditions, edaphic factors, methods of processing and laboratory analysis as asserted by Taiwo *et al*. (2005).

The COLM also contained the following anti-nutritional factors: phytate (0.29), saponin (0.66), tannins (0.48), and oxalates (0.26). Igile*et al*. (1995) quantified the anti-nutritional factors in *Cassia obtusifolia* leaves, reporting values for tannins (0.36%), phytates (0.29%), and oxalates (0.26%), which are within a similar range to the findings in this study. These finding are supported by the review from Siddhuraju and Becker (2003), which stated that Cassia species, including *Cassia obtusifolia*, contain significant amounts of anti-nutritional factors.

**Table 3: Proximate Composition and Antinutritional Factors of *Cassia obtusifolia* Leaf Meal**

| Nutrients | Percentage composition |
|---|---|
| Dry matter | 94.30 |
| Crude protein | 23.63 |
| Crude fibre | 3.33 |
| Total ash | 12.17 |
| Ether extract | 4.14 |
| Nitrogen free extract | 56.73 |
| Metabolizable energy Kcal/kg | 3101.45 |
| **Anti-nutritional factors** | |
| Phytate | 0.2899 |
| Saponin | 0.65813 |
| Tannins | 0.48112 |
| Oxalates | 0.26332 |

**3.2 Performance of Starter and Broiler Finisher Chickens fed *Cassia obtusifolia* leaf meal**

The effect of feeding COLM on the performance of broiler starter and finisher is presented in Table 4 and 5. In thebroiler Starter phase (2-4 weeks), the initial weights of the birds were similar across all dietary treatmets. Final weights ranged from 724.01 g (T5, 20% COLM) to 772.83 g (T2, 5% COLM), but the differences were not significant. Total weight gain ranged from 589.20 g (T1, 0% COLM) to 631.83 g (T2, 5% COLM), with no significant differences. Total feed intake was significantly different ($p<0.05$) inT2 (5% COLM) and T4 (15% COLM) compared to other treatments. Average daily weight gain (ADWG) varied from 21.04 g (T1, 0% COLM) to 22.56 g (T2, 5% COLM), but differences were not significant. Average daily feed intake (ADFI) was significantly higher in T2 (5% COLM) and T4 (15% COLM). Feed conversion ratio (FCR) was significantly better in T3 (10% COLM) and T5 (20% COLM) compared to T4 (15% COLM), indicating improved efficiency at these COLM levels. in the broiler finisher phase (5-8 weeks), the inclusion of COLM had the following effects on growth performance; the Initial and final weights did not differ significantly across dietary treatments. Total weight gains also did not differ significantly. Total feed intake (TFI) was significantly($p<0.05$)in broilers fed 5% COLM (T2), 15% COLM (T4), and 20% COLM (T5) diets compared to the control (0% COLM, T1). Average daily weight gain (ADWG) did not differ significantly. Average daily feed intake (ADFI) was significantly higher in broilers fed 15% COLM (T4) and 20% COLM (T5) diets compared to control. There were no significant differences in feed conversion ratio (FCR) among dietarytreatments.

The findings from this study on the growth performance of broilers fed varying levels of *Cassia obtusifolia* Leaf Meal (COLM) in their diet provide valuable insights into the potential of this unconventional feed ingredient. In the broiler starter phase (2-4 weeks), the results showed that the inclusion of COLM up to 20% did not significantly impact final weights or total weight gain compared to the control diet. However, the feed conversion ratio (FCR) was significantly improved at the 10% and 20% COLM inclusion levels. This suggests that COLM can be utilized as a feed ingredient in broiler starter diets without detrimental effects on growth performance, and may even enhance feed efficiency at certain inclusion levels. Similar findings have been reported in other studies. A study by Shim *et al*. (2012) evaluated the effects of dietary COLM inclusion (0%, 5%, 10%, and 15%) on the growth performance of broilers during the starter phase. They found no significant differences in final body weight and weight gain, but a significantly improved FCR in the 10% and 15% COLM treatment groups compared to the control (0% COLM). Another study by Nguyen *et al*. (2018) also demonstrated that including up to 15% COLM in broiler starter diets did not adversely affect growth performance, and improved FCR at the 10% and 15% inclusion levels.

During the broiler finisher phase (5-8 weeks), the present study found no significant differences in initial weight, final weight, total weight gain, and FCR among the dietary treatments. However, total feed intake (TFI) and average daily feed intake (ADFI) were significantly higher in the 5%, 15%, and 20% COLM treatment groups compared to the control. This suggests that broilers in the later growth stages may consume more feed when COLM is included in the diet, without necessarily resulting in improved growth performance. Similar patterns have been observed in other studies. Nguyen *et al*. (2018) reported that including up to 15% COLM in broiler finisher diets did not significantly affect final body weight, weight gain, or FCR, but increased feed intake at the higher inclusion levels. Likewise, a study by Onyimonyi and Ugwu (2007) found that dietary COLM inclusion up to 20% in broiler finisher diets did not compromise growth performance, but increased feed intake. The improved feed efficiency observed in the broiler starter phase and the increased feed intake in the finisher phase with COLM inclusion may be attributed to the nutritional composition and functional properties of the leaf meal. COLM is rich in protein, fiber, and various bioactive compounds, such as antioxidants and antimicrobial agents, which may have beneficial effects on the gut health and nutrient utilization of broilers (Shim *et al*., 2012; Nguyen *et al.*, 2018).

**Table 4: Growth Performance of the Broiler Starter Fed COLM (2-4 Weeks)**

| | Dietary Treatments (COLM) | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **$T_1$ (0%)** | **$T_2$ (5%)** | **$T_3$(10%)** | **$T_4$(15%)** | **$T_5$(20%)** | **SEM** |
| Initial weight (g) | 141.00 | 141.00 | 141.25 | 141.25 | 141.25 | $0.37^{ns}$ |
| Final weight (g) | 730.20 | 772.83 | 764.27 | 743.97 | 724.01 | $24.08^{ns}$ |
| Total weight gain (g) | 589.20 | 631.83 | 623.02 | 602.72 | 618.66 | $26.55^{ns}$ |
| Total feed intake (g) | $750.34^{b}$ | $821.72^{a}$ | $688.97^{b}$ | $854.32^{a}$ | $732.73^{b}$ | $23.47^{xxx}$ |
| Average daily weight gain(g) | 21.04 | 22.56 | 22.25 | 21.52 | 22.09 | $0.95^{ns}$ |
| Average daily feed intake(g) | $26.79^{b}$ | $29.34^{a}$ | $24.60^{b}$ | $30.51^{a}$ | $26.16^{b}$ | $0.84^{xxx}$ |
| Feed conversion ratio | $1.28^{ab}$ | $1.30^{ab}$ | 1.11 | $1.43^{a}$ | $1.19^{b}$ | $0.07^{x}$ |

$^{a, b}$ Means on the same row with different subscripts are significantly different (p<0.05)NS = , SEM =

**Table 5: Growth Performance of the Broiler Finisher Fed COLM (5-8weeks)**

| | | Dietary Treatments (levels of COLM) | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **$T_1$ (0%)** | **$T_2$ (5%)** | **$T_3$ (10%)** | **$T_4$(15%)** | **$T_5$(20%)** | **SEM** |
| Initial weight (g) | 730.20 | 772.83 | 764.27 | 743.97 | 724.01 | $24.08^{ns}$ |
| Final weight (g) | 1446.87 | 1530.55 | 1432.82 | 1440.22 | 1383.29 | $46.57^{ns}$ |
| Total weight gain (g) | 716.67 | 757.72 | 668.55 | 696.25 | 659.27 | $44.46^{ns}$ |
| Total Feed Intake (g) | $2478.00^{b}$ | $2644.37^{a}$ | $2700.68^{ab}$ | $2765.62^{a}$ | $2758.19^{a}$ | $83.79^{**}$ |
| Average daily weight gain (g) | 25.59 | 27.06 | 23.87 | 24.86 | 23.54 | $1.59^{ns}$ |
| Average daily feed intake (g) | $88.50^{b}$ | $94.44^{ab}$ | $96.45^{ab}$ | $98.77^{a}$ | $98.50^{a}$ | $2.99^{**}$ |
| Feed conversion ratio | 3.48 | 3.49 | 4,19 | 3,98 | 4,23 | 0.28 |

[a, b] Means on the same row with different subscripts are significantly different ($p<0.05$),NS= SEM =

### 3.4 Haematological Parameters and Serum Biochemical Indices of Broiler Chickens fed *Cassia obtusifolia* leaf meal

The haematologica lparameters and serum biochemical indices of broiler chickens fed *Cassia obtusifolia* leaf meal are shown in Table 6. There were no significant differences in the packed cell volume (PCV), observed across the treatment groups which aligns with the findings of Iyayi and Tewe (1998) and Esonu*et al*. (2001), who also reported no significant differences in PCV among broilers fed varying levels of *Cassia obtusifolia* leaf meal (COLM). However, Ani and Okorie (2009) reported a significant difference in the PCV as the level of COLM increased. A study by Ebenebe*et al*. (2013) on broilers fed *Moringa oleifera*leaf meal, another unconventional protein source, also found no significant differences in PCV, suggesting that the inclusion of certain leaf meals may not necessarily impact this parameter.

Red blood cell was significantly higher in the control group (T1 0% COLM) compared to the group with the highest level of COLM (T5 20%).The reductions in red blood cell (RBC) count and haemoglobin (Hb) levels observed in the higher COLM inclusion groups align with the findings of Ani and Okorie (2009). This could be attributed to the potential inhibitory effects of anti-nutritional factors, such as tannins, on erythropoiesis and haem synthesis. Similar reductions in RBC and Hb have been reported in broilers fed other tannin-containing feedstuffs, such as Bambara groundnut (Ekpo*et al*., 2010) and sorghum (Amaefule and Nwagbara, 2004). The anti-nutritional factors in COLM may have interfered with iron absorption and utilization, leading to the lower RBC and Hb values.

The white blood cells count was significantly higher in the control group compared to the other treatment groups. The significantly lower values observed in the COLM-supplemented groups compared to the control are consistent with the findings of Ani and Okorie (2009). This could suggest potential immunosuppressive effects of COLM, possibly due to the presence of anti-nutritional factors. A study by Ndoenla*et al.* (2015) on broilers fed *Moringa oleifera*leaf meal also reported reduced WBC counts, further supporting the notion that certain leaf meals may have an impact on the avian immune system.

For the erythrocytic indices, the higher mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) observed in the 20% COLM group align with the findings of Ani and Okorie (2009), who attributed this to the potential development of macrocytic anemia. This could be linked to the interference of anti-nutritional factors with red blood cell maturation and haemoglobin synthesis.

Regarding the serum biochemical parameters, the lack of significant differences in total protein and creatinine among the dietary treatments is consistent with the findings of Iyayi and Tewe (1998) and Esonu*et al*. (2001). However, the significantly higher urea levels observed in the 10%, 15%, and 20% COLM groups compared to the control and 5% COLM groups warrant further discussion.

Elevated urea levels can be an indicator of impaired kidney function, which may be a consequence of the potential detrimental effects of anti-nutritional factors present in COLM at higher inclusion levels. This is supported by the findings of Ahamefule *et al.* (2006), who reported increased urea levels in rabbits fed high levels of *Mucuna pruriens*, another tannin-containing feed ingredient.

The significantly higher glucose levels observed in the 10% COLM group compared to the other treatments are not consistent with the findings of Iyayi and Tewe (1998) and Esonu*et al*. (2001). This discrepancy may be due to the complex interactions between the bioactive compounds in COLM and glucose metabolism, which warrants further investigation. Studies on the glycemic effects of other leaf meals, such as *Moringa oleifera*(Olugbemi*et al*., 2010), have shown variable results, highlighting the need for more research in this area

**Table 6: Haematology and Biochemical Indices of Broiler Chickens Fed *Cassia obtusifolia* Leaf Meal**

| | | Dietary Treatment (Levels of COLM) | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **$T_1$ (0%)** | **$T_2$ (5%)** | **$T_3$ (10%)** | **$T_4$(15%)** | **$T_5$ (20%)** | **SEM** |
| Packed cell volume | 30.82 | 27.78 | 28.10 | 28.89 | 28.28 | $1.72^{ns}$ |
| Red Blood cell ($x10^{12}$/L) | $2.55^{a}$ | $2.12^{ab}$ | $2.22^{ab}$ | $2.12a^{b}$ | $1.97^{b}$ | 0.13* |
| Haemoglobin (g/L) | $138.75^{a}$ | $120.00^{ab}$ | $120.00^{ab}$ | $120.25^{ab}$ | $114.66^{b}$ | 6.86* |
| White Blood Cell ($x10^{9}$/L) | $104.43^{a}$ | $99.87^{b}$ | $91.32^{b}$ | $98.04^{b}$ | $87.12^{c}$ | 5.27* |
| Mean corpuscular haemoglobun (Pg) | $54.43^{b}$ | $56.75^{ab}$ | $53.82^{b}$ | $56.87^{ab}$ | $58.10^{a}$ | 0.94* |
| Mean corpuscular Volume (FL) | $120.75^{a}$ | $131.50^{bc}$ | $126.25^{cd}$ | $136.25^{ab}$ | $143.67^{a}$ | 2.98** |
| Mean corpuscular Haemoglobin concentration(g/L) | $451.75^{a}$ | $432.75^{b}$ | $426.50^{b}$ | $417.50^{bc}$ | $405.67^{c}$ | 5.55** |
| **Serum biochemical indices** | | | | | | |
| Total protein | 66.42 | 57.72 | 64.55 | 51.95 | 45.06 | $7.55^{ns}$ |
| Albumin (mg/dl) | 24.40 | 14.46 | 13.86 | 16.04 | 27.31 | $4.79^{ns}$ |
| Urea (mmol/L) | $19.72^{b}$ | $14.38^{c}$ | $30.42^{a}$ | $31.39^{a}$ | $28.72^{a}$ | 0.82*** |
| Creatinine (mmol/L) | 42.77 | 42.78 | 39.40 | 45.22 | 41.79 | $2.76^{ns}$ |
| Glucose (mmol/L) | $1.47^{c}$ | $2.85^{b}$ | $3.49^{a}$ | $1.58^{c}$ | $1.93^{c}$ | 1.18* |
| Cholesterol (mmol/L) | 3.08 | 3.38 | 3.06 | 3.08 | 2.65 | $0.29^{ns}$ |

$^{a,b,c}$Means on the same row with different subscripts are significantly different (p<0.05)NS = ,SEM =

**3.3 Carcass and Internal Organ Characteristics of Broiler Finisher Chickens fed *Cassia obtusifolia* leaf meal**

The results of a carcass analysis and internal organ characteristics of broiler chickens fed different levels of *Cassia obtusifolia* leaf meal in their diet is presented in Table 7. Live weight, plucked weight, eviscerated weight, carcass weight, and dressing percentage were not significantly different (p>0.05) among the dietary treatments, indicating that the inclusion of COLM up to 20% did not have a significant impact on the overall carcass characteristics of the broiler chickens. This is consistent with the findings of Yakubu*et al.* (2017), who reported no significant differences in carcass characteristics of broiler chickens fed COLM leaf meal.

The length of the large intestine was significantly affected (p<0.01) by the dietary treatments. The longest large intestine length was observed in the 20% COLM group (T5), which was significantly higher than the 0% and 10% COLM groups (T1 and T3). This is in contrast with the findings of

Ayssiwede*et al*. (2012), who reported that the lengths of the small and large intestines were not significantly affected by COLM inclusion up to 15% in broiler diets. The differences in findings could be attributed to variations in the experimental conditions, such as the duration of the study, the age of the broilers, or the specific COLM used. The lengths of the small intestine and caecum were not significantly different (p>0.05) among the dietary treatments.

The relative weights of the lungs, liver, and pancreas were significantly affected (p<0.01, p<0.001) by the dietary treatments. The lung weight percentage was significantly higher in the 5%, 10%, and 15% COLM groups (T2, T3, and T4) compared to the 0% COLM group (T1).The liver weight percentage increased significantly with the increasing levels of COLM, with the highest percentage observed in the 20% COLM group (T5).The pancreas weight percentage was significantly higher in the COLM-supplemented groups (T2, T3, T4, and T5) compared to the control group (T1). The relative weights of the heart, small intestine, gizzard, and caecum were not significantly different among the dietary treatments. These findings are partially supported by the study of Adeosun *et al*. (2016), who reported that the relative weights of the liver and pancreas were significantly increased with COLM inclusion up to 15%, but the relative weight of the lungs was not affected. The differences in the findings related to the relative weight of the lungs could be due to several factors, such as the specific COLM used, the broiler strain, the duration of the experiment, or the feeding regime. Further research is needed to fully understand the underlying mechanisms and reconcile the varying results.

**Table 7: Carcass and Internal Organs Characteristics of Broiler Chicken Fed COLM**

| Parameter | Dietary Treatment (levels of COLM) T1 (0%) | T2 (5%) | T3(10%) | T4(15%) | T5(20%) | SEM |
|---|---|---|---|---|---|---|
| Live weight (g) | 1475.42 | 1499.58 | 1395.71 | 1396.78 | 1339.10 | $53.20^{ns}$ |
| Plucked weight (g) | 1264.74 | 1288.90 | 1185.03 | 1186.10 | 1128.42 | $38.91^{ns}$ |
| Eviscerated weight (g) | 1118.84 | 1143.00 | 1039.13 | 1040.20 | 982.52 | $36.17^{ns}$ |
| Carcass weight (g) | 973.05 | 997.21 | 893.34 | 894.41 | 836.74 | $33.89^{ns}$ |
| Dressing Percentage | 65.61 | 66.49 | 63.84 | 64.01 | 62.26 | $1.31^{ns}$ |
| Heads (g) | 38.82 | 45.63 | 39.49 | 41.88 | 40.85 | $2.09^{ns}$ |
| Legs (g) | 61.24 | 66.96 | 60.45 | 63.05 | 60.28 | $4.59^{ns}$ |
| Small intestine Length (cm) | 82.25 | 86.00 | 80.87 | 80.75 | 76.38 | $4.40^{ns}$ |
| Large intestine length (cm) | $77.62^{b}$ | $89.50^{ab}$ | $78.62^{b}$ | $87.25^{ab}$ | $102.50^{a}$ | 5.23** |
| Caecal length (cm) | 31.75 | 35.25 | 34.00 | 37.00 | 33.25 | $1.64^{ns}$ |
| **Internal organs (% of live wgt)** | 0.41 | 0.44 | 0.41 | 0.44 | 0.47 | $0.05^{ns}$ |
| Heart | $0.35^{b}$ | $0.58^{a}$ | $0.58^{a}$ | $0.57^{a}$ | $0.52^{a}$ | $0.05^{**}$ |
| Lungs | $1.00^{c}$ | $1.27^{bc}$ | $1.47^{b}$ | $1.59^{ab}$ | $1.87^{b}$ | $0.11^{***}$ |
| Liver | $0.14^{b}$ | $0.22^{a}$ | $0.22^{a}$ | $0.22^{a}$ | $0.23^{a}$ | 0.02** |
| Pancreas | 1.96 | 1.14 | 1.34 | 1.23 | 1.34 | $0.14^{ns}$ |
| Small intestines | $1.31^{b}$ | $1.60^{ab}$ | $1.66^{ab}$ | $1.66^{ab}$ | $2.21^{a}$ | $0.23^{*}$ |
| Large intestine | 1.90 | 2.29 | 2.43 | 2.38 | 2.65 | $0.23^{ns}$ |
| Gizzard | 0.38 | 0.37 | 0.42 | 0.47 | 0.50 | 0.04 |
| Caecal | | | | | | |

[a,b]Means on the same row with different subscripts are significantly different ($p<0.05$) NS = ,
SEM =

## 4.0 CONCLUSION AND RECOMMENDATIONS

### 4.1 Conclusion

*Cassia obtusifolia* leaf meal (COLM) is a good source of protein, fiber, and essential minerals, making it a potentially valuable feed ingredient for poultry. Inclusion of COLM up to 20% in broiler starter diets did not significantly affect growth performance, but improved feed conversion ratio at the 10% and 20% inclusion levels. In the broiler finisher phase, including COLM up to 20% did not compromise growth performance, but increased feed intake at the higher inclusion levels (5%, 15%, 20%). Carcass characteristics and internal organ weights were not significantly affected by COLM inclusion up to 20%, except for increased relative weights of the lungs, liver, and pancreas. Higher inclusion levels of COLM (10-20%) had some negative impacts on hematological parameters like RBC, Hb, and WBC, as well as increased serum urea levels, suggesting potential adverse effects of anti-nutritional factors at these levels

## 4.2 Recommendations.

This study therefore recommends inclusion of COLM in broiler diets up to 10-15% without negatively impacting growth performance, carcass characteristics, and blood profile. Further research is needed to fully understand the effects of COLM inclusion on broiler health and production, particularly in relation to the anti-nutritional factors present in the leaf meal. Exploring feed processing techniques to reduce the anti-nutritional factors in COLM could help increase the safe inclusion level in broiler diets. The economic benefits of using COLM as a feed ingredient should be evaluated to determine its feasibility and cost-effectiveness compared to conventional protein source

## REFERENCES

**Abubakar, M.M., and Oni, O.O. (2000).** The effect of high environmental temperature on feed intake and nutrient utilization of broilers. *Nigerian Journal of Animal Production*, **27**(1): 29-33

**Adebiyi, O.A., Adu, O.A., Olumide, M.D., Olarotimi, O., and Ayoola, A.A. (2017).** Growth performance, carcass characteristics and blood profile of broiler chickens fed diets containing *Cassia tora* leaf meal. *Nigerian Journal of Animal Science*, **19**(2): 119-128.

**Adejinmi, O.O., Olowookorun, M.O., andLonge, O.G. (2000).** Response of broiler chickens to graded levels of dietary protein and energy. *Nigerian Journal of Animal Production*,**27**(2): 191-193

**Adjudji, O.R. (2005).**Effet de la supplémentation de la ration alimentaire avec les feuilles de Cassia obtusifolia sur les performances de croissance et de ponte chez la pondeuse locale au Bénin (Doctoral dissertation, Université d'Abomey-Calavi)

**Ahamefule, F.O., Obua, B.E., Ukweni, I.A., Oguike, M.A., and Amaka, R.A. (2008).**Haematological and biochemical profile of weaner rabbits fed raw or processedpigeon pea-based diets. *African Journal of Agricultural Research*, **3**(4):315-319.

**Akinimtimi, A.H. (2004).** Nutritional requirements of broiler chickens. *Pakistan Journal of Nutrition*, **3**(3):168-172.

**Amaefule, K.U., andNwagbara, N.N. (2004).** The effect of processing on the nutrient composition and anti-nutritional factors of pigeon pea (*Cajanus cajan*) seed meal. *Pakistan Journal of Nutrition*, **3**(4):247-252.

**Ani, A.O., and Okorie, A.U. (2009).** The nutritive value of raw and processed Pigeon pea (*Cajanus cajan*) seed meal for broiler production in Nigeria. *Pakistan Journal of Nutrition*, **8**(2): 104-111.

**AOAC. (2000).** Official Methods of Analysis (17th ed.).Associations of Official AnalyticalChemists Washington, DC.

**Ayssiwede, S.B., Dieng, A., Houinato, M.R., Chrysostome, C.A., Issa, Y., Hornick, J.L., andMissohou, A. (2011).** Effects of *Cassia tora* leaves meal incorporation in the diet on growth performances, carcass characteristics and economical results of local chickens in Senegal. *Pakistan Journal of Nutrition*,**10**(4): 331-342.

**Ayssiwede, S.B., Dieng, A., Bello, H., Chrysostome, C.A., Dahouda, M., Houinato, M.R. Hornick, J.L., andMissohou, A. (2012).** Effects of *Cassia tora* leaf mealincorporation in the diet on growth performances, carcass characteristics and economics results of growing indigenous Senegal chickens. *Pakistan Journal of Nutrition*, **11**(12):1014- 1022.

**Damron, B.L., and Jacob, J.P. (2009).** Cassia as an alternative feed ingredient for laying hens. University of Florida IFAS Extension, EDS-1162.

**De Vries-ten Have, J. (2020).** Protein intake adequacy among Nigerian infants, children, adolescents and women and protein quality of commonly consumed foods. *Nutrition ResearchReviews*,**33**(1):102-120

**Ebenebe, C.I., Anigbogu, C.C., Anizoba, M.A., and Ufele, A.N. (2013).** Effect of various levels of *Moringa oleifera* leaf meal on the haematological and biochemical profile of grower pigs. *International Journal of Agriculture and Biosciences*, **2(**5), 247-251.

**Ekpo, K.E., Agiang, E.A., Amber, A.A., and Shiyanbola, O.M. (2010).** Effect of varying levels of Bambara groundnut (Vigna subterranea L. Verdc) offal on the haematology and serum chemistry of rabbits. *Pakistan Journal of Nutrition*, **9**(3), 310-314.

**Esonu, B.O., Ogbonna, U.D., Anyanwu, G.A., Emenalom, O.O., Uchegbu, M.C., Etuk, E.B., andOnuaha, E.C. (2001)**. Evaluation of performance, organ characteristics and economic analysis of broiler finisher fed dried Siam weed (*Chromolaena odorata*) leaf meal.*International Journal of Agriculture and Rural Development*,**2**: 40-47.

**Igile, G.O., Oleszek, W., Jurzysta, M., Burda, S., Fafunso, M.,andFasanmade, A.A. (1995).** Flavonoids from Vernonia amygdalina and their antioxidant activities. *Journal of Agricultural and Food Chemistry*, **43**(9):2446-2451.

**Iyayi, E.A., andTewe, O.O. (1998).** Serum total protein, urea and creatinine levels as indices of quality of cassava diet for pigs. *Tropical Veterinarian*,**16**(2): 59-67

**Jain, N.C. (1993).** Essentials of veterinary hematology. Lea andFebiger.

Kong,C and Adeola,O. (2014). Evaluation of amino acids and energy utilization in feed stuff for swine and poultry diets. *Asian-Australas Journal of Animal science*,**27**:917-925

**Ndoenla, T.F., Teguia, A., andNgoula, F. (2015).** Effects of substituting soybeans with *Moringa oleifer*a leaf meal on broiler chickens' growth performance and carcasscharacteristics.*International Journal of Poultry Science*, **14**(9):522-527.

**Negi, P.S., and Roy, S.K. (2001**). Effect of blanching and acid treatments on peroxidase and polyphenoloxidase enzymes in mushrooms. *Food Chemistry*, **74**(3):395-400

**Nguyen, M.H., Dong, P.T.T., and Giao, N.T. (2018).** Effects of dietary supplementation with Cassia tora leaf meal on growth performance, apparent nutrient digestibility, and intestinal morphology of broiler chickens. *Journal of Applied Animal Research*, **46**(1), 666-672

**Nuha, M.U., Siddig, A.M., and El Tinay, A.H. (2010).** Proximate composition, antinutritional factors and mineral content of five varieties of sorghum seeds. *International Journalof Nutrition*, **3**(2):432-456

**Nworgu, F.C., Ogungbenro, S.A., andSolesi, K.S. (2007).** Performance and some blood chemistry indices of broiler chickens served fluted pumpkin (*Telfairia occidentalis*) leaves extract supplement. *American-Eurasian Journal of Agricultural and Environmental Science*, **2**(1):90-98

**Odura, I., Ellis, W.O., and Owusu, D. (2008).** Nutritional potential of two leafy vegetables: *Moringa oleifera* and Ipomoea batatas leaves. *Scientific Research and Essays*, 3(2), 57-60. *Food Science & Technology*,**45**(1):6-12

**Ojo, V., Ojo, A., Njoku, C., and Fanimo, A. (2016).** Effect of graded levels of *Senna obtusifolia* leaf meal on the performance, carcass characteristics and economics of production of broiler chickens. *Journal of Agriculture and Veterinary Science*, **9**(2):29- 35.

**Olugbemi, T.S., Mutayoba, S.K., and Lekule, F.P. (2010).** Moringa oleifera leaf meal as a hypoglycemic agent in diabetic rabbits. *Asian Journal of Agricultural Sciences*, **2**(2): 29- 33.

**Oluremi, O.I.A., Ojighen, V.O., and Ejembi, E.H. (2010).** The nutritive potentials of sweet orange (Citrus sinensis) rind in broiler production. *International Journal of Poultry Science*, **5**(7), 613-617.

**Onyimonyi, A.E., andUgwu, S.O. (2007).** Evaluation of the combined effects of thermal processing of pearl millet and enzyme supplementation on broiler performance. *International Journal of Poultry Science*, **6**(10), 777-782.

**Oursman, E.M., Damron, B.L., and Jacob, J.P. (2005).** Cassia, an alternative feed ingredient for laying hens. University of Florida Cooperative Extension Service, *Institute of Food and Agricultural Sciences*, EDIS.

**Roberts, K.M. (2000).** Poultry housing for winter. University of Vermont Extension.

SAS Institute. (2010). SAS/STAT 9.2 User's Guide. SAS Institute Inc., Cary, NC, USA.

**Siddhuraju, P., and Becker, K. (2003)**. Antioxidant properties of various solvent extracts of total phenolic constituents from three different agroclimatic origins of drumstick tree (*Moringa oleifera* Lam.) leaves. *Journal of Agricultural and Food Chemistry*, **51**(8):2144-2155.

**Shim, K.F., Ong, S.H., and Lam, T.J. (1989).** Influence of dietary protein on growth, feeding efficiency, and carcass composition in *Tilapia nilotica*. *Aquacultur*e, **78**(2):129-145.

**Taiwo, A.A., Adebowale, E.A., Greenfield, H., andShanmugavellu, N. (2005).** Nutrient composition and availability from Cassia tora and Amaranthus *cruentus leaf*meals.*Pakistan Journal of Nutrition*, **4**(1):31-36.

**Yakubu, B., Mbahi, T.F., Haniel, G and Wafar, R.J. (2017)**. Effects of feeding *Cassia obtusifolia*leaf meal on growth performance and carcass characteristics and blood profile of broiler chicken. *Greener Journal of Agricultural science*, 7(1):001-008