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The Nutritional Effect of Cassava Leaf Meal on Broiler Starter Chickens

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Abstract

The nutritional effect of cassava leaf meal on broiler starter chickens was investigated. The cassava leaf meal (CLM) was used to formulate five broiler starter diets at 0%, 2.5%, 5.0%, 7.5% and 10% inclusion levels partly replacing soya bean meal in the diet. The diets were represented as T_1 (0%), T_2 (2.5%). T_3 (5.0%), T_4 (7.5%) and T_5 (10%) respectively. Seventy five (75) three-day-old broiler starter chickens were divided into five treatment groups of fifteen (15) birds each in a completely randomized design (CRD). Each treatment group was further divided into three replicates of five birds per replicate and each of the groups was assigned to one of the treatment broiler starter diet and fed for 28 days. Data were collected on body weight changes, feed intake and feed conversion ratio. Economic parameters determined were cost/kg weight gain, cost of total feed consumed and gross margin. The results indicated that performance of chicks in T4 and T5 (7.5% and 10%) inclusion levels of cassava leaf meal decreased significantly ($P<0.05$) compared to the control (T1) for average final weight, average weight changes and average daily weight gain. Feed intake at 10% CLM (T5) was significantly decreased compared to T1 (the control) and T3 (5% CLM). The feed conversion ratio revealed that T1, T2, T3 and T5 representing 0%, 2.5%, 5% and 10% CLM inclusion levels were statistically similar ($P>0.05$). T_1 (0%), followed by T_2 (2.5%), then T_3 (5%) revealed higher revenue earnings and a better gross margin as a result of heavier average weight changes and better feed conversion ratio. The haematological indices showed that the haemoglobin, packed cell volume and red blood cell increased as the dietary levels of cassava leaf meal increased with T5 increasing significantly ($P<0.05$) compared to the control. The white blood cell increased significantly ($P<0.05$) at T5 compared to the rest of the treatments. Biochemical indices showed that total protein increased progressively as the dietary inclusion level increased. Cholesterol, serum alkaline phosphatase, and Serum alanine transaminase were significantly increased ($P<0.05$) at T5 compared to the control. It was therefore concluded that cassava leaf meal could serve as a protein source to replace soya bean meal in the diet of broiler finishers at a level not exceeding 2.5% to reduce cost of production and earn higher revenue.

Keywords: Nutritional effect, cassava leaf, broiler starter, cost and returns, haematology, serum indices

Introduction

It is very obvious that the population of Nigeria is increasing daily and this has doubled the demand for food and dietary protein needs. Poultry products are among the most common and available protein sources that enable us to meet the protein needs of the people in Nigeria. With the growth of the population, meeting the animal protein requirements of the masses requires doubling output from our poultry industry. The expansion of the poultry industry over the years has been militated against by high cost of energy and protein source ingredients such as maize, groundnut cake and soya bean required to feed the industry. Protein is a dietary essential required in the body of animals for growth, reproduction, metabolic and biochemical processes et cetera. High cost of protein ingredients needed for formulating feed for poultry has increased the operating cost of the industry and consequently leading to high cost of poultry products that most consumers are unable to buy in order to meet their protein delights. Therefore it becomes necessary to research into alternative poultry feed sources that are available, cheap and not competing with human or industrial demands that can partly or wholly replace soya bean meal in the diet of broilers as a protein source. Cassava leaf meal appears to hold some potential as a protein source on account of its being rich in protein but low in sulfur-containing amino acids (Gomez and Valdivieso, 1985, Phuc *et al*., 2000).

Abu *et al*. (2015) reported that cassava leaf meal contains 25.37% crude protein, 11.17% ether extract, 8.47% ash, 10.63% crude fibre and 73.00% total carbohydrate and concluded that soya bean meal and maize respectively, could be replaced by up to 20% inclusion of cassava leaf meal and 20% cassava peelings in the diets of both broiler starter and finisher rations without any deleterious effect on growth and carcass yield of broilers. Similarly, Iheukwumere *et al.* (2008) reported the chemical composition of cassava leaf meal to be 25.30% DM, 25.10% crude protein, 11.40% crude fiber, 12.70% ether extract, 46.10% nitrogen free extract and 9.10% ash, and capped it up that cassava leaf meal at 5% inclusion level could be used in broiler finisher ration without any deleterious effect. The cassava plant has been known to yield about 10 – 30 t/ha of leaves that have been wasted or used as manure (Bokanga, 1994).

Despite the huge nutritional quality of cassava leaf meal, it contains some phytochemicals and anti-nutrients. It has been reported that cassava leaf meal contains 26.03-38.33 mg/100mg alkaloids, 48.07-58.94 mg/100g flavonoids, 1.58-1.65 mg/100g saponins, 0.49-0.57 mg/100g cyanogenic glycosides and 0.45-0.71 mg/100g tannin. The anti-nutrients composition were oxalate 29.32-35.77 mg/100g, phytate 1.95-2.17 mg/100g, cyanide 31.48-35.77 mg/100g, and trypsin inhibitor in the range of 0.48-0.72 mg/100g (Ogbuji and David-Chukwu, 2016).

This research therefore, was to evaluate the nutritional effect of feeding graded levels of cassava leaf meal to broiler starter chicks.

Materials and Methods

This experiment was carried out at the Poultry unit of Teaching and Research farm, Imo State University Owerri, which is located within the South-Eastern agro-ecological zone of Nigeria. Owerri lies on latitude $5^0$29"N and longitude $7^0$20"E. It is almost 91m above sea level with annual rainfall, temperature and relative humidity ranging from 1500mm-2200mm, 20.0-27.50 ^{0}C and 75-90% respectively (Accuweather, 2022). The cassava leaf used for this experiment were harvested from the cassava section of Imo Victory Cooperative Farms, Ezioha, Eziama-

Obiato in Mbaitoli L.G.A of Imo state. The leaves were chopped for faster and effective drying on a mat floor. The chopped leaves were sun-dried for three (3) days until they became crispy while still retaining the greenish coloration. The leaves were turned regularly to prevent uneven drying and possible decay of the leaf. The dried leaves were then milled using a hammer mill to produce cassava leaf meal (CLM). A sample of the leaf meal was taken to the laboratory for proximate and phytochemical analysis according to AOAC (2010).

The cassava leaf meal (CLM) was then used to formulate five broiler chicken starter diets at 0%, 2.5%, 5.0%, 7.5% and 10% inclusion levels partly replacing soya bean meal in the diet. The experimental diets and their calculated nutrient contents are presented in Table 1.

Table 1: Ingredients and calculated nutrient composition of the experimental broiler starter diets

Ingredients	T1 0% CLM	T2 2.5% CLM	T3 5% CLM	T4 7.5% CLM	T5 10% CLM
Maize	48.00	48.00	48.00	48.00	48.00
Soya bean meal	16.00	13.50	11.00	8.50	6.00
Cassava leaf meal	0.00	2.50	5.00	7.50	10.00
Groundnut cake	15.00	15.00	15.00	15.00	15.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Blood meal	2.00	2.00	2.00	2.00	2.00
Palm kernel cake	8.00	8.00	8.00	8.00	8.00
Wheat offal	4.00	4.00	4.00	4.00	4.00
Bone meal	4.00	4.00	4.00	4.00	4.00
Salt	0.25	0.25	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated Nutrient Composition					
Crude protein	23.00	23.42	23.13	22.87	22.59
ME(Kcal/Kg)	2798.27	2736.76	2735.59	2734.43	2733.25
Calcium	1.60	1.60	1.59	1.58	1.58
Phosphorus	1.14	1.13	1.11	1.10	1.08
Lysine	1.07	1.04	1.04	1.02	1.00
Methionine	0.54	0.53	0.51	0.50	0.48
Ash	3.45	3.50	3.45	3.55	3.58
Crude fibre	4.24	4.92	5.60	6.28	6.89
Lipid	4.78	4.69	4.60	4.52	4.43

Seventy-five day old broiler chicks were purchased from a certified poultry vendor in Owerri. The chicks were brooded together for three days to stabilize them. Thereafter, the chicks were randomly divided into five treatment groups of fifteen (15) birds each in a Completely Randomized Design (CRD). Each treatment group was further divided into three replicates of five birds per replicate and kept in a deep litter compartment of 1m x 0.5m. Brooding continued in the various compartments while the experimental trial went on. Each of the groups was assigned to one of the treatment broiler starter diet. Water and feed were given *ad libitum*. The necessary routine vaccinations and medications were given as and when due. The trial lasted for 28 days. The birds were weighed at the beginning of the trial to obtain their initial body weights.

Thereafter, the weighing was done on weekly basis. Daily feed intake was determined, daily, by subtracting the weight of the leftover feed from the weight of the initial feed given. Data were collected on feed intake and body weight changes. Also feed conversion ratio was calculated by dividing the average daily feed intake by average daily weight gain.

Data collected were subjected to analysis of variance using the SPSS Software (2012). Where analysis of variance indicated significant treatment effects, means were separated using Duncan New Multiple Range Test (DNMRT) (SPSS, 2012). Economic parameters determined were average weight changes, average daily weight gain, average daily feed intake, cost/kg weight gain, and cost of total feed consumed. Cost of production (₦) = Cost/Kg weight gain multiplied by average weight changes. Price/Kg meat (₦) = Price of selling one Kg of meat. Revenue (₦) = Price/Kg meat multiplied by the average weight changes. Gross margin (gain/ profit) = Revenue minus cost of production.

Haematological and serum indices studies

At the last day of the feeding trial, three birds per treatment were randomly selected to determine their haematological and serum indices. 5ml blood samples were collected from the wing vein of each of the birds using a syringe and needle, and placed in the specimen bottles with EDTA (Ethylene Diamine Tetra Acetate) for haematological studies. Blood was analysed within three hours of collection for haemoglobin (HB), packed cell volume (PCV), red blood cells (RBC), mean cell volume (MCV), mean cell haemoglobin (MCH), mean cell haemoglobin concentration (MCHC), and white blood cells (WBC). Another 5ml of blood was collected and placed in the specimen bottles without EDTA for serum biochemical analysis. Parameters analysed were urea, total protein, creatinine, cholesterol, serum electrolytes and liver enzymes. The methods outlined by Ochie and Kolhatkar (2000) were used for the haematological and serum indices analyses.

Results

Proximate analyses of cassava leaf meal in this study revealed that it contained 33.25% crude protein, 33.79% crude fibre, 10.40% lipids, 7.03% ash, 8.23% nitrogen free extract and a metabolizable energy of 2373.14 Kcal/kg. The results of the performance characteristics of broiler starter birds fed cassava leaf meal are shown in Table 2. The results show that the average final weight, average daily weight changes, average daily weight gain, average daily feed intake and feed conversion ratio were affected by the dietary treatment (P<0.05).

Table 2: Performance characteristics of broiler starter chicks offered dietary cassava leaf meal as a protein source

Parameters	T1 0% CLM	T2 2.5% CLM	T3 5% CLM	T4 7.5% CLM	T5 10% CLM	SEM
Average initial weight (g)	174.07	173.61	173.85	173.11	173.85	5.57
Average final weight (g)	1018.93^{a}	931.13^{ab}	898.87^{ab}	779.67^{b}	800.93^{b}	41.43
Average weight changes (g)	844.86^{a}	757.52^{ab}	725.02^{ab}	606.56^{b}	627.08^{b}	39.80
Average daily weight gain (g)	30.17^{a}	27.05^{ab}	25.89^{ab}	21.66^{b}	22.40^{b}	1.40
Average daily feed intake (g)	63.33^{a}	58.73^{ab}	62.68^{a}	62.00^{ab}	56.42^{b}	1.55
Feed Conversion ratio (g)	2.10^{b}	2.17^{b}	2.42^{ab}	2.86^{a}	2.52^{ab}	0.17

a,b,c: means within the same row with different superscripts are significantly different (p<0.05)

T4 and T5 (7.5% and 10% inclusion levels of cassava leaf meal respectively) were significantly decreased (P<0.05) compared to the control (T1) for average final weight, average weight changes and average daily weight gain. Feed intake at 10% dietary level (T5) was significantly decreased compared to T1 (control) and T3 (5% inclusion level). The feed conversion ratio shows that T1, T2, T3 and T5, representing 0%, 2.5%, 5% and 10% inclusion levels respectively, were statistically similar (P>0.05).

Data on the cost and returns of broiler starter chicks offered dietary cassava leaf meal are shown in Tables 3. Feed cost was highest at T1 due to the high cost of soya bean meal, decreasing gradually as the cassava leaf meal was increased. Cost per Kg weight gain was lowest at T1 due to high feed conversion ratio or low value for feed conversion ratio. This means that it cost less to produce one Kg of meat. T4 (7.5% CLM) had a high mean cost/Kg weight gain due to poor feed conversion ratio or high value for feed conversion ratio. This means that it cost more to produce one Kg of meat which is uneconomical. Cost of feed consumed was lowest at 10% inclusion level T5 (10% CLM) and highest at 0% inclusion level (T1). The revenue or sales from the product and gross margin were highest at T1 (0% CLM inclusion level).

Table 3: Cost and returns on broiler starter chicks offered dietary cassava leaf meal as a protein source

Parameters	T1 0% CLM	T2 2.5% CLM	T3 5% CLM	T4 7.5% CLM	T5 10% CLM
Feed cost (₦)	450.00	438.75	427.5	416.25	405.00
Cost/kg weight gain (₦)	936	956.5	1034.6	1223.8	1024.7
Cost of feed consumed (₦)	790.79	724.58	750.13	738.22	642.58
Price/Kg meat (₦)	2500	2500	2500	2500	2500
Revenue (₦)	2112.18	1893.83	1812.60	1508.05	1567.73
Gross margin (₦)	1321.39	1169.25	1062.47	769.83	925.15

Note: Selling price per kg meat is ₦ 2500

The haematological characteristics of broiler finisher birds offered cassava leaf meal are presented in Table 4. There was a remarkably significant treatment effect (P<0.05) for all the

Table 4: Haematological indices of broiler starter chicks offered cassava leaf meal as a protein source

Parameters	T1 0% CLM	T2 2.5% CLM	T3 5% CLM	T4 7.5% CLM	T5 10% CLM	SEM
Packed cell volume (PCV)	36.63^{c}	36.53^{c}	37.00^{bc}	37.50^{b}	38.13^{a}	0.14
Haemoglobin (Hb)	12.21^{c}	12.18^{c}	12.33^{bc}	12.47^{b}	12.71^{a}	0.05
Red blood cells (RBC)	4.27^{b}	4.31^{b}	4.30^{b}	4.36^{b}	4.49^{a}	0.03
Mean cell volume (MCV)	81.80^{b}	81.87^{ab}	81.77^{b}	82.27^{ab}	82.37^{a}	0.14
Mean cell haemoglobin (MCH)	27.40^{b}	27.67^{b}	27.60^{b}	27.93^{b}	28.50^{a}	0.15
MCHC	32.43^{b}	32.39^{b}	32.44^{b}	32.46^{b}	32.90^{a}	0.10
White blood cell (WBC)	18.33^{b}	21.67^{b}	18.33^{b}	19.67^{b}	26.67^{a}	1.15
Neutrophil	51.33^{c}	55.00^{bc}	56.33^{bc}	61.33^{b}	70.33^{a}	2.17
Lymphocyte	24.00^{c}	27.00^{bc}	28.33^{bc}	31.00^{ab}	$34,33^{a}$	1.58
Monocyte	4.00	3.00	3.67	2.67	4.00	0.43
Eosinophil	2.00	2.00	2.00	1.00	2.67	0.44
Basophyl	0.00	0.00	0.00	0.00	0.00	0.00

a,b,c: means within the same row with different superscripts are significantly different (p<0.05) parameters studied except for Monocytes, Eosinophils and Basophils. Mean PVC, Hb, RBC, MCV, MCH, MCHC, WBC and Neutrphils in T1 (0% CLM), T2 (2.5% CLM) and T3 (5.0% CLM) were statistically similar (P>0.05), but significantly lower than those of T5 (10% CLM) (P<0.05).

Mean values for T4 and T5 were similar (P>0.05) only for MCV and Lymphocytes.

The biochemical indices of broiler starter birds offered cassava leaf meal are presented in Table 5. Total protein and globulin increased significantly (P<0.05) as the inclusion level of cassava leaf meal increased. T5 (10%) inclusion level was significantly increased (P< 0.05) compared to the rest treatment.

Table 5: Biochemical Indices of broiler starter chicks offered Cassava leaf meal

Parameters	T1 0% CLM	T2 2.5% CLM	T3 5% CLM	T4 7.5% CLM	T5 10% CLM	SEM
Total Protein	2.13^{d}	2.97^{c}	3.40^{bc}	3.77^{b}	4.67^{a}	0.14
Globulin	2.60^{c}	2.73^{bc}	2.93^{bc}	3.13^{b}	3.67^{a}	0.13
Albumin	1.57	1.53	1.87	1.70	1.80	0.14
Creatinine	0.23^{c}	0.26^{bc}	0.40^{a}	0.34^{ab}	0.36^{ab}	0.03
Urea	3.67^{bc}	2.33^{c}	4.43^{ab}	5.70^{a}	5.40^{ab}	0.47
Total Cholesterol	69.67^{c}	74.67^{bc}	84.00^{ab}	76.00^{bc}	90.00^{a}	3.34
AST	65.00^{b}	68.67^{ab}	75.33^{ab}	74.67^{ab}	83.33^{a}	4.39
ALT	2.53^{ab}	2.13^{b}	3.10^{ab}	3.97^{a}	3.97^{a}	0.37
ALP	811.33^{b}	642.67^{c}	826.67^{ab}	791.00^{b}	934.67^{a}	31.47

a,b,c: means within the same row with different superscripts are significantly different (p<0.05); ALP indicates serum alkaline phosphatase; AST indicates Serum aspartate transaminase; ALT indicates Serum alanine transaminase.

Blood creatinine at T3 (5%) inclusion level of cassava leaf meal was significantly increased compared to T1 (0%) and T2 (2.5%). Serum urea increased significantly (P< 0.05) as the inclusion level of cassava leaf meal increased. Serum urea for T3 (5%), T4 (7.5%) and T5 (10%) were statistically similar (P>0.05) but significantly higher than those of birds in T1 (0%) and T2 (2.5%). Serum total cholesterol increased (P<0.05) as the inclusion level of cassava leaf meal increased. Feeding 10% CLM significantly (P<0.05) increased total cholesterol compared to the control, T2 (2.5% CLM) and T4 (7.5% CLM). Serum liver enzymes, AST, ALT and ALP showed significant treatment effect. Serum AST in T1, T2, T3 and T4 were statistically similar (P>0.05), just as T2, T3 and T4 were similar (P>0.05) statistically. It revealed that AST was significantly higher in birds fed 10% CLM (T5) compared to birds on the control diet (T1 (0% CLM)). Serum ALT showed statistical similarity in T1 (0%), T3 (5%), T4 (7.5%) and T5 (10%). T2 (2.5%) was significantly lower (P<0.05) compared to T4 and T5. Serum ALP recorded in T5 was also statistically (P<0.05) higher than that observed in T2.

Discussion

Performance characteristics

The average weight changes, daily weight gain and feed conversion ratio were significantly different (P<0.05). The average final weight, average weight changes, and average daily weight gain were highest in birds which were fed the 2.5% CLM diet (T_2), and started declining significantly ($P<0.05$) compared to the control. The decline in weight gain could be attributed to a higher intake of tannin, phytate and oxalate resulting in nutrient imbalance and poor feed conversion ratio which is a pointer to poor efficiency of feed utilization. This implies that there was poor digestion and utilization of the nutrients especially proteins, possibly as a result of amino acid imbalance.

The values for feed conversion ratio obtained in this study were lower than the values 2.29-3.24 and 2.74-3.38 reported by Esiegwu (2021) for broiler starters offered nutritional supplement of fluted pumpkin leaf meal, and Fasuyi and Nonyerem (2007) for broiler starters offered *Telfairia occidentalis* leaf meal as protein supplement respectively, but similar to the values of 2.06-2.80 reported by Onu (2012) for starter broilers offered aqueous extract of *Telfairia occidentalis* leaf extract. The values were higher than the reference value 1.7 to 2 for broilers (Ghosh, 2015). The cassava leaf meal dietary treatment performed best at T_2 (2.5%) inclusion levels for feed conversion ratio and other parameters investigated. The depression in performance at 10% inclusion level of cassava leaf meal agrees with the general observation that at high leaf meal inclusion levels in poultry diets, growth is depressed (D'Mellow and Acomovic, 1989). This also agrees with Ravindra *et al*. (1986) who evaluated cassava leaf meal as a substitute for coconut and reported that broiler performance was depressed at higher levels of inclusion but gives satisfactory results at lower levels of inclusion.

Costs and returns of the broiler starter chicks fed varying levels of cassava leaf meal

The high cost of feed in T_1 was due to the high cost of soya bean meal, and this is what we want to minimize being one of the objectives of this research. Cost per kg weight gain was lowest at T1 compared to other treatment as a result of better feed conversion ratio which means that it cost less to produce one kg meat. T4 had the highest cost per kg weight gain due to poor feed conversion. Broilers on the control diet, T_1 (0%) had the highest value for cost of feed consumed due to high cost per kg of feed, whereas those on the 10% CLM diet, T_5 had the lowest value for cost of feed due reduced cost per kg of cassava leaf meal. T_1 (0%), followed by T_2 (2.5%), then T_3 (5%) revealed a higher revenue earnings and a better gross margin as a result of heavier average weight changes and better feed conversion ratios.

The cassava leaf meal did not show excellence in performance above soya bean meal and so produced lesser weight gain than the soya bean group, that is, the control, T_1 (0%). That is why despite the reduction in the costs of feed consumed as a result of using the cassava leaf meal in the treatment groups, the revenue and gross margin remained low compared to the control. The target of every producer is to produce heavier birds and make high profit. Cassava leaf meal did not compare favorably with soya bean meal in producing heavier broilers, and hence reduction in revenue and profit.

Haematological characteristics of the broiler starter chickens

The haemoglobin (Hb) increased significantly ($P<0.05$) with increase in the dietary levels of the cassava leaf meal. This is an indication that it can support high oxygen-carrying capacity by the blood in chickens by being able to increase the haemoglobin. This implies that there was likely to be adequacy of oxygen in the body tissues, effective functioning of the tissues and maintenance of healthy cells. Haemoglobin is primarily responsible for transport of oxygen to the body's tissues. The values were within the range 12.77-13.00 reported by Esiegwu and Obih

(2022) for broilers offered nutritional supplement of comfrey leaf extract and higher than the values 9.60-9.89 reported by Oguntoye *et al*. (2018) for broiler chickens fed varying levels of DL-methionine and inorganic sulphur. However, the values were within normal reference range 7.0-13 reported by Banerjee (2013). Reduction in the concentration of haemoglobin suggested the presence of toxic factors such as haemaglutinin, which can have an adverse effect on blood formation (Oyawoye and Ogunkunle, 1998; Oguntoye *et al*., 2018).

The packed cell volume (PCV) increased significantly (P<0.05) with increased dietary levels of cassava leaf meal. PCV is the volume percent of red blood cells in circulating blood (Purves *et al*., 2003). The increase in PCV was an indication that the dietary treatment of cassava leaf meal have the capacity to increase the red blood cells, thereby increasing oxygen supply to the tissues and thus strengthening the immune system and maintaining a healthy and intact body system. Healthy tissues result from healthy body cell growth which culminates in healthy body systems and invariably a healthy chicken or animal. A decrease in PCV below the normal range is a pointer to liver and kidney diseases, malnutrition of vitamin B12, and folic acid deficiencies (Demoranville and Best, 2013). Kepeme *et al*. (2011) reported that when the PCV values are below the normal range, the chickens become anaemic. The PCV values obtained in this study were higher than the values 30.9-33.41% for broiler finishers offered supplementary *Telfairia occidentalis* (pumpkin) leaf extract (Alabi *et al*., 2017) but close to 37.67- 41.33 for broiler finisher chickens offered comfrey leaf extract by Esiegwu and Obih (2022). The values from this work fall within the normal reference range 25-45% (Banerjee, 2013), 22-35% (Jain, 1989) and 30-33% or 35-45% for male chickens (Swenson, 1977).

The red blood cells (RBC) increased significantly with dietary inclusion of cassava leaf meal. Red blood cells function to transport oxygen from the lungs to the tissues and take CO_2 back to the lungs to be exhaled. The increase in value of red blood cell implies that the cassava leaf meal was able to keep the health and immune system of the animals intact. Red blood cells in the circulating blood transport adequate oxygen and nutrient to the cells and remove gaseous waste products out of the body, thus purifying the tissues and nourishing them healthily. The values for the RBC were within the normal reference range of 7-12 as reported by Banerjee (2013), Jain (1989), and Swenson (1977). Low values for Hb and RBC are good indicators of emerging anaemia (Mohammed and Oloyede, 2009). Esiegwu and Obih (2022) reported that normal values for RBC, PCV and Hb mean adequacy of amino acid and iron metabolism and utilization for haeme and normal haemoglobin synthesis.

The mean cell volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concenteration (MCHC) increased significantly (P<0.05) with increase in dietary inclusion of cassava leaf meal. This implies that the dietary intake of cassava leaf meal provided adequate amino acids and iron for haemoglobin synthesis. It was reported that a low level of mean cell haemoglobin is an indication of anaemia (Aster, 2004). Similarly, PCV, Hb, and MCH have been reported as the major indices for evaluating circulatory erythrocytes and are significant in the diagnosis of anaemia and for the bone marrow's capacity to produce red blood cells in mammals (Chineke *et al*., 2006). The MCHC values were within the normal reference values of 26.0-35.0% reported by Banerjee (2013). The MCH values also fell within the standard reference values (25-27pg) reported by Swenson (2004). The mean cell volume (MCV) were within the range 81.60-89.10fl reported by Wikivet (2013). This implies that the production of red blood cells by the bone marrow was adequate and the chickens were in good health.

The white blood cells, the neutrophil and the lymphocyte increased (P<0.05) as the dietary inclusion of the cassava leaf meal increased. A rise in the number of white blood cells is a strong indicator of toxicity of diet or poor detoxification process, which leads to increase in production of white blood cell to fight foreign substances in the body (Oguntoye *et al*., 2018). Similarly, Esiegwu and Obih (2022) reported that the white blood cells and the differentials are good indicators of toxin, and rises in the presence of infection. Eosinophils increase in allergy and in parasitic infections, and neutrophils are walls of defense against bacteria in the tissues. Their numbers increase when acute infection is present (Barnerjee, 2013). Valencia (2012) reported that a high WBC could be caused by infection, immune system disorder or stress.

Similarly, it has been reported that white blood cell differentials rise in number in the event of infections to engulf bacteria (monocyte and neutrophil), to detoxify the body system (eosinophil), to prevent clotting and stasis of blood and lymph (basophil) and to form antibodies against antigens (lymphocytes) (Banerjee, 2013). White blood cells were within the normal reference range of $9\text{-}31\text{x}10^3/\text{mm}^3$ (Banerjee, 2013). The cassava leaf meal did not impact negatively or cause any deleterious effect on the blood of the animals since the WBC values were within the normal range. The monocyte, eosinophil and basophil did not show any detrimental effect (P>0.05) on the blood of the chickens.

Serum biochemical indices of the broiler starter chickens

Total protein and globulin increased significantly (P<0.05) as the dietary cassava leaf meal were increased. The increase in total protein as the dietary cassava leaf meal increased was a pointer to effective amino acid metabolism and utilization. Decreased serum protein concentration has been reported as an indication of alteration to normal metabolism due to interference in protein utilization (Bolu and Balogun, 2009). There was adequate supply and improved utilization of dietary proteins from feeding cassava leaf meal.

Urea is one of the blood indices used to measure protein quality. Esiegwu (2017) reported that the higher the urea quantity, the lower the protein quality. That means, urea quantity is inversely proportional to protein quality. The serum urea of the treatment groups was statistically similar (P>0.05) to the control. The non-significant differences relative to the control was a pointer to good protein quality as a result of proper amino acid metabolism and utilization (Esiegwu, 2021). The values for urea was lower than the value 5.60-6.30 and 9.38-10.50 reported by Esiegwu (2021) and Oguntoye *et al*. (2018). Serum creatinine is also used to evaluate protein quality in the blood. Ogunbode *et al*. (2016) reported that increase in blood creatinine could be as a result of excess breakdown of blood proteins. Yuengang *et al*. (2008) in the same vein added that excess blood creatinine is from muscle when wasting occurs and creatinine phosphate is catabolized. That means the animal is surviving at the expense of body reserve, which can lead to weight loss. The values from this trial were lower than 0.92-1.0 mg/dl and 54.00-62.00 mg/100ml reported by Oguntoye *et al*. (2018) and Esiegwu (2021) respectively. The values were also lower than the 0.90-2.0 mg/dl for normal broiler chicken reported by Okorie *et al.* (2011).

Serum cholesterol increased significantly with the dietary inclusion of cassava leaf meal. The values were, nevertheless, still below the range 157.93-173.94 mg/dl reported by Oguntoye *et al*. (2018). The rise in cholesterol level implies that fat is not being adequately mobilized, metabolized and utilized. The liver enzyme, serum alkaline phosphotase (ALP) and Serum aspartate transaminase (AST) increased significantly with the inclusion of cassava leaf meal at 10% dietary level compared to the control. Serum alanine transaminase (ALT) increased significantly (P<0.05) but was comparable to the control. The liver enzymes activities are used for checking toxicity and monitoring protein quality (Ukpabi *et al*., 2015). The increase in ALP and AST at 10% dietary levels may suggest that from this point the protein quality may be challenged.

Conclusion

The result of the trial showed that cassava leaf meal contains nutrients which can be of value in animal nutrition especially proteins, fat and carbohydrates.

It also revealed that cassava leaf meal could serve as a protein source for broiler starter chickens, replacing soya bean in the ration at a level not exceeding 2.5%. It is economical and cost effective to use cassava leaf meal at this level.

The study also revealed that cassava leaf meal did not compare favorably with soya bean meal in producing heavier birds.

The trial also revealed that cassava leaf meal causes depression in performance of broilers at inclusion levels of 7.5% and above.

The study showed that cassava leaf meal had no deleterious effect on the haematological and serum biochemical indices of broiler finisher chickens at the current inclusion levels of this study.

It was therefore concluded that cassava leaf meal could serve as a protein source to replace soya bean meal in the diet of broiler starter at a level not exceeding 2.5% in order to earn higher revenue.

Recommendation

It was therefore, recommended that cassava leaf meal could serve as a protein source in broiler starter ration at not more than 2.5% inclusion level.

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