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Blood Profile and Cost Benefits of Broiler Chickens Fed Fish Meal Alternatives

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Abstract

The experiment was carried out to investigate the effect of fish meal alternatives (maggot, termite, grasshopper and lizard meals) on the haematology, serum biochemical profile and cost benefit analysis of producing broiler chickens. One hundred and fifty (150) broiler chicks (Marshall Breed) were used for the experiment. The chicks were assigned into five dietary treatments in triplicates (30 chicks per treatment and 10 chicks per replicate): control (T_1) had conventional fish meal (65%), (T_2) maggot meal, (T_3) termite meal, (T_4) grasshopper meal and (T_5) lizard meal as fish meal alternatives with 5% inclusion level at starter phase and 2.5% at finisher phase. The experiment lasted eight weeks and data were obtained on blood indices and cost benefit. At the end of the research, six birds per treatment (two per replicate) were randomly selected, bled and blood samples were collected for analysis. The results obtained for haematological parameters showed no significant ($P>0.05$) differences in all except in neutrophils, mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC). The highest value (5.33) of neutrophils level was obtained in T_1 while birds on lizard meal (T_5) had the least value (2.00). Birds in T_2 recorded the lowest values of 29.35pg and 62.34fl for both MCH and MCV respectively, while birds in T_3 recorded highest values in both parameters. Birds in T_5 recorded the least MCHC value (33.00%), while those in T_4 recorded the highest (34.66%). In serum biochemical profile, total protein, globulin, cholesterol and aspartate transaminase (AST) showed no significant ($P>0.05$) differences among the treatment means, while albumin and alanine transaminase (ALT) of birds where there were significantly ($P<0.05$) differences among the dietary treatments. In cost benefit analysis, birds in T_2 (maggot meal) had highest (₦564.31) gross profit followed by T_3 (₦540.02). In conclusion, maggot meal posed no adverse effects on the evaluated blood profile of the birds and as such recommended for use in place of fish meal.

Keywords: Haematological parameters, serum biochemical, production cost, broiler chickens

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Introduction

High cost of poultry feed is primarily due to the stiff competition between man and poultry industry for conventional feedstuffs especially energy and protein sources. Onunkwo and Okocha (2018) reported that the nutrients in fish meal aid in disease resistance by boosting and helping to maintain a healthy functional immune system. Unfortunately, this ingredient is not easy to come by in terms of cost. Therefore, there is a need to look inward to substitute this high cost feed ingredient with a locally available and low cost alternative. In searching for the alternatives however, care must be taken to use the type that will not have negative

impact on the system of the animal especially the blood.

Blood is very important in the development of animals, and plays a vital role in physiological, nutritional and pathological status of organisms (Muhammad *et al.*, 2000). In vertebrates, according to Wikivet (2013), blood is composed of blood cells suspended in blood plasma. Plasma constitutes 55% of blood fluid and contains proteins, glucose, mineral ions, hormones, carbon dioxide and blood cells. Haematological and serum biochemical values could serve as baseline information for comparison in condition for nutrient deficiency. Emiola *et al*. (2013) reported that their indices are essential indicators of health status of animals and indispensable in the diagnosis and treatment of diseases. They are also tools for assessing the quality of feed and to ascertain the health status of animals that are placed on experimental diets (Merck, 2010).

Haematological parameters are those that are related to the blood and blood-forming organs (Stenesh, 1975). Packed cell volume and red blood cell are good indicators of the blood volume and oxygen carrying capacity. It is from the above that this study assessed the effect of maggot, termite, grasshopper and lizard meals as alternative sources to fish meal, on haematology and serum chemistry, and cost benefits of producing broiler chickens from the fish meal alternatives.

Materials and Methods

Experimental site

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm, Ibrahim Badamasi Babangida University, Lapai, Niger State. The area is located in the Vegetative Zone of Guinea Savannah, Middle Belt of Nigeria. It lies on longitude 9.02^{o}N and latitude 6.3^{o}E of the equator with an average temperature range of 21^{o}C – 36.5^{o}C and a rainfall range of 1100-1600mm (Usman, 2013).

Procurement and preparation of test ingredients

Maggots used in the experiment were bred from layers droppings sprinkled with blood. They were obtained by culturing housefly larvae on the droppings. The droppings were spread on a wet platform in order to attract houseflies (*Musca domestica*) which introduced the larvae on the dropping. After seven days, they were ready for harvest, as they migrate to the surface of the substrate. The harvested maggots were oven-dried at 75^{o}C for three hours in order to reduce its moisture content for proper storage. The dried maggot was milled and a sample of the meal was taken to the laboratory for determination of the proximate composition according to A.O.A.C (2005). The winged adult termites (*Macrotermes bellicossus*) were caught using net and broom while on their nuptial flight and, handpicked from the ground for those that have shed their wings. Male and female *Agama agama* lizards (mature) were caught by hunting with catapults, stones and traps. Care was taken to avoid much damage to the carcass during hunting and trapping. The lizards were slaughtered and their viscerals removed. Lizard carcass was sundried for 12 days to appreciable moisture content in the month of December. Dried grasshoppers were purchased from Lapai Local market. The carcass of *Agama agama* lizard, dried termite and grasshopper were later ground into meal using hammer mill into separate bags, and later taken to laboratory for determination of the proximate composition according to the procedures of A.O.A.C (2005).

Experimental diets

The experimental starter diets (Table 1) composed of 5% fish meal as source of animal protein in Treatment 1 (control), 5% of maggot meal (MGM), termite meal (TMM), grasshopper meal (GHM), and lizard meal (LDM) in treatments 2, 3, 4 and 5 respectively. They are designated as T_1, T_2, T_3, T_4 and T_5. At the finisher phase, 2.5% of each test ingredient replaced fish meal in T_2, T_3, T_4 and T_5 respectively (Table 1).

Table 1: Gross composition of experimental broiler starter and finisher diets

Ingredient (%)	Treatment									
	Starter					Finisher				
	T_1	T_2	T_3	T_4	T_5	T_1	T_2	T_3	T_4	T_5
Maize	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Wheat offal	10.00	10.00	10.00	10.00	10.00	15.00	15.00	15.00	15.00	15.00
Groundnut cake	10.88	10.88	10.88	10.88	10.88	09.45	09.45	09.45	09.45	09.45
Soyabean meal	19.42	19.42	19.42	19.42	19.42	18.30	18.30	18.30	18.30	18.30
Fish meal	5.00	-	-	-	-	2.50	-	-	-	-
Maggot meal	-	5.00	-	-	-	-	2.50	-	-	-
Termite meal	-	-	5.00	-	-	-	-	2.50	-	-
Grasshopper meal	-	-	-	5.00	-	-	-	-	2.50	-
Lizard meal	-	-	-	-	5.00	-	-	-	-	2.50
Bone meal	3.00	3.00	3.00	3.00	3.00	3.50	3.50	3.50	3.50	3.50
Limestone	0.80	0.80	0.80	0.80	0.80	-	-	-	-	-
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Total	100	100	100	100	100	100	100	100	100	100
Calculated nutrients:										
Crude protein(%)	22.79	21.83	21.58	22.30	22.32	20.83	20.35	20.12	20.59	20.60
Crude fibre (%)	4.03	4.06	4.20	4.21	4.24	4.38	4.39	4.46	4.47	4.48
Ether extract (%)	4.86	5.00	5.83	4.88	4.71	4.77	4.84	5.26	4.78	4.70
Ash (%)	3.90	3.95	3.28	3.38	3.67	3.65	3.68	3.34	3.39	3.53
ME (kcal/kg)	2846.69	2857.54	2915.93	2833.86	2855.16	2801.63	2807.05	2836.25	2794.46	2805.87

Davo premix Vitamin A (10,000,000 iu), Vitamin D3 (2,000,000), Vitamin E (20,000mg),Vitamin K3 (2,000mg), Vitamin B1 (3,000mg), Vitamin B2 (5,000mg), Niacin (45,000mg), Calcium pantothenate (10,000mg), Vitamin B6 (4,000mg), Vitamin B12 (20mg), Choline chloride (300,000mg), Folic acid (1,000mg), Biotin (50mg), Manganese (300,000mg), Iron (120,000mg), Zinc (80,000mg), Copper (8,500mg), Iodine (1,500mg), Cobalt (300mg), Selenium (120mg), Antioxidant (120,000mg).

Key: T_1 = Fish meal; T_2 = Maggot meal; T_3 = Termite meal; T_4 = Grasshopper meal; T_5 = Lizard meal

Experimental birds and management

Pens were cleaned and disinfected with Izal before the arrival of the chicks. A total of one hundred and fifty (150) day-old broiler chicks of Marshal breed were used for the study. They were assigned into five treatments of 30 chicks each in a completely randomized design (CRD).

Each treatment was replicated thrice with 10 birds each. The chicks on arrival were placed on the experimental diets. They were brooded on deep litter using charcoal as source of heat. Anti-stress was administered to the chicks on arrival and routine management practices were adopted as recommended by Oluyemi and Roberts (2000). Experimental broiler starter feed were fed in the first four (4) weeks while the experimental broiler finisher were fed in the last four (4) weeks. Feeds and water were supplied *ad-libtum*. The birds were vaccinated against gumboro disease at the end of weeks 1 and 3, using Infectious Bursal Disease Vaccine (IBDV) and Newcastle Disease Vaccine (Lasota) at the end of 2nd and 4th weeks. Amprollium® was administered to the birds against coccidiosis at week 5.

Haematological analysis

At the end of the study period, blood samples were collected from six (6) birds per treatment through the jugular vein into bottles containing Ethylene Diamine Tetra-acetic Acid (EDTA) to determine haematological parameters like packed cell volume (PCV), haemoglobin, (Hb), red blood cell (RBC), white blood cell (WBC), neutrophils, lymphocytes, monocytes, eosinophils, mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV) and mean corpuscular

haemoglobin concentration (MCHC). Red blood cell and white blood counts were determined by haemocytometer method using Natt-Herrick solution. Packed cell volume was measured by micro-haematocrit method while haemoglobin values were measured by Sahli's method (Konuk, 1981). Neutrophils, lymphocytes, monocytes and eosinophils were determined using cyanomethaemoglobin method while MCH, MCV and MCHC were calculated according to the procedures of Jain (1986)

$$\text{Mean Corpuscular Haemoglobin (MCH)} = \frac{\text{Hb x 10}}{\text{RBC}}$$

$$\text{Mean Corpuscular Volume (MCV)} = \frac{\text{PCV x 10}}{\text{RBC}}$$

$$\text{Mean Corpuscular Haemoglobin Concentration (MCHC)} = \frac{\text{Hb x 100}}{\text{PCV}}$$

Serum analysis

Blood sample meant for serum biochemical studies were collected into bottles containing no anti-coagulant to enhance serum separation. The blood sample was allowed to clot and used to determine total protein (TP), albumin, globulin, cholesterol, alanine transaminase (ALT), and aspartate transaminase (AST). The serum was separated immediately after clotting by centrifugation at 2000 revolutions per minute for 10 minutes. The biuret method, according to Peters *et al*. (1982) was used in the determination of the total protein fraction and the serum albumin. Globulin was determined according to the method of Kohn and Allen (1995), while the serum enzymes were obtained calorimetrically using the Randox Laboratory Ltd. Co. Antrim, UK test kits.

Cost benefits

The feedstuffs acquired and processing activities involved were monetized and price per kg (₦) of each feedstuff was determined for economic analysis. Veterinary care and miscellaneous (variable cost) were calculated as the total amount of money spent on vaccines drugs, day-old chicks and other expenses divided by the number of birds per treatment. Average body weight (kg) was the final body weight of the birds before slaughtering. Price per feed was calculated by taking into consideration the individual feedstuff used in compounding the diet. Total investment was the total money spent during the cause of production. Gross return was the live weight gain multiplied by the price of chicken per kg. Gross profit was the profit realized from the sales of birds. It is given as: Gross return – Total investment.

Statistical Analysis

The experiment was a completely randomized design (CRD) and data collected were subjected to one-way analysis of variance (ANOVA) using SPSS (2006) 15.0 for Windows Evaluation Version, using LSD to compare means that were significantly different.

Results

The results of haematological analysis were presented in Table 2. There were no significant (P>0.05) differences in the parameters except neutrophils, mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV), and mean corpuscular haemoglobin concentration (MCHC). Haemoglobin values ranged from 11.77g/dl in birds fed T_2 to 13.60g/dl in birds fed T_1. Birds fed T_1 and T_3 had the highest PCV value of 30.67% while the lowest (25.00%) was from birds fed T_2. Values obtained for red blood cell and total white blood count range from 3.61 – 4.44 x 10^{12}/l and 3.07 – 4.12 x 10^{9}/l respectively. A similar trend was observed in both parameters where birds in T_1 had the highest and those in T_5 had the lowest. Birds fed T_2 gave the lowest (9.33%) lymphocytes while T_3 had the highest (11.00%). Birds fed T_5 had the lowest (2.00%) neutrophils with the highest (5.33%) from those fed T_1. Monocytes values ranged from 1.67% in birds fed T_2 to 5.67% in birds fed T_1. Eosinophills values ranged from 0.67 - 2.00%, with the highest value obtained from birds in T_3, T_4 and T_5, and the least recorded in birds fed T_2. Birds in T_3 had the highest: 28.21pg

and 84.71fl for MCH and MCV respectively, while birds in T_2 recorded the least in the parameters. Mean corpuscular haemoglobin concentration values ranged from 33.00% in birds on T_5 to 34.66% from birds in T_4.

Table 2: Haematology parameters of birds fed different sources of animal protein

Parameter	T_1	T_2	T_3	T_4	T_5	SEM (±)	LSD
Heamoglobin (g/dl)	13.60	11.77	13.53	12.27	12.27	0.39	1.28
PCV (%)	30.67	25.00	30.67	26.00	27.00	1.20	3.82
RBC (x 10^{12}/l)	4.44	4.01	4.06	3.87	3.61	0.15	0.49
TWBC (x 10^9/l)	4.12	3.67	3.38	3.37	3.07	1.86	0.47
Neutrophils (x10^9/l)	5.33^a	2.67^{ab}	2.33^b	2.33^b	2.00^b	0.46	1.23
Lymphocytes (%)	9.67	9.33	11.00	10.67	10.67	0.67	2.40
Monocytes (%)	5.67	1.67	2.00	2.00	2.00	0.67	2.02
Eosinophils (%)	1.33	0.67	2.00	2.00	2.00	0.21	0.59
MCH (pg)	30.63^{ab}	29.35^b	33.33^a	31.71^{ab}	33.99^a	0.79	2.12
MCV (fl)	69.08^b	62.34^b	75.54^a	67.18^b	74.79^a	2.48	6.28
MCHC **(%)**	44.34^{ab}	47.08^a	44.11^{ab}	47.19^a	45.44^b	0.22	6.11

^{ab}*-Means in the same row with different superscripts differs significantly (P< 0.05);* SEM: standard error of mean

LSD = least standard deviation, RBC: red blood cell; TWBC: total white blood count; MCH: mean corpuscular haemoglobin; MCV: mean corpuscular volume; MCHC: mean corpuscular haemoglobin concentration

Table 3 showed that there were no significant (P>0.05) differences among all the serum parameters except in albumin and alanine transaminase (ALT). Birds in T_2 had the highest (4.70g/dl) total protein while those in T_3 and T_5 had the lowest (4.42g/dl). Albumin values ranged from 1.70g/dl in T_2 to 1.80g/dl in T_3 and T_4. Birds in T_3 had highest globulin (1.76g/dl) and cholesterol (1.77mmol/l), while those in T_5 had the least globulin (1.50g/dl) and those in T_4 gave the least cholesterol (1.46mmol/l). The highest (10.54IU/L) enzyme ALT value was recorded in T_1 while the least (6.68IU/L) was recorded in T_5. Aspartate transaminase values ranged from 11.33IU/L in birds fed T_2 to 12.33IU/L) in those fed T_3.

The cost benefit was calculated in Naira (₦) and the results were shown in Table 4. Total cost of feed consumed showed that birds in T_1 had the highest (₦1252.37), followed by those in T_2, while the lowest (₦949.12) came from those in T_5. Total investment ranged from ₦1557.49 in T_5 to ₦1961.10 in T_1. The gross profit (₦) was at the highest (564.31) in T2 while birds in T5 had the lowest (372.31).

Table 3: Serum parameters of birds fed with different source of protein

Parameter	T_1	T_2	T_3	T_4	T_5	SEM (±)	LSD
Total Protein (g/dl)	4.63	4.70	4.42	4.57	4.42	0.07	0.23
Albumin (g/dl)	1.73^{ab}	1.70^b	1.80^a	1.80^a	1.72^{ab}	0.02	0.05
Globulin (g/dl)	1.52	1.51	1.56	1.54	1.50	0.14	0.08
Cholesterol (mmol/l)	1.53	1.67	1.77	1.46	1.67	0.45	0.12
ALT (IU/L)	10.54^a	9.35^b	7.45^c	6.70^d	6.68^d	0.46	0.06
AST (IU/L)	11.67	11.33	12.33	11.67	11.66	0.15	0.47

^{abcd}*-Means in the same row with different superscripts differs significantly (P< 0.05);* SEM: standard error of mean; LSD = least standard deviation; ALT: alanine transaminase; AST: aspartate transaminase

Table 4: Cost analysis of broiler chickens fed test ingredients

Parameter	Treatment				
	T_1	T_2	T_3	T_4	T_5
Final live weight (g)	2400	2367	2167	2167	1930
Mortality (%)	6.67	13.33	20.00	23.33	33.33
Cost of day old chick (₦)/bird	160	160	160	160	160
Cost of feed (₦/kg)/bird	321.42	250.02	231.67	251.56	221.24
Total feed consumed (kg)/bird	4.700	4.661	4.350	4.440	4.290
Total cost of feed consumed (₦)/bird	1252.37	1165.34	1007.76	1116.93	949.12
Variable cost (₦)	227.33	227.33	227.33	227.33	227.33
Total investment (₦)	1961.10	1802.69	1626.76	1755.82	1557.69
Cost of bird/kg (₦)	1000.00	1000.00	1000.00	1000.00	1000.00
Gross return (₦)	2400.00	2367.00	2167.00	2167.00	1930.00
Gross profit (₦)	438.90	564.31	540.02	411.18	372.31

Discussion

Although haemoglobin, monocytes and eosinophils had no significant (P>0.05) influence on the chickens across dietary treatments, they showed normal values for healthy chickens. Haemoglobin values fell within the normal range of values (11.60 – 13.68 g/dl) reported by Wikivet (2013). This is an indication that the birds were healthy and that they had sufficient blood pigment for proper transportation of oxygen. Packed cell volume values in this study fell below the report of Wikivet (2013) but quite higher than the report (14 – 19 %) of Ukpabi *et al*. (2015), but very close to the range of values reported by Sobayo *et al*. (2013). However, the PCV values obtained in this study fell within Banerjee (2005) recommended range of 23 – 55 %.

Red blood cell values in this study were close to the range reported by Wikivet (2013), but higher than the range (1.68 – 2.38) reported by Lawrence-Azua *et al*. (2018). White blood cell values in this study were a little bit lower than the report of Wikivet (2013). WBC values below the normal range and non-significant (P>0.05) effect of the values revealed that there were no infections in the blood. Neutrophils values showed significant (P<0.05) differences among the treatments. They fell within the normal range of (2.0 – 7.0 $x10^9$/l), with birds in T_1 having the highest significant value of 5.33 $x10^9$/l and those in T_5 having the lowest (2.00 $x10^9$/l). MCH, MCV and MCHC values showed significant (P<0.05) differences across the treatment groups. MCV values fall below the normal range of 81.6 – 89.1 fl in all the treatment groups. MCH values were higher than the normal range (27.2 - 28.9 pg), and those of MCHC were also higher than the normal range of (32.41 – 33.37 %) as reported by Wikivet (2013).

Serum biochemical parameters showed significant (P<0.05) differences in albumin and alanine transaminase (ALT), while total protein, globulin, cholesterol and aspartate transaminase were not significantly (P>0.05) different. Serum protein values fell within the normal range (4.63-4.81 g/dl) in T_1 and T_3, while other treatments were below the range. Total protein values obtained in this study were lower than the report of Egbeyale *et al*. (2017). The decrease in total protein values for birds in T_3, T_4 and T_5 may be due to interference of normal protein metabolism as reported by Bolu and Balogun (2009). Albumin values fell below normal range of 3.28-3.48 g/dl while those of globulin were within the normal range of 1.15-1.53 g/dl. Serum concentration of albumin was significantly (P<0.05) affected by the fish meal alternatives with birds in T_3 and T_4 recording the highest value (1.80 g/dl).

Serum total protein, albumin and globulin are generally influenced by protein intake as reported by Onifade and Tewe (1993), therefore, the obtained values for the parameters in this study suggested nutritional adequacy of the dietary proteins. Serum enzyme activities have been used as indices of toxicity as well as for monitoring protein quality. ALT values ranged from 6.68 – 10.54 IU/L while AST values ranged from 11.33 – 12.33 IU/L. The significant ($P<0.05$) influence in ALT showed that the values decrease along the dietary treatments. The ALT and AST in this study are lower than the report of Nworgu *et al*. (2007) and Wikivet (2013), but AST values were very close to the report of Oko *et al*. (2017).

Economic utilization, according to Alawa and Umunna (1993), is one of the major reasons for the use of alternative feeds. This coincides with one of the objectives of this study. The cost of production and cost per weight gain were presented in Table 4. The least cost of feed consumed and cost of feed per kg weight gain among birds in T_5 could be as a result of the reduced cost of sourcing lizard compared to the expensive fish meal. The same trend was also observed along the dietary treatments except in T_4 (grasshopper) where the cost was greater than T_3 (termite meal). This observation could be as a result of low prices incurred in the source and preparation of the test ingredients. It coincides with the report of Nworgu *et al*. (2000) who stated that there is a need for dietary incorporation of unconventional feed ingredients so as to reduce the cost of production which in turn will increase the profit margin. The highest gross profit recorded among birds in T_2 (maggot meal) and T_3 (termite meal) compared to birds in T_1 (fish meal) revealed that the inclusion of the test ingredients reduced cost of production and thus, higher profit margin. The profit (₦) of birds in T_2 was higher than others, and since net income/profit per bird is generally considered to be the most accurate index of flock performance according to Ojewola *et al*. (2003), it is therefore more profitable to give broiler birds, maggot meal in place of fish meal.

Conclusion

Results obtained from this study revealed that feeding the test ingredients to broiler chickens was healthy and that no infection was traceable to them based on the results from haematological analysis. The results from serum biochemical showed that the values on serum total protein, albumin and globulin in this study revealed nutritional adequacy of the dietary proteins. The highest gross profit recorded among birds in T_2 (maggot meal) showed that it can replace fish meal in the diets of broilers.

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