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Original Research

Effect of Slaughter House Wastes as a Non-Conventional Protein Replacement for Fish Meal on Growth and Carcass Traits of Broiler Chickens

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Abstract

Fishmeal is one of the most expensive ingredients used in broiler feed production and this necessitate the search for cheaper alternatives. Upon this background, a study was carried out using 150 unsexed one-day old broiler chicks distributed randomly into 6 experimental groups designated as T1, T2, T3, T4, and T5 fed diets containing 0, 25, 50, 75, and 100 % of slaughter house processed animal waste as replacement for fish meal. The result indicated significant difference in growth, dressed weight, breast muscle, drumstick, thigh, and wing of the broiler chickens (p<0.05). There were also significant differences observed in the total protein, globulin, cholesterol, urea, ALT and AST (p<0.05). Based on the finding of this study, it was concluded that the inclusion of slaughter house as replacement for fish meal at 25 and 100 percent in broiler chickens was recommended as alternative to fish meal in broiler chicken diets.

Keywords: Broiler Chickens, Blood Biochemical, Carcass, Growth, Slaughter House Waste

Introduction

Protein shortage for human and animal consumption is one of the most critical food insecurity challenge facing the developing countries including Nigeria. This situation is leaving millions of people malnourished across the world as well as causing poor growth of children. Poultry production is one of the livestock productions approaches to solving the problem of protein shortage for human consumption because it is a major contributor of protein supply in forms of egg and meat for human consumption while the rearing of broilers for meat supply stands out as a critical source. This is because broiler chickens are the most prolific of all domestic animals in terms of turnover period and quantity of meat production (Dafwang, 2002). They are fast growing and has a high feed conversion rate which makes them marketable for meat as from 6 – 8 weeks of age as finishers (Kawu *et al*., 2019). The demand for broiler meat is on the rise throughout the world and especially in developing countries such as Nigeria where population is increasing day by day resulting in great demand for meat (Sanon *et al.*, 2013).

However, the demand for meat is becoming threatened by shortage in the supply and increasing cost of feed ingredients for poultry consumption (Aduku, 1992; Afolayan *et al.*, 2012). The processes of procurement of raw materials, production, and supply of feeds to farms for poultry consumption constitutes the highest and most expensive input poultry farming (Ademola and Farinu, 2006). This is alarming because the processes are accounting for more than 60 – 65% of the total cost of production in a typical broiler enterprise where protein represent about 13% of total feed cost (Banerjee, 1992). In Nigeria, the case is critical because feed alone accounts for 70 – 80% of the total cost of poultry production a situation which can be attributed partly to overdependence on conventional animal protein sources among which imported fish meal tops the chart (Ojewola *et al.*, 2005). Meanwhile, avoiding the use of fish meal as an ingredient due to high cost could negatively impact the production system because it is a protein source for the supply of essential amino acids which plant protein sources cannot supply.

In recent years there have been studies carried out targeting the use of local alternative animal protein source such as maggot, termites, grasshoppers, and silkworm as replacement of fish meal (Egbewande *et al.*, 2020; Ojewola *et al.*, 2005). These studies suggested that some of the identified alternatives can either partially or completely replace the fish meal leading to a reduction in cost of poultry without any negative impact on the chicken productivity. The exploration of these alternative becomes options for reducing the increasing cost of producing broilers which is a situation that has led to loss of production by some farmers and or feed producers in Nigeria (Esonu *et al*., 2003; Madubuike and Ekenyem, 2001). Some of these unconventional sources of nutrients can effectively substitute directly for cereal grains, and protein such as fish meal without any compromised production performances and induction of deleterious effects to animal's health. Hence, this present study aim was carried out for evaluation of the growth performance, carcass yield, and economics of production of broiler chickens fed diets containing varying levels of meat processing wastes as replacement for fish meal.

Materials and Methods

The Study Location and Experimental Site

The research was carried out in the Poultry Production Unit of the Teaching and Research Farms, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria. Geographically, the study location lies between latitude 9.31 and 9.45 degrees, of the equator. Agroecologically, the location falls within the Southern Guinea Savannah agroecological zone of Nigeria with mean rainfall ranges between 1100 and 1600mm while mean temperature were 21 °C and 36.5 °C (Allakonon *et al*., 2021).

The Experimental Diets

The ingredients used for the production of the experimental feed include maize, wheat offal, groundnut cake (GNC), soybean meal (SBM), fish meal, and salt were purchased from local markets within the metropolis of Minna (GPS). The slaughter house processed animal wastes were obtained from government accredited slaughter abattoir located in Suleja, Niger State of Nigeria (GPS). The processed waste comprises of blood, pieces of meat, and bone collected fresh, washed, and then cooked at 100 ºC for five minutes using pressure cooker (model) then oven dried at 105 ºC for six hours, and later milled prior incorporation into the feed. The experimental diets of the broiler starter and finisher were formulated with locally procured feed ingredients. The starter diet was fed from 1 to 28 days while the finisher diet was fed from 29 to 56 days of age. The diets were designated as T1, T2, T3, T4, and T5 containing

0, 25, 50, 75, and 100 % of slaughter house processed animal waste (Table 1). The experimental diets contained 2794.78 kcal/kg metabolizable energy and 22.50 % CP at the starter phase, while 2763.06 kcal/kg metabolizable energy and 20.11 % crude protein at the finisher phase.

Table 1: Nutrients and chemical composition of the diets fed to the broiler chicken at starter phase

Ingredient (%)	**T1**	**T2**	**T3**	**T4**	**T5**
Maize	50.2	50.2	50.2	50.2	50.2
Groundnut cake	11.13	11.13	11.13	11.13	11.13
Soyabean meal	19.57	19.57	19.57	19.57	19.57
Wheat offal	10	10	10	10	10
Fish meal	5	03,75	2.5	1.25	0
Slaughter house waste	0	1.25	2.5	3.75	5
Bone meal	3	3	3	3	3
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.3	0.3	0.3	0.3	0.3
Methionine	0.3	0.3	0.3	0.3	0.3
Total	100	100	100	100	100
Analyzed Nutrients Composition					
Crude protein (%)	23.43	23.35	23.26	23.17	23.08
Crude fibre (%)	4.53	4.54	4.55	4.57	4.58
Ash (%)	2.44	2.65	2.87	3.08	3.29
Fat (%)	4.99	4.98	4.97	4.95	4.94
Calcium (%)	1.25	1.29	1.34	1.39	1.44
Phosphorus (%)	0.84	0.86	0.87	0.89	0.91
Metabolizable energy (kcal/kg)	2884.85	2884.35	2883.85	2883.35	2882.85

Premix composition: Each 2.5Kg of the premix contained 8,500,000.00 IU, 1,500,000.00 IU, 10, 000.00 mg, 1,500.00 mg, 1,600.00 mg, 4,000.00 mg, 20,000.00 mg, 5,000.00 mg, 1,500.00 mg, 10.00 mg, 500.00 mg, 750.00 mg, 175,000.00 mg, 200.00 mg, 3,000.00 mg, 1,000.00 mg, 20, 000.00 mg, 40,000.00 mg, 200.00 mg, 30,000.00 mg, and 1,250.00 mg of vitamins A, D3, K3, B1, B2, Niacin, Panthothenic acid, vitamins B6, B12, Folic acid, Biotin, Chlorine chloride, Cobalt, Copper, Iodine, Iron, Manganese, Selenium, Zinc, and Antioxidant. T1- control, T2 – diet containing 25 % SHW as replacement for fish meal, T3 - diet containing 50 % SHW as replacement for fish meal, T4 - diet containing 75 % SHW as replacement for fish meal, T5 - diet containing 100 % SHW as replacement for fish meal.

Birds and their Management

The birds used for the study were 150 unsexed one-day old broiler chicks obtained from a reputable commercial hatchery. Prior to the arrival of the birds, the pen was cleaned, and disinfected with anti-parasitic formulation Izal® while wood shaving was spread on the floor to serve as litter material. The Litter was thereafter changed periodically throughout the period of experiment to prevent infections. On arrival, the chicks were served with clean water containing anti-stress (Vitalyte®). The chicks were randomly allocated into each group of the experimental diets and their initial weight were recorded. The chicks were brooded under an electric-powered brooder and ventilator for provision of optimum heat and ventilation. The lighting was supplied for 24 hours in the house throughout the experimental period. The birds were maintained on vitamin supplementation, and antibiotics administration; and on their 7th and 14th days old, they were administered with an attenuated vaccine (Lasota) for the control of Newcastle Disease. Similarly, on the 21st and 28th days, an attenuated vaccine (Gumboro) was administered to the birds for the control of Infectious Bursal Disease (IBD); both the Lasota and Gumboro were administered via drinking water. Apart from the vaccines, at the third week, a coccidiostat was administered via drinking water for the control of coccidiosis in the chicken.

Experimental Design

The experimental was completely randomized design with a population of 150 unsexed broiler chicks grouped into 5 experimental groups as T1, T2, T3, T4, and T5, respectively. In each group, there was 3 replicates assigned with 10 birds giving a total of 30 chicks per group and a total of 150 chicks observed for the study. The experimental model was a simple linear model presented as follows:

$$X_{ij} = \mu + e_{ij} \quad \text{..} \quad \text{(Equation i)}$$

Where;

X_{ij} = the j^{th} observation in the i^{th} treatment
μ = the overall mean
X_i = effect of i^{th} treatment
e_{ij} = Random error

Data Collection

There was data collection on biochemical composition of the experimental diets for each group using the procedures of Association of Official Analytical Chemist (AOAC, 2000). For the biochemical composition, the parameters determined were the dry matter, moisture, crude protein, ether extract, crude fibre, ash, nitrogen free extract and metabolizable energy. There were records of the bird parameters which were taken throughout the experimental period and these include feed intake, bodyweight changes, average daily bodyweight gain, average daily feed intake, feed conversion ratio, and mortality of the birds.

In addition to the performances of the birds, there was an evaluation of the carcass traits of the birds which was carried out at the end of the experimental study. For the carcass evaluation, six broiler chickens were randomly selected per group, the birds were starved off feed overnight then slaughtered the following morning through a sharp cut through the jugular vein. The slaughtered birds were manually de-feathered through immersion in hot water for two minutes to facilitate feathers removal after which the carcasses were cut into primal cuts and the internal organs were carefully removed for evaluation. The carcass trait including bodyweight before and after slaughtering, and meat yield were determined; while the percentage of the internal organs to the bodyweight per bird was also evaluated.

There was also a determination of the blood composition and serum biochemical profile of the chicken slaughtered for each of the experimental group using another set of randomly selected six birds per group. The selected birds were bleeded through the jugular vein and 2 mL of blood was collected into bottle laced with anticoagulant Ethylene Diamine Tetra-acetic Acid (EDTA) for the full blood count while for serum biochemistry, the blood was collected into plain bottles, allowed to coagulate then subjected to serum separation in the laboratory for downstream analyses. The blood count parameters determined include packed cells volume (PCV), percentages of the red blood cell (RBC), while blood cell (WBC), neutrophils, lymphocytes, monocytes and eosinophils. The serum biochemical profile was carried out to determine the total protein, albumin, globulin, cholesterol, alanine transaminase (ALT), and aspartate transaminase (AST); the creatinine and urea concentrations. These biochemical parameters were determined using calorimetrically kits of Randox Laboratory Ltd. Co. (Antrim, UK).

Statistical Analysis

All data obtained were subjected to one-way analysis of variance (ANOVA) using the statistical package SAS, significant differences were determined at $p<0.05$, homogenous means were separated using the Duncan Multiple Range Test tools of the same software.

Result and Discussion

The proximate chemical composition of the slaughter house waste (SHW) indicated that it contained 94.62 % dry matter, while moisture, crude protein, crude fibre, ash, and ether extract were 5.38 %, 64.89 %, 10.51 %, 9.21 %, and 6.66 %, respectively. The nitrogen free extract (NFE) and metabolizable energy were 3.38% and

258.37kcal/100g (Table 2). There were significant differences in the performances of the broiler chickens due to the intakes of the SHW as part of their diets ($p<0.05$). The final bodyweight of chicken in T5 was the highest followed by T1 and T2, while T3, and T4 were the lowest.

Table 2: Nutrients and chemical composition of the diets fed to the broiler chicken at finisher phase

Ingredient	**T1**	**T2**	**T3**	**T4**	**T5**
Maize (%)	52.2	52.2	52.2	52.2	52.2
Groundnut cake (%)	9.47	9.47	9.47	9.47	9.47
Soyabean meal (%)	18.03	18.03	18.03	18.03	18.03
Wheat offal (%)	13	13	13	13	13
Fish meal (%)	2.5	1.875	1.25	0.625	0
Slaughter house waste (%)	0	0.62	1.25	1.87	2.5
Bone meal (%)	3.5	3.5	3.5	3.5	3.5
Premix (%)	0.25	0.25	0.25	0.25	0.25
Salt (%)	0.25	0.25	0.25	0.25	0.25
Lysine (%)	0.4	0.4	0.4	0.4	0.4
Methionine (%)	0.4	0.4	0.4	0.4	0.4
Total	100	100	100	100	100
Analyzed Nutrients Composition					
Crude protein (%)	20.82	20.78	20.74	20.69	20.65
Crude fibre (%)	4.61	4.62	4.62	4.63	4.64
Ash (%)	2.28	2.39	2.49	2.6	2.71
Fat (%)	4.75	4.75	4.74	4.73	4.73
Calcium (%)	1.36	1.38	1.41	1.43	1.46
Phosphorus (%)	0.87	0.88	0.89	0.9	0.91
Metabolizable energy (kcal/kg)	2846.19	2845.94	2845.69	2845.44	2845.19

Premix composition: Each 2.5Kg of the premix contained 8,500,000.00 IU, 1,500,000.00 IU, 10, 000.00 mg, 1,500.00 mg, 1,600.00 mg, 4,000.00 mg, 20,000.00 mg, 5,000.00 mg, 1,500.00 mg, 10.00 mg, 500.00 mg, 750.00 mg, 175,000.00 mg, 200.00 mg, 3,000.00 mg, 1,000.00 mg, 20, 000.00 mg, 40,000.00 mg, 200.00 mg, 30,000.00 mg, and 1,250.00 mg of vitamins A, D3, K3, B1, B2, Niacin, Panthothenic acid, vitamins B6, B12, Folic acid, Biotin, Chlorine chloride, Cobalt, Copper, Iodine, Iron, Manganese, Selenium, Zinc, and Antioxidant. T1- control, T2 – diet containing 25 % SHW as replacement for fish meal, T3 - diet containing 50 % SHW as replacement for fish meal, T4 - diet containing 75 % SHW as replacement for fish meal, T5 - diet containing 100 % SHW as replacement for fish meal.

The feed intake of the chickens followed the same pattern whereby the broiler chicken fed with diet containing 100 % slaughter house waste as source of protein had the highest feed intake which was followed by the birds in the control group (T1), while the lowest feed intake was recorded for birds fed with diet containing 75 % SHW as major source of protein. The feed conversion ratio was at its best in broiler chickens fed 100 % SHW followed by the birds in T1, T2 and T4, while the last was recorded for the birds in T3 which were fed diet containing 50 % SHW (Table 3).

Table 3: Proximate chemical composition of the slaughter house waste used as replacement for conventional fish meal in the study as determined on dry matter basis

Proximate content	**Parameter value (%)**
Dry matter	94.62
Moisture	5.38
Crude protein	64.89
Crude fibre	10.51
Crude fat	6.66
Ash	9.21
Nitrogen free extract	3.38
Metabolizable energy (kcal/100g)	258.37

The use of the SHW as a non-conventional protein source also significantly affected some carcass traits of the broiler chickens ($p<0.05$); the differences was observed in dressed weight, breast muscle, drumstick, thigh, and wing. The broiler chickens in T5 had the highest dressed weight while birds fed diets containing 75% SHW recorded the lowest dressed weight. Meanwhile, the highest percentage weight breast muscle, drum stick, thigh, wing, and back was recorded for birds in T2 as presented in Table 4.

Table 4: Effect of slaughter house waste as a non-conventional protein replacement for fish meal on performance characteristics of the broiler chickens

Parameters	T1	T2	T3	T4	T5	SEM	p-value
Initial weight (g)	29.65	30.02	29.97	29.61	30.02	0.45	0.79
Final weight (kg)	2.06^{a}	2.03^{b}	1.63^{c}	1.63^{c}	2.60^{d}	7.07	0
Body weight gain (g)	2.03^{a}	2.00^{b}	1.60^{c}	1.60^{d}	2.57^{c}	0.32	0
Daily weight gain (g)	36.25^{a}	35.71^{b}	28.57^{c}	28.57^{d}	46.43^{c}	0.03	0
Feed intake (kg)	3.92^{a}	3.86^{b}	3.10^{c}	3.09^{d}	3.98^{c}	0.01	0
Daily feed intake (g)	70.00^{a}	68.93^{b}	55.36^{c}	55.18^{d}	71.07^{c}	0.01	0
Feed conversion ratio	1.93	1.93	1.94	1.93	1.53	0.01	0.88
Mortality (%)	0	0	0	0	0	0	0

abc Means with different superscripts on the same row differ significantly (p<0.05). T1- control, T2 – diet containing 25 % SHW as replacement for fish meal, T3 - diet containing 50 % SHW as replacement for fish meal, T4 - diet containing 75 % SHW as replacement for fish meal, T5 - diet containing 100 % SHW as replacement for fish meal.

There was no significant difference in the packed cell volume, haemoglobin, red blood cells, monocytes, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular in all the groups ($p>0.05$). However, there were significant differences in values of total protein, globulin, cholesterol, urea, ALT and AST ($p<0.05$) which indicated that the intake of the SHW significantly affected the serum biochemical profile (Table 5).

Table 5: Effect of slaughter house waste as a non-conventional protein replacement for fish meal on carcass trait and meat yield of the broiler chickens

Parameter (%)	T1	T2	T3	T4	T5	SEM	p value
Live weight (kg)	2.06^{a}	2.03^{b}	1.63^{c}	1.63^{c}	2.60^{d}	7.07	0
Dressed weight (kg)	1.46	1.35	1.36	1.07	1.66	164.98	0.26
Dressed weight (%)	70.87	66.5	83.44	65.64	63.85	0.56	0.79
Head	4.25	5.07	4.88	4.78	3.69	5.19	0.06
Neck	4.50^{ab}	6.64^{b}	5.88^{acb}	5.35^{a}	4.95^{cb}	8.34	0.03
Breast muscle	30.17^{a}	33.35^{a}	27.86^{ab}	27.43^{b}	22.82^{b}	36.56	0.01
Drumstick	14.39^{a}	17.73^{a}	15.05^{a}	12.37^{b}	13.99^{a}	17.92	0
Thigh	15.11^{ab}	17.60^{c}	15.69^{abc}	16.18^{b}	12.26^{ab}	16.49	0.02
Shank	5.79	5.49	6.13	6.17	4.99	7.15	0.17
Wing	13.06^{ab}	15.52^{b}	13.64^{a}	13.41^{c}	13.28^{ab}	12.96	0
Back	19.1	22.21	19.07	21.34	19.3	24.5	0.08

abc Means with different superscripts on the same row differ significantly (p<0.05). T1- control, T2 – diet containing 25 % SHW as replacement for fish meal, T3 - diet containing 50 % SHW as replacement for fish meal, T4 - diet containing 75 % SHW as replacement for fish meal, T5 - diet containing 100 % SHW as replacement for fish meal.

The chemical composition of slaughter house waste evaluated on dry matter basis in this present study revealed that it contained high crude protein content comparable with fish meal which is a conventional source of protein used in the production of broiler's feeds. It could therefore be implied that the slaughter house was is an alternative source of protein that can replace fish meal in broiler's feed. This is in agreement with the submissions of Saran *et al*. (2019) and Huque *et al*. (1992) which reported 69.80 and 68.80 % crude protein content for sun dried flesh obtained from slaughter houses. Similarly, Ahmed *et al*. (2018) also reported that slaughter house residue contained 69.77 % crude protein which is also comparable with the values obtained in this present study; all pointing to the fact that animal disposable waste meat, bones, and blood can be explore as source of dietary protein for broiler chicken production.

Table 6: Effect of slaughter house waste as a non-conventional protein replacement for fish meal on serum biochemistry of the broiler chickens

Parameters	T1	T2	T3	T4	T5	SEM	p-value
Total protein (g/dl)	6.57[a]	5.17[bc]	5.87[ab]	5.83[ab]	4.43[c]	0.55	0.03
Albumin (g/dl)	1.93	2.3	2.3	2.4	2.56	0.24	0.18
Globulin (g/dl)	2.90[a]	4.13[b]	2.97[a]	2.83[a]	4.03[b]	0.19	0
Cholesterol (mol/dl)	1.67[a]	2.67[b]	2.23[bc]	1.73[a]	1.90[ac]	0.21	0
Urea (mmol/L)	5.27[a]	5.53[a]	4.43[b]	5.40[a]	4.97[ab]	0.27	0.01
ALT(IU/L)	28.67[a]	32.33[a]	39.00[b]	47.33[c]	43.33[bc]	2.95	0
AST(IU/L)	31.67[a]	28.33[a]	22.33[b]	16.33[c]	14.70[c]	1.81	0
Creatinine (mg/dl)	1.23	1.1	0.93	1.23	1.3	0.12	0.08

abc Means with different superscripts on the same row differ significantly ($p<0.05$). T1- control, T2 – diet containing 25 % SHW as replacement for fish meal, T3 - diet containing 50 % SHW as replacement for fish meal, T4 - diet containing 75 % SHW as replacement for fish meal, T5 - diet containing 100 % SHW as replacement for fish meal.

The results on the performance of broiler chicken fed with diets containing percentage of slaughter house waste suggested that dietary manipulation through incorporation of slaughter house waste is an important source of animal protein that could be effective for the improvement of growth in broiler chickens. This is in agreement with submission of Seifdavati *et al.* (2008) which stated that substituting fish meal with more than 25 % SHW containing blood meal significantly increased chickens daily weight gain and decreases the cost of producing a unit meat because slaughter house wastes as non-desirable product of abattoir could be cheaper compared with the regular sources of protein such as the fishmeal and soybean which are usually expensive especially for developing countries such as Nigeria. The collection and processing of these waste products from abattoir could is a strategy for improved production of broiler chickens at cheaper cost without causing any adverse effect on the chicken's performance. This was observed earlier by authors including Toor and Fahimullah (1972) and Donkoh *et al.* (1999; 2002) which suggested that the use of slaughter house waste may not cause any harmful effect on growth and performances of broiler chickens.

Table 7: Effect of slaughter house waste as a non-conventional protein replacement for fish meal on haematological parameters of the broiler chickens

Parameters	T1	T2	T3	T4	T5	SEM	p value
Neutrophil	51.67[a]	60.00[b]	59.33[b]	66.67[b]	66.33[b]	3.31	0.01
PCV (%)	37	34.67	36	32.33	35.33	2.39	0.42
HB (gdl^{-1})	12.33	11.63	12	10.77	11.83	0.78	0.39
RBC ($\times10^6$µl)	3.80[a]	3.63[ab]	3.60[ab]	3.17[b]	3.70[ab]	0.24	0.17
TWBC(x10^3ml)	39.53[a]	45.40[bac]	41.53[ab]	48.33[b]	45.97[bc]	2.59	0.04
LYMPH	45.33[a]	37.67[ab]	37.33[ab]	30.33[b]	31.33[b]	3.79	0.02
MONO	1	1.33	1.67	1.67	1	0.82	0.85
MCV (fl)	97.3	95.3	100.1	102	95.63	3.61	0.34
MCH (pg)	32.4	31.76	33.33	33.9	32.8	1.24	0.51
MCHC (%)	33.3	33.33	33.3	32.27	33.47	0.1	0.39

abc Means with different superscripts on the same row differ significantly ($p<0.05$). T1- control, T2 – diet containing 25 % SHW as replacement for fish meal, T3 - diet containing 50 % SHW as replacement for fish meal, T4 - diet containing 75 % SHW as replacement for fish meal, T5 - diet containing 100 % SHW as replacement for fish meal.

The underlying improvement in the feed intakes and the feed conversion ratio of the chickens fed with the diets containing the SHW could be responsible for the superior and comparable performance of the chickens compared with the group fed with diets containing fish meal as the source of proteins. This finding is in compliance with reports linking improved daily feed intake, feed conversion ratio and daily nitrogen retention in broiler chicken with performance improvement when substituting different protein sources in broilers (Seifdavati *et al.*, 2008). This was confirmed in this study whereby broiler chickens fed with diet containing SHW as total replacement for fish meal had the highest feed intake, best feed conversion ratio, and final body weight gains; these findings are in agreement with earlier reports of Tikhonovskaya and Snitsar (1992), Okanović *et al*. (2019). Furthermore, the comparative performance of broilers fed with the SHW in replacement for fish meal could be because of efficiency of protein utilization owing that the amino acid profile of the SHW could be similar to that of the fish meal which is a conventional source of protein.

Apart from performance in growth, the use of SHW as a source of protein in place of fish meal also indicated that the SHW significantly improved the product yield of the broiler as revealed in the cut-up parts of the broiler chickens. The highest percentage breast muscle was recorded in the group fed with the SHW at both lower and higher levels of SHW inclusions in the diets. This is in agreement with the report of Ahmed *et al*. (2018), which stated that broilers fed a 15 % slaughter house residue as source of protein had a desirable carcass weight. Although, it is evident that the use of SHW at 100 % level of inclusion increased the carcass weight of broiler chickens but even at lower inclusion of 25 %, production improvement can be achieved which means it is safe to use the SHW as unconventional source of protein for broilers' consumption.

The results of the serum biochemistry of the broiler chickens fed with SHW indicated that the SHW is a safe ingredient without any harmful effects on vital organs such as the liver because the ALT is within the normal ranges (Wikivet, 2013). This corroborate with the results of the haematology of the broiler chickens which show no significant differences with the control; the implications of these could be link with the fact that the SHW may not pose any deleterious effect on the health status of the birds because the values of the haematology parameters are within the normal range recommended by Akinmutimi (2004); and Ibrahim (2012) for healthy broiler birds.

Conclusion

The incorporation of slaughter house waste into diets of broiler chickens as demonstrated in this present study indicated that the material is an important source of animal protein comparable with fish meal and it could be used for improving the growth performance of broiler chicken. Furthermore, the inclusion of the SHW at 100 % replacement for fish meal is a potential source of animal protein for broiler chicken production because the inclusion poses no any deleterious effect on growth performance and health of the chickens as revealed in the blood profile of the chickens. Also, based on the finding of this research, the inclusion of 25 and 100 percent SHW as a replacement of fish meal with slaughtered house waste in feed of broiler chicken is recommended.

Conflict of Interests

There is no conflict of interest.

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