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Growth Performance of Ross Broilers fed Dietary inclusion of Hydrolyzed Chicken Feather Meal

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ABSTRACT

This research was designed to evaluate the growth performance of Ross broilers given diet that included hydrolyzed feather meal. Two hundred and twenty-five day-old Ross 308 broiler strains of chicken was used for the study period of eight weeks, the chicks were randomly distributed to five experimental diets namely D1 (control), D2 (Inclusion of HCL precipitated hydrolysed feather meal), D3 (Inclusion of HNO_3 precipitated hydrolysed feather meal), D4 (Inclusion of H_2SO_4 precipitated hydrolysed feather meal) and D5 (Inclusion of H_3PO_4 precipitated hydrolysed feather meal). Each experimental diet consisted of 45 broilers replicated thrice with 15 birds per replicate in a complete randomized design. The data obtained was caused to undergo statistical analysis. The result of proximate composition of the test ingredients of different acid-treated feather meal showed that hydrolysed feathers precipitated with HNO_3 had highest level of protein content (83.63%) compared with other acid-treated feather meal, followed by feather meal treated with HCL (82.40%), while hydrolysed feathers precipitated with H_2SO_4 and HNO_3 had similar level of protein content. Notable differences (P<0.05) were observed across the diets for feed intake, daily weight gain, feed conversion ratio and final weight. Conclusively, the HCL hydrolysed feather meal diet performed similar to the control diet.

Keywords
Acid treatment; Broilers, Diet; Feather meal; Performance

Introduction

Chicken is a good source of protein that has contributed immensely in the consumption of animal protein (Oleforuh-Okoleh*et al.* 2015). However, there are challenges faced in the production of poultry meat and one of the pending issues concerning poultry production is feed, as a result of the competition involved for usage of the conventional feed ingredients by human, animal and industry which has resulted to high cost of conventional feed ingredients and in turn made feed cost to account for high range in the overall production cost (Lasekan*et al.*, 2013; Mottet&Tempio 2017). Consequently, so as to lessen the total expenses incurred during poultry production, reduction of feed cost must be looked into by exploring the use of unorthodox feed sources that have the potential to produce the same outcome as conventional feeds and at decreased cost. The frugality of using cheapened and unorthodox feed ingredients to reduce feed cost in poultry production is very important in maximization of profit (Akter*et al.*, 2003; Hussein *et al.*, 2014).
The major significance of unconventional feed resources is that they can be used for animal feeding with no competition from industry and human beings (Mahapatra, 2016). Future hopes

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of safeguarding animal's feeding and improving their food security will depend on the increased utilization of these unconventional feed ingredients depending on the quality and quantity of the ingredient. Utilization of these unconventional feed ingredients which may be regarded as waste can therefore reduce cost of poultry production (William *et al*., 1991).

Commercial chicken processing plants process huge amounts of chickens on daily or weekly basis, the processing of chickens generates large quantities of feather as waste products (Gopinath*et al*.,2015) and disposing these wastes from the poultry processing house is a major challenge, various disposal methods include burning or burying of which are environmentally unfriendly. The burning of feathers is known to cause air pollution while in landfills the rate of decomposition is slow and burying would require a lot of land. Cost of wastes disposal compels that these feathers should be recycled or reused (El-Boushy& Vander Poel 1990; Zhang *et al*.,2013). Raw feathers contain 90% protein content called keratin and feather constitute 7% weight of the live bird. Raw feathers are relatively insoluble and have a very low digestibility of 5% hence; a great deal of research interest has been aroused over the possibility of processing feather to enhance its digestibility (Caires*et al*., 2010; Mazotto*et al.,* 2017).

Currently, feather is underutilized as unconventional feed ingredient for low digestibility, processing of feather waste as a feed ingredient will contribute positively in resolving the increasing human's protein requirement by getting more protein from animal sources and at an increased availability of poultry meat (Grazziotin*et al*., 2006). There are advanced processing methods for hydrolysing feather proteins in order to make them more consumable, valuable and available for monogastric animals. Earlier studies have shown that alkaline and acid hydrolysis is quite efficient for breaking down of feather waste which contains keratin and collagen (Akpor*et al.,* 2018). Hence this reserach was conducted to determine the growth performance of Ross broilers fed dietary inclusion of hydrolyzed feather meals.

Methods Materials and Methods

Process of Treating the Feathers

For preparation of feather Meal (hydrolysates), raw white coloured chicken feather wastes were obtained from the poultry slaughterhouse of Commercial Farm of Landmark University in OmuAran, Nigeria. The collected feather wastes were washed first with water and detergent and rinsed properly to remove every trace of detergents. The washed feathers were then sundried for 2 days. The procedure reported by Akpor et al., (2018) [14]was used for hydrolysis of the feather. To recover the hydrolyzed feather from solution, 10 % of respective acids (H_2SO_4, HCl, HNO_3 and H_3PO_4) were added gradually until a precipitate is formed, which was recovered from solution by filtration with a muslin cloth. The filtrate (referred to as hydrolysate) was air-dried to constant weight and stocked in clean vessels at room temperature.

Site of Experiment and Animal Management

The research was conducted at the poultry unit of Landmark University Teaching and Research Farm OmuAran, Kwara State, Nigeria. The research protocol was authorized by Landmark University Committee on Animal Ethics and the research was carried out with strict compliance to the NIH principles. The experiment was conducted using two hundred and twenty-five (225) day-old Ross 308 broiler strains of chicken for the study period of eight weeks, the chicks were distributed randomly to five dietary treatments namely D1 (control), D2 (Inclusion of HCL treated feather meal), D3 (Inclusion of HNO_3 treated feather meal), D4 (Inclusion of H_2SO_4

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treated feather meal) and D5 (Inclusion of H_3PO_4 treated feather meal). Each experimental diet as shown in Table 1 has 45 Ross broilers replicated thrice with 15 birds per replicate in a complete randomized design (CRD). All the diets were formulated for the starter (day old – week 4) and finisher phase (week 5 – week 8).

The experimental birds were given feed in the morning at 8am and evening at 4pm on daily basis. Feed given were weighed using a top loader sensitive weighing scale to achieve the requisite amount of feed to be given to each treatment and the quantity per replicate. The leftover from the feed given birds in each replicate was measured and recorded to know the amount of feed consumed by the birds daily. Water was supplied to the birds *ad libitum.* All vaccination and medication programme were carried out as at the time recommended. On weekly basis, the weight of birds in each replicate was measured and the outcome was used to determine the average weight gain of each replicate as well as their feed conversion ratio (FCR).

Table 1: Composition of experimental starter and finisher diets

Ingredients	Starter phase					Finisher phase				
	D1	D2	D3	D4	D5	D1	D2	D3	D4	D5
Maize	54	54	54	54	54	64	64	64	64	64
Soybean meal	40	40	40	40	40	30	30	30	30	30
Feather meal	0	2	2	2	2	0	2	2	2	2
Fish meal	2.5	0.5	0.5	0.5	0.5	2.5	0.5	0.5	0.5	0.5
Bone meal	2	2	2	2	2	2	2	2	2	2
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Limestone	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Broiler premix	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total	100	100	100	100	100	100	100	100	100	100

Proximate Composition and Histological Analyses

The treated feathers and experimental diets proximate composition were analyzed using the AOAC methods(2005) and the following parameters were calculated: moisture content, crude protein, fat content, crude fibre, phosphorus, calcium, methionine and lysine.

Heart, one important organ of the transport system and gizzard another important organ of the digestive system of birds fed experimental diets were preserved in formalin and taken for histological analysis in histopathology laboratory. Binocular Olympus Model CX21FSI Microscope and 12Mega Pixel Samsung Camera were used for photomicrographs of magnification X 10.

Data Analysis

The data obtained was caused to undergo statistical analysis of variance with the use of SAS Analytical computer package; version 9.1.(SAS, 2012) significant means were separated using Duncan's Multiple Range Test at 5% probability.

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Results and Discussions

Proximate composition result of the test ingredients of different acid-treated feather meal showed that all the different acid treated feathers has high protein content, however, feathers treated with HNO_3 had the highest level of protein content compared with the other acid-treated feather meal, followed by feather meal treated with HCL, while feathers treated with H_2SO_4 and HNO_3 had similar level of protein content (Table 2). The protein content of feather treated with HNO_3 (83.53%) is within the range of the findings reported by earlier investigators (Ewing, 1997; Williams *et al*. 1991). The higher protein value of 83.53% may be due to the nitrogen content of the acid which could have been added advantage over other acids used in the process of feather treatment. The protein content for the feathers treated with H_2SO_4 and H_3PO_4 were lower to the finding of Ewing (1997). Feathers treated with H_2SO_4 had the lowest fat and fibre content of 3.77% and 0.96% respectively.

Table 2: Proximate composition of different acid-treated feather meal

	Hydrolyzed Feathers precipitated with HCL	Hydrolyzed Feathers precipitated with HNO_3	Hydrolyzed Feathers precipitated with H_2SO_4	Hydrolyzed Feathers precipitated with H_3PO_4
Moisture (%)	12.30	12.09	12.66	11.27
Protein (%)	82.40	83.63	81.24	81.22
Fat (%)	4.03	3.94	3.77	4.32
Fibre (%)	1.01	1.05	0.96	0.99
Ash (%)	1.36	1.34	1.23	1.29

All the different acid-treated feather meal had high moisture content which range from 11.27% - 12.66%, this could be due to the process of hydrolysis used for the conversion of raw feather insoluble protein into processed feather digestible protein (Grazziotin*et al*. 2006). The cooking process was to increase the digestibility of the protein content of the raw feather. However, high moisture content of the treated feather meal can have negative effect on the shelf life of the test ingredient if not properly dried to the minimal moisture level.

The protein content of the control diet (D1) and diets supplemented with feather meal treated with HNO_3 (D3) were similar compared to the remaining experimental diets (Table 3). However, proximate composition results showed that all the experimental starter diets crude protein (CP) content were within the CP requirement for broiler starter (Pan *et al.*, 2016). D4 had the least fibre and crude fat content compared to the remaining diets. The energy values of all the diets with acid treated feather meal were all higher than the control diet.

Table 3: Proximate composition of experimental starter diets

Feed composition (%)	D1 (Control)	D2 (HCL)	D3 (HNO_3)	D4 (H_2SO_4)	D5 (H_3PO_4)
Moisture	6.44	5.40	5.24	5.11	5.33
Crude protein	23.02	22.97	23.05	21.83	21.95
Crude fibre	4.09	4.51	4.14	3.85	4.66
Ether extract	3.55	3.94	3.63	3.45	4.50
Calcium	1.37	1.38	1.37	1.38	1.35

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Phosphorus	1.17	1.16	1.16	1.15	1.17
Lysine	1.39	1.39	1.37	1.36	1.36
Methionine	0.66	0.65	0.65	0.64	0.65
Energy (ME Kcal/kg)	2694.05	2716.25	2714.75	2703.25	2705.25

The trend of results of the proximate composition of the finisher experimental diets was similar to that of the starter diets. Diets D1 (control) and D3 (HNO_3) has similar crude protein content of 20.02% and 20.05% respectively. The protein content values for D2 (HCL), D4 (H_2SO_4) and D5 (H_3PO_4) were similar, thus indicating that the incorporation of the hydrolyzed feathers had no negative impact on the nutritional adequacy of the dietary treatments (Table 4). Loow*et al*. (2016) reported the use of alkalis and acids in hydrolysis of feather wastes as a very regular approach used in transition procedure for improved nutritional content of feather wastes. D4 (H_2SO_4) had the least fibre and ether extract content compared with other diets. The energy values of all the diets with acid treated feather meal were all higher than the control diet.

Table 4: Proximate composition of experimental finisher diets

Feed composition (%)	D1 (Control)	D2 (HCL)	D3 (HNO_3)	D4 (H_2SO_4)	D5 (H_3PO_4)
Moisture	7.24	6.42	6.15	6.10	6.23
Crude protein	20.02	19.95	20.05	19.80	19.75
Crude fibre	5.07	5.15	5.95	4.95	5.06
Ether extract	4.51	4.74	5.30	4.14	5.50
Calcium	2.35	2.36	2.36	2.37	2.35
Phosphorus	1.12	1.14	1.14	1.15	1.15
Lysine	1.09	1.09	1.07	1.06	1.06
Methionine	0.46	0.45	0.45	0.44	0.45
Energy (ME Kcal/kg)	2894.05	2911.27	2912.55	2905.20	2906.25

Table 5 showed that there was no notable differences ($P<0.05$) in the initial weight as compared with other parameters. Feed intake for the broilers given D1(control), D4 (H_2SO_4) and D5(H_3PO_4) were not significantly different though birds fed D4 (H_2SO_4) had the highest feed intake of 93.53g/bird, feed intake for birds fed D3 (HNO_3) was the least but not significantly different from those birds fed D2 (HCL). The reduced feed intake for D2 and D3 may be due to increased energy level of D2 and D3. Daily weight gain for birds fed D1 (control), D2 (HCL) and D5 (H_3PO_4) were similar but birds fed D3 (HNO_3) had the least daily weight gain. The feed conversion ratio showed significant difference ($P<0.05$) across the diets, D3 (HNO_3) had the highest (2.63) an indication of low rate of utilization of the diet (Mazotto*et al*., 2017). Feed conversion ratio was similar for D1 (control), D2 (HCL) and D5 (H_3PO_4). This observation was reflective in the final weight of the birds fed D1, D2 and D5. The poor performance of birds on diet D3 despite the higher crude protein content might be due to the colour and odour of the diet (Heugten&Kempen 2002). Feed consumption and ultimate utilization might be affected by nutrient digestibility (Gopinath*et al*., 2015; Mazotto*et al*., 2017) however; nutrient digestibility was not measured in this study. Birds fed control diet and the respective hydrolyzed feather meals showed high mortality result, which could be as a result of a factor outside the diet, probably the environmental factor such as heat stress.

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Table 5: Growth performance characteristics of broilers fed experimental finisher diet

	Parameters Measured					
	Initial weight (g/bird)	Final weight (g/bird)	Feed intake (g/bird)	Daily weight gain (g/bird)	Feed conversion ratio	Mortality
	NS	*	*	*	*	*
	Means ± SE	Means ± SE	Means ± SE	Means ± SE	Means ± SE	Means ± SE
D1	309.83±0.88	2520.8±10.20^{a}	92.12±1.17^{a}	46.06±1.47^{a}	2.02±0.36^{a}	10.00±1.83^{a}
D2	311.00±0.88	2406.2±10.20^{a}	89.92±1.17^{b}	43.65±1.47^{a}	2.06±0.36^{a}	10.01±1.83^{a}
D3	308.00±0.88	1917.0±10.20^{d}	88.16±1.17^{b}	33.52±1.47^{c}	2.63±0.36^{b}	10.01±1.83^{a}
D4	308.00±0.88	2163.2±10.20^{c}	93.53±1.17^{a}	38.65±1.47^{b}	2.42±0.36^{b}	13.34±1.83^{b}
D5	310.00±0.88	2356.2±10.20^{b}	93.34±1.17^{a}	42.63±1.47^{a}	2.19±0.36^{a}	13.34±1.83^{b}

$^{a-c}$Means in the same column with different superscript differ significantly ($p<0.05$*) whereas means with the same letter are not significantly different.

Figures 1 and 2 showed histological results of the effects of the different acid treated diet on the heart and gizzard of birds fed different experimental diets. Figure 1 shows the Photomicrographs of the heart of birds fed D1 (control) and D4 (H_2SO_4) showed normal myocardium, the Photomicrographs of the heart of birds fed D2 (HCL) and D3 (HNO_3) showed mild infiltration of the myocardium by mononuclear inflammatory cells. Photomicrograph of the heart of a bird fed D5 (H_3PO_4) showed intense infiltration of the inter-myocardial spaces by mononuclear inflammatory spaces. Figure 2 shows the photomicrograph of the gizzard of birds fed D1 (control) showed normal *muscularispropia* devoid of epithelial lining, the photomicrographs of the gizzard of birds fed D2 (HCL) showed scanty infiltration of the *muscularispropia* by mononuclear inflammatory cells, while the gizzards of birds fed D4 (H_2SO_4) and D5 (H_3PO_4) showed few mononuclear inflammatory cells within the *muscularispropia*.

Fig.1: Photomicrographs of the heart of birds fed experimental diets

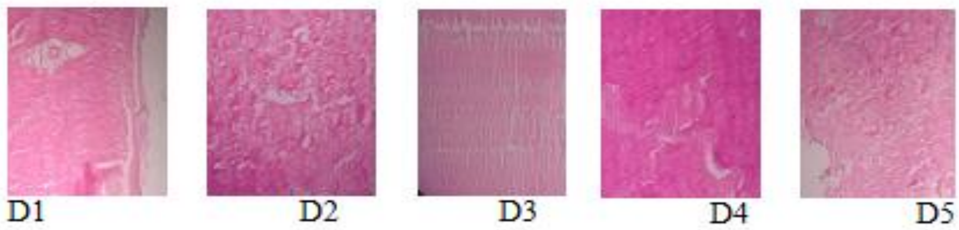

Fig. 2:Photomicrographs of the gizzard of birds fed experimental diets

Conclusion

Due to the results attained in this present research, it was decided that the HCL precipitated hydrolyzed feather meal diet performed similar to the control diet with regard to the final weight, feed conversion ratio and mortality, hence of all the acid precipitated hydrolyzed feather meal diet, HCL treated feather meal diet was not detrimental to heart and gizzard of the chickens.

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