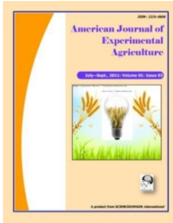

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Performance and Carcass Characteristics of Broiler Finishers Fed Different Levels of Poultry Offal Meal and Crayfish Waste Meal as Replacement for Fishmeal

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Authors' contributions

This work was carried out in collaboration between all authors. Authors ARA and ADO designed the study, managed the literature searches, and wrote the protocol. Author IOA wrote the first draft of the manuscript and performed the statistical analyses. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

Aims: There is need to supply birds with the nutrients required in order to maintain normal growth and reproduction. The escalating cost of dietary protein ingredients necessitates the search for alternatives in poultry production. The inclusion of crayfish waste (CW) and poultry offal (PO) in chicken feeds could reduce the cost of dietary proteins. The study evaluated the utilisation of CW and PO as dietary protein sources for chicken production.
Study Design: One hundred and eighty day-old Marshall broiler chicks were used for the study in a completely randomized design. Proximate composition of the poultry offal meal and crayfish waste was determined using the analytical methods of AOAC (1996). Data generated were subjected to analysis of variance and significant treatment means were separated using Duncan Multiple Range Test.
Place and Duration of Study: The study was carried out in the Poultry Section of the Teaching and Research Farm of the Lagos State Polytechnic, Ikorodu. The study lasted for nine weeks (five weeks for the starter period and four weeks for the finisher period).

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Methodology: One hundred and eighty day-old Marshall broiler chicks were used for the study. Thirty chicks were assigned to each dietary treatment, which was replicated three times in a completely randomized design. Six experimental diets containing fish meal (FM), crayfish waste meal (CWM) and poultry offal meal (POM) were used thus: control diet which was diet 1 contained 2.1% FM of the total ingredients, while diets 2,3,4,5 and 6 contained 2.79% POM, 3.92%CWM, 2.09% POM + 0.98%CWM, 1.40% POM + 1.96% CWM, and 0.69% POM + 2.94%CWM, respectively. Birds were fed the starter diets for five weeks after which the finisher diets were fed for four weeks.

Results: The CWM contained 35.0, 12.9 and 3.9% CP, CF, and EE, respectively and 1454Kcal/kg ME, while the POM contained 51.9, 1.8 and 6.2% CP, CF and EE correspondingly with 2600Kcal/kg ME. However, FM contained 65.1, 0.8 and 6.0% CP, CF and EE with corresponding ME of 2860Kcal/kg. The control birds (diet 1) and diet 6 consumed 2.98kg similar to diets 2 (2.97kg) but differed significantly (P =0.05) from those on diets 3, 4, and 5. The protein efficiency ratio (PER) and feed conversion ratio (FCR) were similar for all treatments. Chicken fed diet 3 had an eviscerated weight of 84.27% which was significantly (P=.05) better than others.

Conclusion: Diets 4 and 6 which contained 2.09%POM: 0.98% CWM and 0.69% POM: 2.94% CWM respectively were identified as the most cost effective treatments and selected as the best inclusion levels.

Keywords: Broiler finishers; carcass; crayfish waste; performance; poultry offal.

1. INTRODUCTION

Feed formulation for livestock requires a clear understanding of the nutrient requirements of different classes of livestock in relation to age, production objectives and physiological state. In addition, the nutrient compositions of the available raw material resources need to be known (Ranjhan, 2000). The low level or absence of specific nutrients in the diet may lead to low production rate, nutritional deficiency symptoms and easy susceptibility to diseases. Wastes emanating from poultry processing and shrimp industries in Nigeria are mostly biodegradable and are usually dumped in the open on available land. The wastes being proteins putrify and gases such as ammonia, carbon dioxide among others are usually released during the process of biodegradation (Caires et al., 2010). The roles that poultry plays in the livelihood of rural communities in developing countries cannot be over-emphasised (Akinola and Essien, 2011). Poultry have short generational interval and are good and efficient feed converters. Contributions from poultry production especially rural poultry production include provision of cash income, satisfying family's nutritional needs, as well as satisfying religious and socio-cultural needs (Akinola and Essien, 2011). However, among the challenges of poultry production in Nigeria, scarcity and escalating cost of dietary ingredients constitute the highest. Feed has been estimated to contribute 70-80% of the total cost of rearing poultry (Singh, 1990). The high cost of feed is linked to reliance on conventional feed resources. Fish meal has been used as a source of dietary animal protein largely because of its balanced amino acids profile. Incidentally, the direct competition between man and poultry for fish has led to the scarcity, high cost and adulteration of fish meal. The study was carried out to investigate the performance and carcass characteristics of broiler chicken fed different levels of poultry offal meal and crayfish waste meal as replacement for fish meal.

2. MATERIALS AND METHODS

The study was carried out in the Poultry Section of the Teaching and Research Farm of the Lagos State Polytechnic, Ikorodu. One hundred and eighty day-old broiler finishers were used for the study.

2.1. Management of Experimental Birds

Thirty chicks were assigned to each dietary treatment, which was replicated thrice in a completely randomized design. The chicks were reared on a deep litter system with feed and water supplied *ad-libitum*. Before the arrival of the day-old chicks, the brooder house, feeders and drinkers were properly cleaned and disinfected with *Morigad* disinfectant (which contained phenol as an active ingredient). The house was partitioned into pens according to the design of the experiment. Wood shavings used as litter materials were spread on the floor of the pen at the height of 2.5cm. At the starter phase, the feeders were flat trays and fountain drinkers. Coal pots were provided in addition to electric bulbs (200 watts) as source of heat for brooding. Ventilation was adequate, and the brooding temperature of 32 – 35ºC was maintained according to (Oluyemi and Roberts, 2001). The birds were vaccinated thus: day-old (vaccination against new castle disease; at fourteenth day, they were vaccinated against gumboro (infectious bursal disease); on days 16 and 28, they were vaccinated against new castle disease. Crayfish wastes were collected from Universal Fisheries, Isolo Local Government Development Area, Lagos, Nigeria.

2.1.1 Experimental diets and data collection

A batch was drained and oven-dried at 65ºC for 24 hours followed by plate milling. Another batch was parboiled after collection, drained and oven-dried before milling. Proximate compositions of the samples were subsequently determined using the analytical methods of A.O.A.C. (1996). Drained and oven-dried crayfish wastes which had the higher crude protein value were used with other feed ingredients to formulate experimental diets. Poultry offal used for the study was collected from a broiler processing farm in Ikorodu, Lagos, Nigeria. They were boiled in a container for about 45minutes, allowed to cool and subsequently poured into a sac for draining. Further draining was achieved by pressing followed by oven-drying at 65ºC for 48 hours. Dried poultry offal was subsequently crushed and fine-milled. A proximate composition of the poultry offal meal was determined using the analytical methods of A.O.A.C. (1996). Six experimental diets were formulated with different levels of crayfish waste meal and poultry offal meal replacing fishmeal thus for the finisher period: control diet which was diet 1 contained 2.1% FM of the total ingredients, while diets 2,3,4,5 and 6 contained 2.79% POM, 3.92%CWM, 2.09% POM + 0.98%CWM, 1.40% POM + 1.96% CWM, and 0.69% POM + 2.94%CWM respectively (Table 2). The experimental diets for the starter period are shown in Table 1. Each diet was fed for a period of 5 weeks for the starter period and 4 weeks for the finisher study. Records of feed consumption and body weight were kept on weekly basis while body weight gain and feed conversion ratio (FCR) were estimated from the data collected. Proximate composition of the poultry offal meal and crayfish waste was determined using the analytical methods of (AOAC, 1996). At the end of the ninth week, three birds per replicate were slaughtered after they were starved overnight. The live weight and bled weight were taken. Eviscerated carcass was cut into prime cuts (thighs, drumsticks, wings, breast and back) and weighed. The abdominal fat and weights of the organs (liver, heart and gizzard) were also taken. The dressing out percentage was calculated as the proportion of hot carcass weight over live weight.

2.1.1.1 Statistical Analysis

Data generated were subjected to analysis of variance using SAS statistical package (SAS, 2003). The design employed was completely randomized and significant treatment means were separated using Duncan Multiple Range test of the same software.

2.1.1.1.1 Mortality

The broiler finisher chickens fed a combination of poultry offal meal and crayfish waste meal did not record any mortality.

Table 1. Composition and determined analysis of broiler (starter) diets with different levels of poultry offal and crayfish waste meal as replacement for fish meal

Ingredients (%)	**1**	**2**	**3**	**4**	**5**	**6**
Maize	40.00	40.00	40.00	40.00	40.00	40.00
Wheat Offal	7.00	8.00	9.54	8.52	8.93	9.26
Maize Bran	17.00	14.97	12.43	14.17	13.45	12.86
Soya Meal	10.00	10.00	10.00	10.00	10.00	10.00
Groundnut cake	20.00	20.00	20.00	20.00	20.00	20.00
Fish Meal (65%)	3.00	0.00	0.00	0.00	0.00	0.00
Poultry Offal Meal	0.00	3.98	0.00	2.98	1.99	0.99
Crayfish waste meal	0.00	0.00	5.59	1.40	2.79	4.20
Oyster Shell	1.26	1.26	1.00	1.24	1.20	1.15
Bone Meal	1.20	1.20	0.90	1.15	1.10	1.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25
25% Broiler Premix$^+$	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.04	0.04	0.04	0.04	0.04	0.04
Determined Composition						
Crude Protein (%)	22.26	22.25	22.22	22.23	22.23	22.22
ME KCal/Kg	2813	2800	2742	2783	2768	2754
Crude Fibre (%)	3.77	3.20	4.24	3.26	4.63	4.78
Ash (%)	1.55	1.71	2.34	1.15	1.59	2.06
Ether Extract (%)	1.72	0.53	0.79	0.68	0.13	0.45

FM= Fish meal; POM = Poultry offal meal; CWM = Crayfish waste meal
1= 2.1% FM; 2= 2.79% POM; 3= 3.92%CWM; 4=2.09%POM: 0.98%CWM;
5= 1.40%POM: 1.96%CWM; 6= 0.69%POM: 2.94%CWM
+ Broiler vitamin premix supplied the following vitamins and trace elements per kg diet: vit A (7812.5 IU), vit D_3 (1562.5 IU), vit E (25.0mg), vit K_3 (1.25mg), vit B_1 (1.8mg), vit B_2 (3.44mg), niacin (34.4mg), calcium pantothenate (7.19mg), vit B_3 (3.1mg), vit B_{12} (0.02mg), choline chloride (312.5mg), folic acid (0.6mg), biotin (0.1mg), manganese (75mg), iron (62.5mg), zinc (50.0mg), copper (5.3mg), iodine (0.9mg), cobalt (0.2mg), selenium (0.1mg), antioxidant (75mg).

Table 2. Composition and determined analysis of broiler (finisher) diets with different levels of poultry offal and crayfish waste meal as replacement for fish meal

Ingredients (%)	1	2	3	3	5	6
Maize	47.00	47.00	47.00	47.00	47.00	47.00
Wheat Offal	5.60	6.50	6.85	6.90	6.90	6.90
Maize Bran	14.00	12.45	12.00	11.90	11.90	11.92
Soya Meal	5.00	5.00	5.00	5.00	5.00	5.00
Groundnut cake	18.00	18.00	18.00	18.00	18.00	18.00
Fish Meal (65%)	2.00	0.00	0.00	0.00	0.00	0.00
Poultry Offal Meal	0.00	2.65	0.00	1.99	1.33	0.66
Crayfish waste meal	0.00	0.00	3.72	0.93	1.86	2.79
Oyster Shell	1.27	1.27	0.90	1.25	1.20	1.00
Bone Meal	1.40	1.40	0.80	1.30	1.15	1.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Broiler Premix^{+}	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.08	0.08	0.08	0.08	0.08	0.08
Lysine Hcl	0.15	0.08	0.15	0.15	0.15	0.15
Determined Composition						
Crude Protein (%)	19.36	19.35	19.36	19.35	19.36	19.36
ME (KCal/Kg)	2919	2909	2889	2899	2884	2892
Crude Fibre (%)	3.53	4.10	4.90	3.90	4.80	4.00
Ash (%)	1.11	0.99	1.03	0.92	1.31	1.15
Ether Extract (%)	0.98	1.47	1.20	1.48	0.80	0.96

POM = Poultry offal meal; CWM = Crayfish waste meal; FM = Fish meal
1= 2.1% FM; 2= 2.79% POM; 3= 3.92% CWM; 4=2.09%POM: 0.98%CWM;
5= 1.40% POM: 1.96% CWM; 6= 0.69% POM: 2.94%CWM
+ Broiler vitamin premix supplied the following vitamins and trace elements per kg diet: vit A (7812.5 IU), vit D_3 (1562.5 IU), vit E (25.0mg), vit K_3 (1.25mg), vit B_1 (1.8mg), vit B_2 (3.44mg), niacin (34.4mg), calcium pantothenate (7.19mg), vit B_3 (3.1mg), vit B_{12} (0.02mg), choline chloride (312.5mg), folic acid (0.6mg), biotin (0.1mg), manganese (75mg), iron (62.5mg), zinc (50.0mg), copper (5.3mg), iodine (0.9mg), cobalt (0.2mg), selenium (0.1mg), antioxidant (75mg).

3. RESULTS AND DISCUSSION

Proximate composition of test ingredients is shown in Table 3. The CWM contained 35.0, 12.9 and 3.9% CP, CF and EE respectively and 1454Kcal/kg ME, while the POM contained 51.9, 1.8 and 6.2% CP, CF and EE correspondingly with 2600Kcal/kg ME. However, FM contained 65.1, 0.8 and 6.0% CP, CF and EE with corresponding ME of 2860Kcal/kg. Presented in Table 4 are the performance characteristics of broiler finishers fed a combination of poultry offal meal and crayfish waste meal as replacement for fish meal. Birds on diets 1 and 6 had the highest average feed intake of broiler finishers (2.98kg) which were closely followed by those in diets 2 (2.97kg) which were significantly (P=.05) higher than birds fed other diets. The broiler finisher chickens fed diet 5 ranked best with 2.41 which compares with 2.40 of control birds. However, there were no significant differences between treatment means in their feed conversion ratio. Protein efficiency ratio of broiler finisher chickens indicated that those fed diets 1 were the most efficient (2.17) which was closely followed by diets 5 (2.16). Birds fed diet 2 had the least value of 1.95. However, differences between the treatment means were not significant. The carcass characteristics of broiler birds fed poultry offal meal and crayfish waste meal as replacement for fish meal are presented on Table 5. The eviscerated weight expressed as percent live weight ranged from

61.58 to 84.27. Chickens fed diet 3 (84.27) had a significantly (*P*=.05) higher value than those fed other dietary treatments. The carcass relative composition (%) showed various significant differences (*P*=.05) between treatment means without following a specific trend. The neck and back values were respectively highest (8.93, 21.42) in diet 5. The values, though similar to those fed control diet (diet 1), were significantly (*P*=.05) different from other dietary treatments. Also, the breast meat value for diet 6 chickens was significantly (*P*=.05) higher (24.00) than other dietary treatments. In respect of the drumsticks value, similarities were observed between chickens fed diets 2 (13.92), 3 (13.42%), and 6 (13.42) as well as those of diets 1 (15.39), 4 (15.47) and 5 (14.29) accordingly. The weight of the gizzard showed similarity between treatments except for dietary treatments 4 (3.44) which was significantly (*P*=.05) higher than others. In the case of heart, birds fed diets 1 (0.97) and 4 (0.83) were significantly (*P*=.05) higher than the others. Diet 5 (2.01) had the highest numerical value for liver size. Diet 6 (1.85) had the highest value of abdominal fat which significantly (P=.05) differed from other dietary treatments. The least value was recorded for diet 1 (0.43).

The 35.02% crude protein of un-parboiled crayfish waste used for this study is lower than 43.71% reported by Fanimo et al. (1996) and 50.89% in tunnel-dried samples (Rosenfeld et al., 1997) but similar to 35.2% reported by Ngoan et al. (2000). The nutritional value of crayfish waste is also affected by processing method and collection time. The head, which constitute about 70% of shrimp waste is known to contain some bacteria which during storage can produce a dicarboxylic reaction turning amino acids to biogenic amines, resulting in depletion of the nutritional value with a possible toxic effect (Rosenfeld et al., 1997). Samples used in this study were dried soon after collection to forestall the commencement of the activities of the spoilage bacteria. The percent crude protein of POM in this study (51.31) is lower than 62.5 reported for broiler offal (Islam et al., 1994), 60.00 in chicken offal meal (Fanimo et al., 1996) and 56.00 in poultry visceral offal meal (Salami and Oyewole, 1997), but similar to 50.15 reported by Mutucumarana et al. (2010). The reason for variation in the nutritive values of POM may be due to the variation in source and types of raw materials, storage time of raw materials prior to rendering and processing conditions (Najafabadi et al., 2007). The composition of POM is affected by the source or type of poultry and processing method. When the entire gastro-intestine and the contents are utilized, the composition would also depend on the constituents of the previous feed consumed by the birds. The broiler chickens fed with diet 3 consumed a significantly less quantity of feed than others thereby gaining the corresponding least weight. Conversely, chickens placed on diet 6 which consumed most also gained best weight. This result is in agreement with (Caires et al., 2010) as well as (Fanimo et al., 1996) who reported a reduced weight gain when increased quantity of shrimp waste meal was consumed by broiler chickens. The non-significant differences that were observed in feed conversion ratio and protein efficiency ratio further indicated the extent of feed and protein utilisation respectively, because it relates protein intake to body weight gain. Mean body weight gain was not significantly different across the treatments. This further confirms the previous findings by Mutucumarana et al. (2010). It has been observed that feeding POM up to 10% fulfills the amino acid requirement of poultry Fritts et al. (2002). The present study proved the assertion that the amino acids in POM are sufficiently balanced to be considered in the formulation of poultry rations and can be successfully used to replace dietary fish meal at the levels of inclusion without having any negative effect on weight gain. The similarities in the carcass values between most of the dietary treatments indicate the uniformity of the diets. The breast muscles and drumsticks are the most economically important portion of the carcass and also provide the greatest portions of edible meat in broilers (Smith and Teeter, 1987). The relative muscle weights of these two cuts were not significantly different which confirms the findings

of (Rosenfeld et al., 1997) when shrimp waste meal was used to replace soyabean meal and (Salami and Oyewole, 1997). The sizes of the liver, gizzard, heart and abdominal fat respectively, were similar to earlier reports (Fanimo et al., 1996; Mohammed et al., 2009). Mixtures of POM and CWM did not have adverse effect on the health of broilers since record of mortality was not affected by the various mixtures. This agreed with result of the finding by Bolu and Adakeja (2008). The results of the previous study carried out by Ologhobo et al. (2012) on carcass characteristics of broiler finishers fed poultry offal meal as replacement for fishmeal revealed that the chickens fed diet 2 (75%FM; 25%CWM) had the best eviscerated weight followed by those that were fed diet 4 (25%FM; 75%CWM). The two treatments were significantly (P=.05) different whereas other treatment means were similar (*P*=.05). The drumsticks which ranged between 17.52% (diet 2) and 16.34% (diet 5) of the eviscerated weight were also similar (P=.05) between treatment means. The breast and back showed similarity between treatments except for chicken fed with diet 3 (50%; 50%CWM) which was significantly heavier than those fed diet 1 (control) and diet 2 (25%FM;
75%CWM) respectively.

Table 3. Proximate composition of test ingredients

Composition	POM	CWM	FM
Dry matter (%)	85.90	81.30	81.60
Crude protein (%)	51.91	35.02	65.12
Crude fibre (%)	1.83	12.90	0.80
Ether extract (%)	6.22	3.85	6.00
Ash (%)	5.92	11.56	23.45
ME (Kcal/kg)	2600.00	1454.00	2860.00

POM = Poultry offal meal; FM = Fish Meal; CWM = Crayfish waste meal

Table 4. Performance characteristics of broiler finisher chickens fed different levels of poultry offal meal and crayfish waste meal as replacement for fishmeal

Variables	1	2	3	4	5	5	SEM
Mean initial weight (kg/bird)	0.85	0.85	0.70	0.81	0.80	0.87	3.01
Mean final weight (kg/bird)	2.10[a]	1.97[a]	1.78[b]	1.92[ab]	1.90[b]	2.03[a]	0.10
Mean weight gain (kg)	1.25	1.12	1.09	1.13	1.12	1.16	0.07
Mean feed intake (kg/bird)	2.98[a]	2.97[a]	2.76[bc]	2.85[b]	2.68[c]	2.98[a]	0.13
Feed conversion ratio	2.40	2.68	2.55	2.54	2.41	2.56	0.15
Protein efficiency ratio	2.17	1.95	2.03	2.05	2.16	2.02	0.08
Cost of feed (N/kg)	43.33[a]	35.54[b]	35.44[b]	35.40[b]	35.51[b]	35.47[b]	
Cost of feed/bird (N)	121.32	105.55	97.81	100.89	95.17	105.70	

Means with different superscripts in the same rows are significantly (P=.05) different.
EW= eviscerated weight; LW= live weight; 1= contained 2.1% FM; 2= contained 2.79% POM,
3= contained 3.92% CWM; 4 contained 2.09% POM: 0.98% CWM; 5= contained 1.40%
POM: 1.96%CWM,
6= contained 0.69% POM: 2.94% CWM; SEM=standard error of mean.

Table 5. Carcass characteristics of broiler chicken fed a combination of poultry offal meal and crayfish waste meal as a replacement for fish meal

Variables	1	2	3	4	5	6	SEM
Mean Live weight (kg/bird)	2.10^{a}	1.97^{a}	1.78^{b}	1.92^{ab}	1.90^{b}	2.03^{a}	0.10
Plucked weight (kg/bird)	1.43	1.62	1.60	1.55	1.53	1.36	0.10
Plucked weight (% LW)	68.10^{d}	82.23^{b}	89.88^{a}	80.23^{c}	80.52^{c}	67.00^{e}	0.017
Eviscerated weight (kg/bird)	1.30	1.45	1.50	1.33	1.39	1.25	0.08
Eviscerated weight (% LW)	61.90^{e}	73.60^{b}	84.27^{a}	69.27^{d}	73.16^{c}	61.58^{e}	0.014
Dressed weight (kg/bird)	1.25^{cd}	1.31^{b}	1.40^{a}	1.25^{cd}	1.30^{bc}	1.23^{d}	0.0004
Dressed weight (%/LW)	59.52^{f}	66.49^{c}	78.65^{a}	65.10^{d}	68.42^{b}	60.59^{e}	0.0003
Carcass relative composition							
Neck (kg/bird)	0.10^{b}	0.10^{b}	0.10^{b}	0.10^{b}	0.12^{b}	0.10^{b}	0.004
Neck (% EW)	7.7^{ab}	6.88^{ab}	6.71^{b}	7.55^{ab}	8.93^{a}	6.40^{b}	0.4
Back (kg/bird)	0.26^{ab}	0.27^{ab}	0.22^{b}	0.24^{b}	0.3^{ab}	0.22^{a}	0.001
Back (% EW)	19.62^{ab}	18.90^{b}	14.41^{c}	18.09^{b}	21.42^{a}	18.00^{b}	0.53
Breast (kg/bird)	0.23^{cd}	0.32^{a}	0.28^{abc}	0.25^{bcd}	0.22^{d}	0.3^{ab}	0.001
Breast (%EW)	17.61^{cd}	22.33^{b}	18.44^{cd}	18.86^{c}	16.01^{c}	24.00^{a}	0.37
Wings (kg/bird)	0.23	0.25	0.24	0.25	0.3	0.22	0.001
Wings (% EW)	17.50^{cd}	17.19^{d}	16.24^{c}	18.87^{b}	21.78^{a}	18.21^{bc}	0.27
Thigh (kg/bird)	0.23^{ab}	0.27^{a}	0.2^{ab}	0.21^{ab}	0.22^{ab}	0.15^{b}	0.001
Thigh (% EW)	17.31^{ab}	18.91^{a}	13.42^{c}	15.47^{a}	16.08^{b}	12.20^{c}	0.52
Drumsticks (kg/bird)	0.20^{a}	0.20^{a}	0.20^{a}	0.20^{a}	0.20^{a}	0.17^{b}	
Drumsticks (% EW)	15.39^{a}	13.92^{b}	13.42^{b}	15.47^{a}	14.29^{ab}	13.42^{b}	0.36
Gizzard (kg/bird)	0.04^{a}	0.04^{a}	0.04^{a}	0.05^{b}	0.04^{a}	0.04^{a}	0.01
Gizzard (% EW)	2.66^{b}	2.55^{b}	2.86^{b}	3.44^{a}	2.51^{b}	2.80^{b}	0.11
Liver (kg/bird)	0.02^{b}	0.03^{a}	0.02^{b}	0.03^{a}	0.03^{a}	0.01^{c}	
Liver (% EW)	1.31^{bc}	1.72^{ab}	1.26^{bc}	1.79^{ab}	2.01^{a}	1.07^{c}	0.16
Heart (kg/bird)	0.01^{a}	0.006^{b}	0.07^{ab}	0.01^{a}	0.006^{b}	0.006^{b}	
Heart (% EW)	0.97^{a}	0.42^{b}	0.44^{b}	0.83^{a}	0.43^{b}	0.44^{b}	0.06
Abdominal fat (kg/bird)	0.006^{b}	0.02^{a}	0.01^{c}	0.02^{a}	0.02^{a}	0.02^{a}	
Abdominal fat (% EW)	0.43^{c}	1.14^{b}	0.68^{c}	1.29^{b}	1.11^{b}	1.85^{a}	0.11

Means with different superscripts in the same rows are significantly (P=.05) different.
EW= eviscerated weight; LW= live weight; 1= contained 2.1% FM; 2= contained 2.79% POM
3= contained 3.92% CWM; 4 contained 2.09% POM: 0.98% CWM; 5= contained 1.40% POM: 1.96%CWM
6= contained 0.69% POM: 2.94% CWM; SEM=standard error of mean

4. CONCLUSION

This study revealed that the inclusion of poultry offal meal (POM) and crayfish waste meal (CWM) at the levels of inclusion had no detrimental effect on the performance of broiler finishers. However, diets 4 and 6 which contained 2.09%POM: 0.98% CWM and 0.69% POM: 2.94% CWM, respectively were identified as the most cost effective treatments and were thereby selected as the best inclusion levels.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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