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ORIGINAL RESEARCH ARTICLE

Utilisation of Frog (*Rana esculanta*) Meal as a Replacement for Fish meal in Broiler Diets

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ABSTRACT

An experiment was conducted to investigate the effect of graded levels of frog meal as replacement for fish meal at 0, 25, 50, 75 and 100% on the performance and carcass characteristics of broiler chickens in a 42-day feeding trial. One hundred and eighty seven-day-old Arbor acre broiler chicks were randomly allotted to 5 dietary treatments in a completely randomised design. Each diet had 6 replicates with 6 birds each. At week 5, two birds per replicate were placed in metabolic cages for a 3-day excreta collection for digestibility determination. At week 6, same sets of birds from each replicate were sacrificed, the digestive tract excised and digesta samples were collected at the terminal ileum. Also, two birds from each replicate were slaughtered by cutting through the jugular vein for carcass characteristics and organs were harvested and weighed. Results showed that there were no significant differences in the final weight, weight gain and feed conversion ratio recorded for birds among the treatments. However, the feed intake, protein intake (PI), protein efficiency ratio (PER), ileal and excreta crude protein digestibility of birds were significantly (P<0.05) influenced by the dietary treatments. Highest feed intake was recorded for birds on 50% Frog Meal (FRM) and 50% Fish Meal (FM), though similar to what was obtained in birds fed other levels of FRM inclusion. Identical PI was recorded for birds on the control diet, 25 and 50% FRM diets and were considerably higher (P<0.05) than PI observed in birds on 75 and 100% FRM. Highest PER (2.21) was observed in birds on 100% FRM diet which was similar to those on 75% FRM inclusion level but least PER (1.99) was recorded for birds on the control diet. Ileal and excreta CP digestibility coefficients of birds on the experimental diets varied significantly (P<0.05). Highest ileal CP digestibility coefficient (0.75) was recorded in birds fed 50% FRM and 50% FM while the least (0.65) value was observed in birds fed 100% FRM. There were no significant differences recorded in the primal cuts and organ weights of birds except for head, drumstick, thighs and shanks. It is concluded that frog meal can replace fish meal up to 100% in broiler diets without adverse effect on performance.

Keywords: Frog meal, Fish meal, Performance response, Broiler chickens

INTRODUCTION

Fish meal is very popular as it is believed to be the main source of protein in poultry diet because of its high level of methionine and lysine. However, the high cost of fish meal among other several poultry feed ingredients made animal nutritionists venture into research on other unconventional available animal feed source that is closest to fish meal and relatively unacceptable to humans. It has been observed that demand for fish meal significantly exceeds availability (Barg and Phillips, 1997; Barlow, 2000). For this reason considerable research efforts have been directed towards the evaluation of other protein ingredients as potential substitutes for fish meal in poultry. Some non-conventional protein sources that had been used in poultry nutrition are: crayfish meal (Ojewole *et al.*, 2005; Asafa *et al.*, 2012); sun-dried shrimp waste meal (Oduguwa *et al.*, 2004); shrimp meal (Rosenfeld *et al.*, 1997; Gernat, 2001); grasshopper meal (Aduku, 1993; Ojewole *et al.*, 2005) and locally processed fish waste meal (Ojewole *et al.*, 2005). Other sources of animal protein that are sparingly used are blood meal, meat meal and recently frog meal (Achionye-Nzeh *et al.*, 2003). The frog waste by-products which is associated with the production of edible frog can be used as a supplemental protein source for monogastric animals. Frog meal is a nutrient-rich by-product, with a composition similar to that of fish, protein (65-71%), fat (7-17%) and ash (13-24%) (Ariyani *et al.*, 1984; Tokur *et al.*, 2008). Frog meal is high in digestible nutrient (Islam *et al.*, 1994; Ali *et al.*, 1995) and can be fed to poultry as replacement for fish meal because of its quality in biological value. The use of frog meal may augment the problem of competitiveness and high cost of animal protein source. Thus, the objective of this study was to evaluate the effect of replacing fish meal with frog meal on growth performance and carcass quality of broilers chickens.

MATERIALS AND METHODS

Management of birds and experimental diets

This study was carried out at the Pullet unit of the Teaching and Research Farm, University of Ibadan, Nigeria. One hundred and eighty (180) one-day-old unsexed Arbor acre broiler chicks used were obtained from a reputable commercial hatchery in Ibadan, Oyo state. The birds were brooded for 7 days after which they were weighed, tagged and allotted to 5 treatment groups in a completely randomised design. Each dietary treatment had 6 replicates of 6 birds. The processed frogs were purchased at Bodija market, Ibadan, Nigeria. The frogs were milled and added to the diets appropriately. The experimental diets and fresh water were supplied *ad libitum*. Treatment 1 was the control diet without frog meal while treatments 2, 3 4 and 5 contained 25, 50, 75 and 100% graded levels of frog meal replacing fish meal respectively. Titanium dioxide (TiO_2) was added as an indigestible dietary marker at the rate of 5g/kg of diet. The gross compositions of the basal diets (starter and finisher) are as shown in Tables 1 and 2.

Feed intake was calculated as difference between amounts given and left over. The birds were weighed at the end of the starter and finisher phases and values were used to calculate body weight gain, feed conversion ratio, protein intake and protein efficiency ratio.

Nutrient digestibility studies

Excreta collection

At week 5, two birds were taken from each replicate and placed in metabolic cages for collection of excreta. Fresh excreta were collected in the morning on a daily basis for 3 days, weighed, and oven dried. The oven-dried excreta were analyzed and subsequently used for total tract crude protein (CP) digestibility calculation.

CP digestibility was calculated as follows:

Apparent CP Digestibility (%) =

$$\frac{\text{CP intake} - \text{CP output}}{\text{CP intake}} \times 100$$

Digesta collection

At week 6, same sets of birds from each replicate were sacrificed, the digestive tract excised and digesta samples were collected at the terminal two-thirds of the section between Meckel diverticulum and 2cm anterior to the Ileo-caeco-colonic junction as described by Agboola (2011). The contents were flushed out with distilled water, pooled according to replicates and frozen. The frozen samples were then freeze-dried and milled for further analysis.

Table 1: Gross composition of experimental diets (g/100gDM) starter phase frog meal inclusion

Ingredients	0%	25%	50%	75%	100%
Maize	56.50	56.50	56.50	56.50	56.50
Soyabean meal	16.00	16.00	16.00	16.00	16.00
Groundnut cake	20.00	20.00	20.00	20.00	20.00
Wheat offal	2.00	2.00	2.00	2.00	2.00
Fish meal (72% CP)	2.00	1.50	1.00	0.50	0.00
Frog meal (71% CP)	0.00	0.50	1.00	1.50	2.00
Dicalcium phosphate	1.50	1.50	1.50	1.50	1.50
Limestone	1.00	1.00	1.00	1.00	1.00
Broiler premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated nutrients	(%)				
Crude protein	23.15	23.14	23.13	23.12	23.11
Energy (kcal/g)	3.00	2.98	2.97	2.95	2.94
Crude fibre	3.36	3.36	3.35	3.35	3.34
Lysine	1.26	1.24	1.22	1.19	1.17
Methionine	0.59	0.58	0.57	0.56	0.55
Calcium	1.12	1.14	1.15	1.17	1.18
Phosphorus	0.48	0.49	0.49	0.50	0.51

*Composition of Premix per Kg of diet: vitamin A, 12,500 I.U; vitamin D_3, 2,500 I.U; vitamin E, 40mg; vitamin K_3, 2mg; vitamin B_1, 3mg; vitamin B_2, 5.5mg; niacin, 55mg; calcium pantothenate, 11.5mg; vitamin B_6, 5mg; vitamin B_{12}, 0.025mg; choline chloride, 500mg; folic acid, 1mg; biotin, 0.08mg; manganese, 120mg; iron, 100mg; zinc, 80mg; copper, 8.5mg; iodine, 1.5mg; cobalt, 0.3mg; selenium, 0.12mg; Anti-oxidant, 120mg.

Calculation of ileal nutrient digestibility

Apparent CP digestibility (%) was calculated using the following equation;

$$D_{CP}(\%) = 1 - \left\{\frac{TiO_2 \text{ diet}}{TiO_2 \text{ digesta}}\right\} x \left\{\frac{CP \text{ digesta}}{CP \text{ diet}}\right\} x\ 100$$

Where:

D_{CP} = % apparent ileal crude protein digestibility

TiO_2 diet = concentration of titanium dioxide in the diet (%)

TiO_2 digesta = concentration of titanium dioxide in the digesta (%)

CP digesta = concentration of crude protein in digesta (%)

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Organs weights

At day 42, two birds from each replicate were selected and slaughtered by cutting through the jugular vein for carcass characteristics, and organs were also harvested and weighed.

Chemical and statistical analyses

The proximate composition of diets and digesta samples were determined by the methods of AOAC (2000). The concentrations of titanium dioxide in samples were estimated by the photometric technique of Brandt and Allam (1987). Data were analysed using ANOVA of SAS (SAS, 2012) and significant level of P = 0.05 was used. The treatment means were compared using Duncan Multiple Range F-Test (1955).

RESULTS AND DISCUSSION

The analysed chemical compositions of the test ingredients and finisher's diets are shown in Tables 3 and 4. The proximate composition of frog meal (FRM) consisted 71.19% crude protein (CP), 2.04% crude fibre (CF), 12.00% ether extract (EE), 10.8% ash and 4.62Kcal/g gross energy (GE) while fish meal (FM) had 72.42% CP, 0.30% CF, 11.00% EE, 10.00% Ash and 3.73Kcal/g GE respectively. Similar chemical composition of FRM and FM recorded is probably an indication that the test ingredients had cognate biological value and nutrient profile. Meanwhile, lower CP content of frog meal (71.19%) as compared to that of fish meal (72.42%) observed in this study probably resulted from the species of frog and different processing methods. The proximate composition of frog meal in the present study was in consonance with the findings of Tokur *et al*. (2008) on the chemical evaluation of frog meal but different from the observations of Fuller (2004). However, the CP value obtained for frog meal in this trial was higher than 47.31% reported by Ojewola *et al*. (2005) for frog probably because the oil in frog meal had been extracted which could have resulted in higher crude protein content.

Table 2: Gross composition of experimental diets (g/100gDM) finisher phase frog meal inclusion

Ingredients	0%	25%	50%	75%	100%
Maize	56.50	56.50	56.50	56.50	56.50
Soyabean meal	16.00	16.00	16.00	16.00	16.00
Groundnut cake	10.00	10.00	10.00	10.00	10.00
Wheat offal	12.00	12.00	12.00	12.00	12.00
Fish meal (72% CP)	2.00	1.50	1.00	0.50	0.00
Frog meal (71% CP)	0.00	0.50	1.00	1.50	2.00
Dicalcium phosphate	1.50	1.50	1.50	1.50	1.50
Limestone	1.00	1.00	1.00	1.00	1.00
Broiler premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated nutrients	(%)				
Crude protein	20.35	20.34	20.33	20.32	20.31
Energy (kcal/g)	2.91	2.89	2.88	2.86	2.85
Crude fibre	3.71	3.71	3.71	3.71	3.71
Lysine	1.20	1.22	1.25	1.26	1.29
Methionine	0.59	0.57	0.58	0.59	0.61
Calcium	1.10	1.12	1.13	1.15	1.16
Phosphorus	0.49	0.50	0.50	0.51	0.52

*Composition of Premix per Kg of diet: vitamin A, 12,500 I.U; vitamin D_3, 2,500 I.U; vitamin E, 40mg; vitamin K_3, 2mg; vitamin B_1, 3mg; vitamin B_2, 5.5mg; niacin, 55mg; calcium pantothenate, 11.5mg; vitamin B_6, 5mg; vitamin B_{12}, 0.025mg; choline chloride, 500mg; folic acid, 1mg; biotin, 0.08mg; manganese, 120mg; iron, 100mg; zinc, 80mg; copper, 8.5mg; iodine, 1.5mg; cobalt, 0.3mg; selenium, 0.12mg; Anti-oxidant, 120mg.

Appreciable ether extract values recorded across the diets in this study is perhaps an indication that frog meal-based diets can supply sufficient energy in broiler diets. This was substantiated by the gross energy value of the frog meal (4.62Kcal/g). Frog meal is a nutrient-rich product. Significant amount of ash content (10.8%) recorded in the present study gave a glimpse of its rich mineral profile. This was posited by the report of Ojewola and Udom (2005).

Table 3: Proximate composition (%) of frog meal and fish meal

Parameter	Frog meal	Fish meal
Dry matter	93.90	91.05
Crude protein	71.19	72.42
Crude fibre	2.04	0.30
Ether extract	12.00	11.00
Ash	10.8	10.00
Nitrogen free extract	3.97	6.28
Gross energy (Kcal/g)	4.62	3.73

The crude protein of experimental finisher's diets ranged from 19.08 to 21.20%. It decreased as the level of frog meal increased in the diets. Crude fibre increased from 2.22 to 3.80% as the level of FRM increased across the dietary treatments. Considerable ether extract values ranging from 10.22% to 16.79% were recorded across the diets. The proximate composition of the diets in the present study was comparable to other related previous findings (Fanimo *et al*., 1996; Rosenfeld *et al.,* 1997; Fanimo *et al*., 1998; Ojewola *et al*., 2005). The performance characteristics of birds on experimental finisher's diets are shown in Table 5. There were no significant differences in the final weight, weight gain and feed conversion ratio recorded for all the birds. This was similar to the findings of Rosenfeld *et al*. (1997) and Asafa *et al.* (2012) who reported that the weight gain and feed conversion ratio of broilers fed different levels of shrimp waste and crayfish waste meal respectively was not significantly different. However, the feed intake, protein intake, protein efficiency ratio, ileal and excreta crude protein digestibility of birds were significantly ($P<0.05$) influenced by the dietary treatments. Highest feed intake was recorded for birds on 50% frog meal (FRM) and 50% fish meal (FM), though similar to what was obtained in birds fed other FRM levels of inclusion. This is not in consonance with the report of Ojewole *et al.* (2005) but was in agreement with the findings of Asafa *et al.* (2012) on performance of broiler finisher chickens fed crayfish meal waste. Ojewole *et al*. (2005) reported improved feed intake in birds on the control diet compared to those on three different animal protein sources. The authors averred that the absence of animal protein in the control diet may have caused depression which resulted in excessive feed intake when compared with birds on other diets. Similar to what was observed in the present study, a significant increase in feed consumption was observed in birds fed with 40 and 80% shrimp meal in laying hen diets compared to birds on the control diet as asserted by Gernat (2001).

Identical protein intake was recorded for birds on the control diet, 25 and 50% FRM inclusion and were higher ($P<0.05$) than protein intake of birds on 75 and 100% FRM diets. This possibly suggested that the protein quality of FRM and FM were similar with relatively closer biological values. There were remarkable variations in the protein efficiency ratio of birds on dietary treatments. Highest PER (2.21) was observed in birds on 100% FRM inclusion level though similar to those on 75% FRM but least PER (1.99) was recorded for birds on the control diet. Contrary to the results of the present study, Asafa *et al.* (2012) stated no significant difference in the PER of birds on crayfish waste meal. However, improved PER in broilers on shrimp waste meal at both the starter and finisher phases was postulated by Oduguwa *et al.* (2004). Hasan *et al.* (1989) on the other hand, opined that frog waste meal included at 28% in the diet of catfish fry (*Clarias batrachus*) gave poor growth when compared to fish meal, poultry by-product meal and linseed meal but economic returns were higher or identical to that obtained with other diets. Similarly, Fagbenro *et al.* (1993) affirmed no difference in performance of 180-day growth trial when frog meal was fed to catfish (*Clarias gariepinus*) compared to fish meal. However, Achionye-Nzeh *et al*. (2003) noticed an improved performance in catfish fingerlings (*Clarias anguillaris*) when fed diet containing 40% frog meal from the edible frog (*Pelophylax* kl. *esculentus*) for 42 days.

Table 4: Proximate composition of experimental diets finisher phase (%) frog meal inclusion

Ingredients	0%	25%	50%	75%	100%
Dry matter	89.71	89.33	89.43	89.00	89.00
Crude protein	21.20	20.77	20.62	19.47	19.08
Crude fibre	2.22	2.23	3.13	3.77	3.80
Ether extract	10.95	13.71	16.79	10.22	14.87
Ash	6.81	5.90	5.54	5.36	6.34
Nitrogen free extract	58.82	57.39	46.08	61.18	55.91

Table 5: Performance of birds on experimental diets (Finisher phase)

	Frog meal inclusion					
Parameter	0%	25%	50%	75%	100%	SEM
Initial Weight (g/b)	107.0	108.50	109.17	108.43	109.05	1.89
Final weight (g/b)	1946.05	2042.24	2053.22	2004.48	1990.14	55.49
Weight gain (g/b)	1839.05	1933.74	1944.05	1896.05	1881.09	55.09
Total Feed intake (g/b)	4368.9^{b}	4535.4^{a}	4623.00^{a}	4525.2^{a}	4468.9^{ab}	93.63
Protein intake (g/b)	926.20^{a}	942.00^{a}	953.26^{a}	881.06^{b}	852.67^{b}	21.58
Feed conversion ratio	2.38	2.35	2.38	2.39	2.38	0.08
Protein efficiency ratio	1.99^{c}	2.05^{b}	2.04^{b}	2.15^{ab}	2.21^{a}	0.06
Ileal CP Dig. Coeff.	0.72^{d}	0.73^{c}	0.75^{a}	0.74^{b}	0.65^{e}	0.004
Excreta CP Dig. Coeff.	0.78^{a}	0.75^{b}	0.68^{e}	0.71^{d}	0.72^{c}	0.004

^{a,b,c,d,e}Means on the same row with different superscripts are significantly (P<0.05) different; Ileal CP Dig. Coeff. = ileal crude protein digestibility coefficient; Excreta CP Dig. Coeff. = excreta crude protein digestibility coefficient.

Ileal CP and excreta (total tract collection) CP digestibility coefficient of birds on the experimental diets varied significantly (P<0.05). Highest ileal CP digestibility coefficient (0.75) was recorded in birds on 50% FRM and 50% FM while the least (0.65) value was observed in birds fed 100% FRM diet. On the contrary, highest excreta CP digestibility coefficient (0.78) was in birds on the control diet while the least (0.68) was recorded for birds on 50% FRM and 50%. In terms of protein quality, the digestion of individual protein and amino acids (AAs) up to the terminal ileum often referred to as ileal digestibility is gaining increasing attention in the feeding of both pigs and poultry. Also, in terms of feed evaluation it has been argued that the measurement of CP and AA flow at the terminal ileum is a more reliable measure of the value of the AAs to chickens than the measurement of total AA excretion (Ravindran *et al.*, 1999; Rodehutscord *et al.*, 2004). In general, amino acid content and protein quality of animal protein are superior to those of vegetable sources (Crouse *et al*., 1999; Hoffman and Falvo, 2004).

In agreement with the previous findings, overall digestibility of protein at both the ileal and excreta sites were appreciably improved but in order to circumvent the activities of caecal microbes to further digest protein at the distal end, measurement of CP and AA flow at the terminal ileum becomes imperative (Rostagno *et al*., 1995; Ravindran *et al*., 1999; Pertilla *et al*., 2001; Huang *et al*., 2005; Agboola, 2011). According to Asafa *et al.* (2012), apparent excreta CP digestibility of graded levels of

Table 6: Carcass characteristics of broiler chickens fed graded levels of frog meal

	Frog meal inclusion					
Parameter	0%	25%	50%	75%	100%	SEM
Live weight	1946.05	2042.24	2053.22	2004.48	1990.14	55.49
Dressed weight	1681.70	1865.60	1740.40	1648.10	1709.30	71.48
Eviscerated weight	1243.83	1349.33	1269.82	1250.93	1264.17	65.08
Head	44.22^{b}	53.55^{a}	48.88^{ab}	47.72^{ab}	48.93^{ab}	1.91
Neck	106.77	111.55	114.27	114.22	109.93	5.13
Breast	344.50	358.27	346.72	359.55	333.98	22.39
Back	309.60	331.93	325.93	310.82	304.22	15.04
Wings	180.27	188.38	181.38	181.82	179.77	8.01
Shanks	73.22^{ab}	85.65^{a}	76.98^{ab}	71.43^{b}	74.77^{ab}	4.16
Thighs	197.55^{ab}	229.82^{a}	204.88^{ab}	205.43^{ab}	195.77^{b}	10.31
Drumstick	186.55^{b}	223.32^{a}	200.93^{ab}	197.22^{ab}	190.55^{ab}	10.53
Liver	3.04	2.88	2.87	2.95	2.81	0.14
Heart	0.64	0.53	0.70	0.49	0.49	0.11
Gizzard (Full)	3.64	3.65	3.69	3.91	3.75	0.81
Gizzard (Empty)	2.62	2.54	2.68	2.84	2.67	0.12

*Means on the same row with different superscripts are significantly (P<0.05) different; *organ weights are expressed as % of live weight.

crayfish waste meal as replacement for fish meal in the diets of broiler chickens were significantly improved. It ranged from 71.01 to 86.18% for 100% crayfish waste meal and 100% fish meal. Improved ileal CP digestibility coefficient observed in the present study showed that frog meal is high in digestible nutrient and therefore enhanced digestion, absorption and utilisation of nutrients. The result of carcass characteristics of birds on graded levels of frog meal in broiler diet is shown in Table 6. There were no significant differences recorded in the live weight, dressed weight and eviscerated weight, neck, breast, back, wings, liver, heart and gizzard weights of birds fed experimental diets. This is probably an indication that frog meal had identical protein quality with fish meal. Similar finding was reported by Ojewole *et al*. (2005) on the organ weights of birds fed three different animal protein sources. According to Rosenfeld *et al*. (1997) effect of different levels of shrimp meal was not pronounced on the carcass yield of broilers but carcass weight was significantly higher for 100% substitution of shrimp meal for soybean meal. Inclusion of FRM in broiler ration significantly ($P<0.05$) influenced the weights of head, shanks, thighs and drumstick of birds on dietary treatments. The head and drumstick of birds on varying levels of FRM diets were similar. Shanks and thighs of birds on FRM diets were comparable to those of birds on the control diet. This suggests that FRM diet was adequately utilised. Numerically, the inclusion of FRM in the diet increased the meatiness of the birds as reflected by the increased live and dressed weights, as well as weights of thigh and drumstick observed in this study.

CONCLUSION

The result of this study showed that chemical composition of FRM was similar to that of FM. The feed intake, protein intake, protein efficiency ratio, ileal and excreta crude protein digestibility of birds were significantly influenced by the dietary treatments. Also, inclusion of FRM in the diet increased the meatiness of the birds as reflected by the increased live and dressed weights, as well as weights of thigh and drumstick. It is concluded that frog meal can replace fish meal up to 100% in broiler diets without compromising birds' performance.

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CONFLICTS OF INTEREST

Authors declared that there is no conflict of interest as regards the conduct and results emanated from this study

REFERENCES

Achionye-Nzeh, G. C., Ogidiolu, O. and Salami, S. 2003. Effects of Dietary Inclusion of *Rana esculenta* on the Growth of *Clarias anguillaris* L. *J. Agric. Res. Dev*., 2: 120-121.

Aduku, A.O. 1993. (Unplished). Tropical Feedstuff. Analysis Table. Ahmadu Bello University, Zaria, Nigeria.

Agboola, A.F. 2011. Precaecal digestible crude protein and amino acids in some conventional feedstuffs in broiler starter diets. *Ph.D thesis*, University of Ibadan, Animal Science Department; pp 32-50.

Ali, M.A., Islam, M.A., Beg, M.A.H. and Howlider, M.A.R. 1995. Performance of White Leghorn and Rhode Island Red breeds on Diets with Frog meal. *Indian J. Anim. Res*., 29 (1): 43-48.

AOAC. 2000. Association of Official Analytical Chemists. Official methods of analysis, 16th Ed. Arlington, VA, USA.

Ariyani, F., Hak, N. and Putro, S. 1984. Utilisation of Frog Waste for Feed. *Lap. Pen. Teknol. Perik. Rep. Fish. Technol.*, 36: 1-7.

Asafa, A.R., Ologhobo, A.D. and Adejumo, I.O. 2012. Effect of Crayfish Waste Meal on Performance Characteristics and Nutrient Retention of Broiler Finishers. *Int. J Poult Sci*, 11: 496-499.

Barg, U. and Phillips, M.J. 1997. Environment and sustainability. In Review of the State of World Aquaculture 1997. FAO Fisheries Circular 886. Rome*: Food and Agriculture Organization of the United Nations.*

Barlow, S. M. 2000. Fishmeal and fish oil: Sustainable feed ingredients for aqua- culture. *The Global Aquaculture Advocate* 3 (2): 85–86.

Brandt, M. and Allam, S.M. 1987. "Analytik von TiO_2 im Darminhalt und Kot nack KjeldahlaufschluB." *Archives of Animal Nutrition* 37: 453 – 454.

Crouse, J.R., Morgan, T., Terry, J.G., Ellis, J., Vintolins, M. and Burke, G.L. 1999. A randomized trial comparing the effect of casein with that of soy protein containing varying amounts of isoflavones on plasma concentrations of lipids and lipoproteins. *Archives of Internal Medicine* **159**:2070-2076.

Duncan, D.B. 1955. Multiple range and multiple F-test. Biometrics, 11: 1-42.

Fagbenro, D., Balogun, B., Ibironke, N. and Fasina, F. 1993. Nutritional Value of Some Amphibian Meals in Diets for *Clarias gariepinus* (Burchell 1822). *J. Aquacult. Trop*., 8 (1): 95-101.

Fanimo, A.O., Mudama, E., Umukoro, T.O. and Oduguwa, O.O. 1996. Substitution of Shrimp Waste Meal for Fish Meal in Broiler Chicken Rations. *Trop. Agri.c* (Trinidad). 73: 210-205.

Fanimo, A.O, Oduguwa, O.O., Jimoh, Y.O. and Faronbi, A.O. 1998. Performance and Carcass Evaluation of Broiler Chicks fed Shrimp Waste Meal Supplemented with Synthetic Amino Acids. *Nig. J Anim. Prod.*, 25: 17-21.

Gernat, A.G. 2001.The Effect of Using Different Levels of Shrimp Meal in Laying Hen Diets. *Poult. Sci,* 80: 633- 636.

Hasan, M. R., Alam, M. G. M. and Islam, M. A. 1989. Evaluation of some indigenous ingredients as dietary protein sources for catfish (*Clarias batrachus*, Linnaeus) fry. *In: Proc. Asian seminar on aquaculture*, IFS, Malang, Indonesia, 14-18 Nov. 1988, 125-137.

Hoffman, J.R. and Falvo, M.J. 2004. Protein – Which is best? *Journal of Sports Science and Medicine*. **3:**118-130.

Huang, K.H., Ravindran, V., Li, X. and Bryden, W.L. 2005. "Influence of Age on the Apparent Ileal Amino acid Digestibility of Feed Ingredients for Broiler Chickens." *British Poultry Science* 46: 236 – 245.

Islam, M.A., Hossain, M.D., Balbul, S.M. and Howlider, M.A.R. 1994. Unconventional Feeds for Broilers. *Indian Vet. J.*, 71 (8): 775-780.

Oduguwa, O.O., Fanimo, O.A., Olayemi, O. and Oteri, N. 2004. The Feeding Value of Sun- Dried Shrimp Waste- Meal Based Diets for Starter and Finisher Broilers. *Arch. de Zootec, ano/vol.* 53, numero 201, pp: 87-90.

Ojewola, G.S. and Udom, S.F. 2005. Chemical Evaluation of the Nutrient Composition of Some Unconventional Animal Protein Sources. *Int. J. Poult. Sci*. 4(10): 745-747.

Ojewola, G.S., Okoye, F.C. and Ukoha, O.A. 2005. Comparative Utilization of Three Animal Protein Sources by Broiler Chickens. *Int. J Poult. Sci*. 4: 462- 467.

Perttilä, S., Valaja, J., Partanen, K., Jalava, T. 2001. "Effect of volume-weight on apparent ileal and excreta amino acid digestibility and feeding value of barley for poultry." *J. Anim. Feed Sci.* 10: 671 – 685.

Ravindran V., Hew, L.L., Ravindran, G. and Bryden, W.L. 1999. A comparison of ileal digesta and excreta analysis for the determination of amino acid digestibility in food ingredients for poultry. *Br. Poult. Sci*. 40: 266 – 274.

Rodehutscord, M., Kapocius, M., Timmler, R. and Dieckmann, A. 2004. "Linear Regression Approach to Study Amino acid Digestibility in Broiler Chickens" *Br. Poult. Sci*. 45: 85 – 92.

Rosenfeld, D.J., Gernat, A.G., Marcano, J.D., Murillo, J.G., Lopez, G.H. and Flores, J.A. 1997. The Effect of Using Different Levels of Shrimp Meal in Broiler Diets. *Poult. Sci*, 76: 581-587.

Rostagno H.S., Pupa, J. and Pack, M. 1995. Diet Formulation for Broilers Based on Total versus Digestible Amino acids. *J. Appl. Poult. Res*. 4: 293 – 299.

SAS, 2012. Statistical Analytical Software Users Guide Statics. Version 8.2. Ed. SAS institute Inc, Cary, NC, USA.

Tokur, B., Gurbuz, R. D. and Ozyurt, G. 2008. Nutritional composition of frog (*Rana esculanta***)** waste meal. *Bioresource Technol*., 99 (5): 1332-1338.