ISSN 1819-1878

Asian Journal of Animal Sciences

http://knowledgiascientific.com

Knowledgia
SCIENTIFIC
A Place to Publish Outstanding Research

Asian Journal of Animal Sciences 2 (2): 58-63, 2008
ISSN 1819-1878

Performance of Broiler Chickens Fed Fish and Shrimp Wastes

[1]J.N. Ingweye, [2]B.I. Okon, [3]J.A. Ubua and [2]A.I. Essien
[1]G.P.O. Box 3385, Calabar, Cross River State, 540001, Nigeria
[2]Department of Animal Science, University of Calabar, P.M.B. 1115, Calabar, Nigeria
[3]Department of Agricultural Education, Cross River University of Technology, Akamkpa Campus, Akamkpa, Cross River State, Nigeria

Abstract: The effects of replacing fish waste meal with shrimp waste meal at five levels (0, 25, 50, 75 and 100%) on broiler chicken performance was studied in a feeding trial involving 204 Anak breed of day-old. Chicks fed iso-nitrogenous and iso-caloric diets (23%) crude protein and 2800 kcal (ME)/KG and 20% crude protein and 3000 kcal (ME) kg^{-1} for the starter and finisher phases, respectively). The birds were shared into five treatment groups and one control of 34 birds each. All the birds were fed and watered *ad libitum* throughout the 56 days experimental period. Daily feed intake and weekly weight gain were recorded. Average weekly feed intake was not significant ($p>0.05$). The 0% replacement level had the best ($p<0.05$) weight gain (212.20 g±9.73 and 520-439±28.61 for the starter and finisher phases respectively), while the 100% level had the least ($p<0.05$) weight gain in both phases. The percent liver, gizzard, abdominal fat, drumsticks and breast were significantly ($p<0.05$) affected by treatment application. Feed conversion ratio was best ($p<0.05$) at the 0% level (i.e 1.67±0.12) for the combined phase while the poorest value was recorded for the 100% level in the combined phase. The replacement of fish waste meal with shrimp waste meal was directly proportional to the feed consumption rate, feed conversion ratio and organ weights but indirectly proportional to weight gain. Findings suggest that the 0%, control and 25% level of replacement of fish waste meal with shrimp waste meal were optimum for broiler chicken performance.

Key words: Broiler, chicken, performance, replacement level, shrimp waste, fish waste

INTRODUCTION

Animal protein consumption in developing countries is far below the minimum figure recommended by the Food and Agriculture Organization (FAO). One of the causes is the low supply level of livestock products especially in countries like Nigeria (RIM, 1992; FMEDR, 2000). One of the major problems hampering the production and supply of livestock products, especially monogastrics is feed, which accounts for about 80% of cost of production (Fanimo *et al*., 2007). Fish meal, a conventional animal protein source in poultry diets is very expensive. This, therefore, has created need for new, cheap and non-conventional animal protein sources, not competed for by man and easily available and in large quantity for poultry farmers. Shrimp waste and fish waste, both by-products of shrimp and fish processing unfit for human consumption, fit this description, (Nigeria Agro Vet News, 1994; Rosenfeld *et al*., 1997; Fanimo *et al*., 1998). Shrimp waste meal is the dried and milled waste of shrimp industry consisting of the heads, hells (shells) and appendages of shrimp (Fanimo *et al*., 1998). Fish waste meal is the dried milled pieces of fish flesh, bones, heads scales and fins resulting from fish processing (Rosenfeld *et al*., 1997). The complete use of wastes as animal protein sources will drastically reduce the cost of poultry than if conventional fish meal was replaced

Corresponding Author: J.N. Ingweye, G.P.O. Box 3385 Calabar, Cross River State, 540001, Nigeria

by any one of the wastes alone. Therefore, this study was designed to evaluate the use of fish waste meal in combination with shrimp waste meal as animal protein sources in poultry diets.

MATERIALS AND METHODS

The study was carried out at the University of Calabar Teaching and Research Farm, Faculty of Agriculture, University of Calabar between October and December. Calabar is the administrative and political capital of Cross River State, Nigeria and is located at latitude 04.57°N and longitude 08.20°E.

Day-old chicks of Anak breed, certified healthy by a veterinarian, numbering 204 were used for this study. They were randomly shared into six groups of five treatments and one control of 34 birds each, subdivided into two replicates of 17 birds each. All the experimental groups were balanced on initial weight basis. Allocation to treatment groups was based on the Completely Randomized Design (CRD) format (2×17×6). Treatment groups consisted of replacing fish waste meal with shrimp waste meal at 0, 25, 50, 75 and 100% levels with the conventional fish meal based diet as the control. The study period was broken into two phases viz., Starter (0-28th day) and finisher (29th-56th day) of age of the birds. Iso-caloric (2800 and kcal (ME) kg^{-1} for the starter and finisher diets, respectively) and iso-nitrogenous (23 and 20% crude protein for the starter and finisher diets, respectively) were formulated for the birds as shown in Table 1. The birds were housed in a deep litter house with space allowance of 8.33 birds/square meter littered with wood shavings and 24 h light photo regiment. They were fed and watered *ad libitum* and put through routine medication and hygiene practices as stipulated by Seifert (1996). The fish waste and shrimp waste were sun-dried on a concrete slab for three days to a constant weight and milled to powder. The test ingredients and compound diets were analyzed for their proximate constituents using the methods of AOAC (1995). The body weights of birds were taken once a week before morning feeding and data obtained for the feed intake, weight gain and feed conversion ratio were subjected to Analysis of Variance (ANOVA) (Steel and Torrie, 1980), while Duncan Multiple Range Test (DMRT) (Duncan, 1955) was used to test the difference between and among treatment means.

RESULTS AND DISCUSSION

The results show that the crude protein content of fish meal, fish waste meal and shrimp waste meal were 63.2, 58.5 and 48.3%, respectively (Table 2). Those of fish meal and fish waste meal were similar to those reported by Fanimo *et al*. (2000) and Dale (2004), respectively. The crude protein value of shrimp waste meal was higher than that published by Oduguwa *et al*. (1998) for sun-dried shrimp waste. The two types of meals are made from different types of fish which vary in their crude protein value. The crude fiber value ranged from 0.82% in fish meal to 13.8% in shrimp waste meal. That of shrimp waste meal was higher than the values reported by Fanimo *et al*. (1996). This could be because chitin was not separated from the fiber component as in the reported literature. The ether extract were 7.38% (fish meal), 10.56% (fish waste meal) and 6.30% (shrimp waste meal). Ether extract values for fish meal and shrimp waste meal were close to those reported in the literature (Fanimo *et al*., 1996, 2000), however, that of fish waste meal was higher than that reported by Dale (2004) and could be explained by the method of processing used to turn the fish waste to a meal as each method leaves different quantity of residual oil in the meal. The highest ash content (22.71%) was recorded for fish waste meal. This was more than values reported for fish meal (Fanimo *et al*., 2000). This may be because fish waste has higher bone and scales contents than conventional fish meal.

The 0% replacement level weight gain was the best ($p<0.05$) in the starter (212.2±9.73 g/bird) and finisher (520.43±28.61 g/bird) phases, though not different ($p<0.05$) from the weight gain of the control and 25% groups. The 100% replacement level had the least ($p<0.05$) weight gain

Table 1: Gross composition of experimental diets (g kg^{-1})

Ingredients	Starter diets: Replacement levels of shrimp waste meal (%) Control	0	25	50	75	100
Maize	509.70	496.60	496.30	484.00	477.70	479.70
Soybean meal	340.30	353.40	353.40	353.40	353.40	353.40
Fish meal	80.00	-	-	-	-	-
Fish waste meal	-	80.00	60.00	40.00	20.00	0.00
Crayfish waste meal	-	0.00	26.30	52.60	78.90	96.90
Wheat offal	30.00	30.00	30.00	30.00	30.00	30.00
Bone meal	20.00	20.00	20.00	20.00	20.00	20.00
Palm oil	10.00	10.00	10.00	10.00	10.00	10.00
Salt	5.00	5.00	5.00	5.00	5.00	5.00
Premix	5.00	5.00	5.00	5.00	5.00	5.00
Determined						
Dry matter	930.10	925.00	928.00	932.00	937.80	940.20
Crude protein	231.10	231.20	233.00	234.10	230.10	229.60
Crude fibre	20.10	28.10	36.00	40.10	48.50	49.20
Ether extract	39.80	50.60	39.90	38.20	37.30	36.00
Metabolizable energy (kcal (ME) kg^{-1})	2810.00	2840.00	2800.00	2790.00	2776.00	2752.00
	Finisher diets: Replacement levels of crayfish waste meal (%)					
Ingredients	Control	0	25	50	75	100
Maize	562.60	556.10	554.00	551.90	549.70	547.70
Soybean meal	307.40	313.90	313.90	313.90	313.90	313.90
Fish meal	-	-	-	-	-	40.00
Fish waste meal	-	40.00	30.00	20.00	10.00	0.00
Crayfish waste meal	-	0.00	12.10	24.20	36.40	48.40
Wheat offal	50.00	50.00	50.00	50.00	50.00	50.00
Bone meal	20.00	20.00	20.00	20.00	20.00	20.00
Palm oil	10.00	10.00	10.00	10.00	10.00	10.00
Salt	5.00	5.00	5.00	5.00	5.00	5.00
Premix	5.00	5.00	5.00	5.00	5.00	5.00
Determined						
Dry matter	928.10	920.30	923.309	928.60	931.80	939.50
Crude protein	201.30	202.20	203.00	204.80	201.20	199.60
Crude fibre	28.10	34.50	43.30	45.50	52.00	54.90
Ether extract	38.90	49.80	37.60	36.90	33.50	32.00
Metabolizable energy (kcal (ME) kg^{-1})	3047.00	3100.00	2980.00	2950.00	2892.00	2890.00

Table 2: Proximate composition of test ingredients (%)

Ingredients	Fish meal	Fish waste meal	Shrimp waste meal
Dry matter	93.21	90.30	90.58
Crude protein	63.20	58.50	48.30
Crude fibre	0.82	1.00	13.30
Ether extract	7.38	10.56	6.30
Ash	19.80	22.71	17.55
Energy (MJ kg^{-1})	12.92	13.71	10.86

of 90.55±3.91 and 304.62±19.20 g/bird for the starter and finisher phases, respectively (Table 3). This was not different ($p>0.05$) from that of the 75 and 50% replacement levels in both phases. The weight gain figures were generally lower than those reported in various literatures (Ojewole and Longe, 2000; Fanimo *et al*., 1996; Oduguwa *et al*., 1998). This could be due to the growth rate of the strain of birds as observed by Oke (1965). Also, the initial slow growth rate as the quantity of shrimp waste meal increases in the diet could be due to the inability of the birds to handle effectively the highly chitinous

Table 3: Performance characteristics of birds fed experimental diets

	Replacement levels of shrimp waste meal in diets (%)					
Parameters	Control	0	25	50	75	100
Starter phase (0-28 days)						
Weight gain (g/bird)	191.43±6.06^{a}	212.21±9.73^{a}	125.52±5.69^{ab}	92.68±3.55^{b}	91.55±3.68^{b}	90.55±3.91^{b}
Feed consumption (g/bird)	296.15±36.55	301.74±40.12	308.41±50.23	316.87±43.11	321.62±51.22	328.85±41.21
Feed conversion ratio	1.54±0.11^{b}	1.45±0.12^{b}	2.41±0.19^{ab}	3.28±0.23^{a}	3.42±0.41^{a}	3.50±0.22^{b}
Mortality (%)	2.94±0.02	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
Finisher phase (29-56 days)						
Weight gain (g/bird)	462.78±20.11^{a}	520.43±28.61^{a}	394.83±23.99^{ab}	355.16±22.11^{b}	341.15±20.98^{b}	304.62±19.20^{b}
Feed consumption (g/bird)	947.49±76.98	987.19±79.06	1010.68±84.60	1015.56±74.16	1041.54±70.07	1048.13±69.79
Feed conversion ratio	2.06±0.19^{d}	1.90±0.13^{d}	2.54±0.31^{c}	2.84±0.28^{bc}	3.02±0.33^{b}	3.42±0.25^{a}
Mortality (%)	2.94±0.01	0.00±0.00	8.82±0.01	2.94±0.03	2.94±0.21	0.00±0.00
Combined phase (0-56 days)						
Weight gain (g/bird)	327.39±18.06	366.34±27.19	260.18±17.54	223.92±16.72	216.35±16.58	197.39±15.91
Feed consumption (g/bird)	621.82±71.33	644.47±65.31	647.05±70.00	666.21±68.11	681.58±59.01	688.49±57.08
Feed conversion ratio	1.79±0.12^{c}	1.67±0.21^{c}	2.48±0.19^{b}	3.06±0.23^{ab}	3.22±0.29^{a}	3.46±0.31^{a}
Mortality (%)	5.88±0.02	0.00±0.00	8.82±0.01	2.94±0.02	2.94±0.02	0.00±0.00

Mean values within rows not carrying the same super scripts are significantly different ($p<0.05$)

diets at that tender age as explained by Fanimo *et al*. (1996). The feed intake range from 296.15±36.55 to 328.85±41.21 g/bird, 947.49±76.98 to 1048.13±69.79 g/bird and 621.82±71.33 to 688.49±57.08 g/bird for the starter, finisher and combined phases respectively.

Generally, feed intake values were non significant ($p>0.05$) and lower than reported values (Fanimo *et al*., 1996, 1998). The trend reflects the slower rate of gain.

The feed conversion ratios were best ($p<0.05$) at the 0% replacement level for all the phases i.e., 1.45±0.12, 1.90±0.13 and 1.67±0.12 for the starter, finisher and combined phases respectively. These were not different ($p>0.05$) from the control in all the phases. The worst values ($p<0.05$) were 3.50±0.22, 3.42±0.25 and 3.46±0.31 for the starter, finisher and combined phases respectively, recorded for the 100% replacement level. These values were not different ($p>0.05$) from the values of the 75 and 50% levels in the combined phase only. The trend has confirmed results reported in reviewed literature (Obun and Ayanwale, 2008; Fanimo *et al*., 1996, 1998). Feed conversion ratio was inversely related to the feed intake. Also, as the level of shrimp waste in the diet increased, feed conversion ratio increased. This could be as a reflection of increasing feed intake and decreasing weight gain.

The terminal live weight range from 1935.23±250.58 to 2163.03±155.57% while the plucked weight, plucked weight percentage, dressed weight and dressing percentage range from 1750.95±243.32 to 1996.28±148.91 g, 90.66±2.99 to 94.20±6.50%, 1327.91±191.32 to 1564±186.63 g and 68.62±4.11 to 72.77±3.22%, respectively (Table 4). These figures are higher than those obtained by Fanimo *et al*. (1996, 1998), except the percent plucked weight and dressing weight. All were not significant. The relative composition of the carcass indicates that the shanks, head, intestine, heart, neck, wings, thighs and back, though non-significant ($p>0.05$) range from 4.34±0.13 to 4.74±0.20%, 2.28±0.21 to 2.63±0.37%, 6.77±0.11 to 8.39±0.12%, 0.53±0.02 to 0.72±0.01%, 5.35±0.18 to 8.12±0.17%, 14.34±0.62 to 19.64±0.55%, 11.86±0.86 to 14.72±0.66% and 13.57±0.99 to 14.76±0.23%, respectively. The trend of the values is similar to those reviewed in literature (Rosenfeld *et al*., 1997; Umoh *et al*., 1980; Oduguwa *et al*., 1998). The percent liver, gizzard, abdominal fat, drumsticks and breast range from 2.43±0.12 to 3.17±0.15%, 2.47±0.16 to 3.45±0.15%, 1.60±0.27 to 2.42±0.26%, 11.04±0.66 to 12.69±0.59% and 11.03±0.76 to 22.34±0.89%, respectively. These values agree with Fanimo *et al*. (1996). The 100% level had the highest ($p<0.05$) liver weight which was not different ($p>0.05$) from that of the 75 and 50% replacement levels while the control had the least ($p<0.05$) liver weight which was not different ($p>0.05$) from the 0% replacement level. The same trend was observed for the gizzard weight. This is not unconnected with the role of the liver in

Table 4: Gross carcass evaluation of birds fed experimental diets

	Replacement levels of crayfish waste meal in diets (%)					
Parameters	Control	0	25	50	75	100
Mean terminal live weight (%)	2162.78±212.38^{NS}	2163.03±155.57^{NS}	2090.28±179.14^{NS}	2020.23±193.52^{NS}	2017.70±218.14^{NS}	1935.23±250.58^{NS}
Plucked weight (g)	1989.48±216.70^{NS}	1996.28±148.91^{NS}	1913.10±169.14^{NS}	1903.08±186.93^{NS}	1829.18±181.03^{NS}	1750.95±243.32^{NS}
Plucked weight (%)	91.99±5.61^{NS}	92.29±3.63^{NS}	91.52±4.08^{NS}	94.20±6.50^{NS}	90.66±2.99^{NS}	90.48±3.52^{NS}
Dressed weight (g)	1564.00±186.63^{NS}	1528.81±153.31^{NS}	1484.13±150.91^{NS}	1490.14±148.09^{NS}	1411.43±184.96^{NS}	1327.91±191.32^{NS}
Dressed (%)	72.35±3.58^{NS}	70.68±3.01^{NS}	71.00±4.10^{NS}	72.77±3.22^{NS}	69.95±3.66^{NS}	68.82±4.11^{NS}
Carcass relative composition (%)						
Shanks	4.41±0.26^{NS}	4.74±0.20^{NS}	4.48±0.18^{NS}	4.39±0.21^{NS}	4.51±0.19^{NS}	4.34±0.13^{NS}
Head	2.38±0.35^{NS}	2.56±0.36^{NS}	2.41±0.29^{NS}	2.39±0.33^{NS}	2.28±0.21^{NS}	2.63±0.37^{NS}
Intestine	7.14±0.18^{NS}	8.39±0.12^{NS}	7.47±0.22^{NS}	7.49±0.13^{NS}	6.77±0.11^{NS}	7.14±0.23^{NS}
Liver	2.43±0.12^{b}	2.46±0.12^{b}	2.79±0.11^{ab}	2.85±0.13^{a}	3.17±0.15^{a}	3.45±0.10^{a}
Heart	0.53±0.02^{NS}	0.54±0.08^{NS}	0.56±0.03^{NS}	0.62±0.04^{NS}	3.45±0.10^{NS}	0.72±0.01^{NS}
Gizzard	2.47±0.16^{a}	2.52±0.16^{b}	2.95±0.13^{ab}	3.05±0.12^{a}	3.26±0.13^{a}	3.45±0.15^{a}
Abdominal fat	1.60±0.27^{b}	2.26±0.24^{a}	1.75±0.21^{b}	1.94±0.23^{ab}	2.18±0.16^{a}	2.42±0.26^{a}
Neck	5.35±0.18^{NS}	5.95±0.19^{NS}	6.43±0.21^{NS}	6.64±0.20^{NS}	7.44±0.18^{NS}	8.12±0.17^{NS}
Wings	14.34±0.62^{NS}	19.64±0.55^{NS}	16.03±0.48^{NS}	15.91±0.47^{NS}	16.14±0.38^{NS}	17.67±0.51^{NS}
Drumsticks	11.04±0.66^{b}	12.69±0.59^{a}	11.09±0.62^{b}	10.80±0.48^{b}	11.21±0.71^{b}	11.51±0.52^{b}
Thighs	14.72±0.66^{NS}	12.79±0.60^{NS}	13.21±0.72^{NS}	12.24±0.50^{NS}	13.05±0.30^{NS}	11.86±0.86^{NS}
Breast	19.80±0.87^{a}	22.34±0.89^{a}	15.77±0.83^{ab}	14.19±0.45^{b}	11.03±0.76^{b}	12.26±0.91^{b}
Back	14.76±0.23^{NS}	13.57±0.99^{NS}	14.15±0.87^{NS}	13.62±1.01^{NS}	13.59±0.76^{NS}	13.82±0.89^{NS}

Mean values within rows not carrying the same superscripts are significantly different ($p<0.05$); NS = Non significant

nutrient (especially chitin) metabolism and very high muscular activity of the gizzard as a result of the digestion of highly chitinous shrimp waste. The 100% replacement level had the highest ($p<0.05$) abdominal fat which was not different from that of 75 and 0% replacement levels whereas the least ($p<0.05$) was recorded for the control which was not different from the 25% replacement level. The high abdominal fat value in the 0, 75 and 100% levels relative to others when crude protein inclusion in diets was not up to 10%, which makes protein still necessary for growth, cannot be readily explained. The lower the level of shrimp waste meal in the diet, the better the percentage weight of drumsticks with the least ($p<0.05$) value recorded for the 50% level. This was not different ($p>0.05$) from the 25, 75 and 100% and the control. The percentage breast was highest ($p<0.05$) in the 0% level though not different ($p>0.05$) from the control while the least ($p<0.05$) percent drumsticks were observed in the 75% level. Oluyemi and Roberts (2000) reported that the breast and drumsticks were the most economically important portions of the carcass. In this study, their best ($p<0.05$) values were obtained in diets not containing shrimp waste meal. This observation agrees with Parr *et al*. (1998). It, however, indicates that fish waste meal and fish meal were of a higher biological value than shrimp waste meal.

Mortality rate of 2.94% was observed for the control in the starter phase, 50%, 75% and control groups in the finisher phase and 50% as well as 75% in the combined phase while the 25% group recorded 8.82% mortality at the finisher and combined phases. The deaths had no defined pattern and could be attributed to Newcastle disease attack in the 4th week as indicated by post-mortem findings and not due to treatment administration. The mortality rates were, however, within the acceptable limits.

CONCLUSION

The aim of this study was to evaluate the usefulness of combining fish waste meal and shrimp waste meal as animal protein sources in chicken feed. Findings suggest that it is possible and feasible. If carried out, the use of these by-products and wastes of fish and shrimp processing would help to reduce the percentage of fish and shrimp wasted during processing, prevent environmental pollution, provide another alternative to fish meal and decrease the cost of chicken meat on the dining table of the consumer.

REFERENCES

AOAC., 1995. Association of Official Analytical Chemists. Official Method of Analysis. 16th Edn. Washington DC, USA.

Dale, M.N., 2004. Alternatives to soybean meal. Poultry tips for the year University of Georgia. Poult. Sci., 44: 19-22.

Duncan, D.B., 1955. Multiple range multiple F-test. Biometric, 11: 1-11.

Fanimo, A.O., E. Mudama, T.O. Umukoro and O.O. Oduguwa, 1996. Substitution of shrimp waste meal for fish meal in broiler chicken rations. Trop. Agric. (Trinidad), 73: 201-205.

Fanimo, A.O., O.O. Oduguwa, Y.O. Jimoh and A.O. Farronbi, 1998. Performance and carcass evaluation of broiler chicks fed shrimp waste meal supplemented with synthetic amino acids. Nig. J. Anim. Prod., 25: 17-21.

Fanimo, A.O., O.O. Oduguwa, A.O. Onifade and T.O. Olutunde, 2000. Protein quality of shrimp waste meal. Bioresour. Technol., 72: 185-188.

Fanimo, A.O., A.J. Adebayo, O.O. Oduguwa and W.O. Biobaku, 2007. Feeding value of cashew nut testa for broiler chickens. Nig. J. Anim. Prod., 34: 83-93.

FMEDR, 2000. Federal Ministry of Economic Development and Reconstruction. 3rd National Development Plan (1975-1980).

Nigeria Agro-Vet News, 1994. Summary of activities of Nigeria Institute of Oceanography and Marine Research Jan/Feb 1994. 1: 6.

Obun, C.O. and B.A. Ayanwale, 2008. Performance, nutrient digestibility and cost evaluation of raw and roasted *Afzelia africana* seed meal fed finishing broiler chicks. Nig. J. Anim. Prod., 35: 9-17.

Oduguwa, O.O., A.O. Fanimo, E.A. Iyayi, O.O. Kaleijaye and O.A. Oyekola, 1998. Preliminary studies on the effects of different processing methods on the nutritive value of shrimp waste meal. Nig. J. Anim. Prod., 25: 139-144.

Ojewole, G.S. and O.G. Longe, 2000. Carcass yield and quality of Broiler Chicken fed varying protein levels. Global J. Pure Applied Sci., 6: 407-407.

Oke, O.L., 1965. Nutritional studies on Nigerian Tubers. West Afr. Pharm., 65: 10-113.

Oluyemi, J.A. and F.A. Roberts, 2000. Poultry Production in Warm Wet Climates. 2nd Edn. Spectrum Books, Ibadan, pp: 190.

Parr, W.H., B.S. Capper, D.R.S. Cot, K.J. Jewers, A.D. Marter, W.N. Nichols, D.R.S. Silvey and J.F. Wood, 1998. Small Scale Manufacture of Compound Animal Feed. Overseas Development Natural Resource Institute (ODNRI) Bull., 9: 135-260.

RIM, 1992. Resource, Inventory and Management Limited. Nigeria Livestock Resource. Vol. 1, Executive Summary.

Rosenfeld, D.J., A.G. Gernat, G.H. Lopez and J.A. Flores, 1997. The effect of different levels of shrimp meal in broiler diets. Poult. Sci., 76: 581-587.

Seifert, H.S.H., 1996. Tropical Animal Health. Kluwer Academic Publishers, Boston, London, UK., pp: 44.

Steel, R.G.D. and. J.H. Torrie, 1980. Principles and Procedures of Statistics. 2nd Edn. A Biometric Approach McGrawHill, New York, pp: 33.

Umoh, I.B., E.O. Ayalogu and O. Bassir, 1980. Evaluation of the nutritive value of some lesser known protein sources in Nigeria peasant diets. Ecol. Food Nutr., 8: 81-86.