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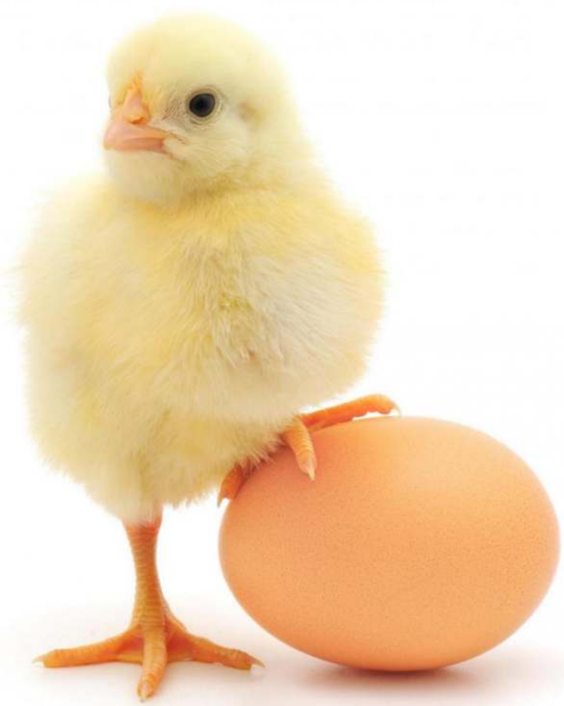

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Comparative Utilization of Three Animal Protein Sources by Broiler Chickens

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Abstract: The effect of including three unconventional animal protein sources in broiler ration was investigated. One hundred and fifty (150) unsexed day-old broiler chicks of Anak Strain were randomly allocated to 5 dietary treatment, each having 3 replications of 10 chicks in a completely randomized design (CRD). Diets 2,3,4 and 5 respectively contained 2.5% of Danish fish meal, locally processed fish meal (fish waste meal), crayfish waste meal, and grasshopper meal, while Diet 1 (control) had no animal protein. Each diet was offered *ad-libitum* to the birds for a period of 49 days. The results showed that, absence of animal protein in diet 1 significantly ($p < 0.05$) depressed feed to-gain ratio (3.40). Diets 3, 4 and 5 were similar to Diet 2, which had feed-to-gain ratio of 2.47. The percentages of the gizzards, livers, kidneys and hearts were not significantly ($p > 0.05$) affected, an indication that satisfactory animal protein can be prepared from these unconventional sources. The percent carcass proximate composition and gross energy were significant ($p < 0.05$), but followed no definite pattern. The percent nitrogen and energy retained were not significantly ($p > 0.05$) but others were. Significant ($p < 0.05$) higher savings (N213.84) was obtained with the use of Danish fish meal, followed by birds fed diets 5 (N206.64), 4 (N196.71) 3 (N175.74) and 1 (N130.24) respectively. Data from this study indicated that locally processed fish meal, crayfish waste meal, and grasshopper meal can serve as a natural substitute for the imported, expensive and unavailable Danish fish meal without negatively effecting performance and economic returns on broiler production.

Key words: Animal protein, broiler ration, alternative protein sources

Introduction

The search for alternative protein sources of feed ingredients as a partial or complete substitute to fish meal, a conventional costly ingredient in poultry rations has been long and tortuous. Demand for feed grade fish and fish meal significantly exceeds availability. Also due to the hazards of pathogenic salmonella contamination of late, most poultry feeds, especially breeder rations, are being formulated without supplementation of fish ingredients. According to Ravinder *et al.* (1996), by-products like meat meal, liver residue meal, silk worm pupae meal, etc; though only available in small quantities, have served to bridge the gap in supply of animal protein sources as well as to lower feed costs. Other unconventional protein sources that had been used at various times include maggots from poultry droppings (Atteh and Oyedeji, 1990); housefly-pupa meal (El-Boushy, 1991); Spent-Sorghum-mash fermented with *Ruminococcus flaveciens* (Abasiekong, 1991); Poultry offal meal (POM) and chicken offal meal (COM), waste products from poultry eviscerating plants (Udedibie *et al.,* 1988; Salami, 1997) and Shrimp waste meal (SWM) (Nwokoro, 1993; Fanimo *et al.,* 1996; Rosenfeld *et al.,* 1997); grasshopper meal (Aduku, 1993) and crustacean, such as squilla (*Orato Squilla nepa*), a novel animal protein (Ravinder *et al.,* 1996). Unconventional feed ingredient as marine waste (MW), and frog waste (FW) are also available for use. The use of agro-industrial by-products to substitute the scarce and expensive conventional feedstuffs towards reducing feed cost has also been widely recognized (Eshiet and Ademosun, 1981; Atteh and Ologbenla, 1993). The need for alternative animal protein sources has also attracted a closer look at locally produced fish meal, crayfish waste meal and grasshopper meal. The objective of the present study was to determine the extent to which these protein sources could be used to support satisfactory performance in broiler chicks and the effects of such dietary incorporation on nutrient utilization, carcass composition and the economy of production.

Materials and Methods

Preparation of test ingredients: Prawn trawling operations off Nigerian coasts always catch thousands of tons of fish and crayfish each year. From these, Local fish meal and crayfish waste meal are often prepared. They are commonly produced in Akwa Ibom, Cross Rivers, and Rivers State, where they are transported into the hinter land. The local fish meal and crayfish waste meal were later purchased from the Local market in Umuahia, Abia State of Nigeria while grasshopper meal was produced from Grasshoppers. Grasshoppers, have become a source of concern to farmers in the northern part of Nigeria, the border towns of Nigeria - Niger Republic and the Savannah region of West Africa, where they often congregate in millions at the onset of

Table 1: Determined Composition (g/kg/Dm) of the test ingredients used in this trial

	Grasshopper meal	Crayfish waste meal	Locally Processed Fish waste meal	Danish (imported) fish meal
Crude protein	357.60	452.80	404.80	613.40
Ether extract	158.60	71.40	82.10	69.40
Crude fibre	10.60	0.00	0.00	0.00
Ash	60.20	59.80	82.10	63.20
Dry matter (%)	97.17	87.11	88.34	90.32
Gross energy (kcal kg^{-1})	1917.00	2635.00	2689.00	2614.00

harvesting period. Grasshopper were harvested from Jibia Village, Katsina State, Nigeria into jute bags which were lowered into drums containing boiled water for 5 - 10 minutes. The grasshopper (now dead) were sundried for 5 days and then milled.

Experimental diets, Birds, Management and Design: One hundred and fifty (150) unsexed day-old broiler chicks of Anak Strain were randomly divided into 5 treatment groups, each having 3 replicates of 10 chicks in a completely randomized design (CRD). The control diet (1) contained none of the test ingredients while diets 2, 3, 4 and 5 contained imported fish meal (Danish), Local fish waste meal, Crayfish waste meal and Grasshopper meal, respectively (Table 2). Each diet was offered *ad-libitum* to the birds for a period of 49 days. Feed intake for each group was recorded and feed efficiency was calculated. At the end of the sixth week, two chicks per replicate were moved to the metabolic-cage. A 3-day adjustment period followed and droppings were collected over the next 4 days. These were dried in a forced-draft oven at 80°C and then ground for analysis. Feed intake per replicate during the period was recorded. The test ingredients, rations and excreta samples were analyzed for proximate components using A.O.A.C (1990) methods.
The feed cost for producing broiler on different diets were calculated for comparison according to the procedure of Sonaiya *et al.* (1986) and Ukachuckwu and Anugwa (1995). On day 49, three chickens whose body weights were closest to mean for each group were selected, weighed after being starved overnight (> 14 hrs.) and killed by cervical dislocation. The feather of the birds were plucked after scalding in hot water at 60°C. The head and shanks were removed and the carcass was eviscerated. The birds organs were weighed. Data collected were statistically evaluated by analysis of variance (Steel and Torrie, 1980), and the Duncan's Multiple Range Test (Gomez and Gomez, 1985) was used to detect differences among means.

Results

The result of the proximate composition of the ingredients are shown in Table 1. Grasshopper meal contained 357.60g kg^{-1} CP (crude protein), 158.6g kg^{-1} EE (Ether extract), 10.60g kg^{-1} CF (Crude fibre) and 60.2g kg^{-1} Ash GE (Gross energy) value was 1917Kcal/kg. Crayfish waste meal contained 452.80 CP; 71.40 EE; 0.00 CF and 59.8g kg^{-1} ash. Local fish meal contains 404.8 CP; 82.10 EE; 0.0 CF and 82.0g kg^{-1} Ash, while Danish fish meal contained 613.4 CP, 69.40 EE, 0.00 CF and 63.2g kg^{-1} ash. The GE values for crayfish waste meal, Local fish meal and Danish fish meal were 2635, 2689, and 2614 kcal/kg, respectively.
Table 3 shows the mean daily feed intake, weight gain and feed-to-gain ratio of broiler chickens fed diets containing the different animal protein sources as substitute for fish meal. The control diet (1) group had significantly ($p < 0.05$) higher feed intake (101.56g) and poorer feed-to-gain ratio (3.40) than the others. Birds fed Diets 3, 4, and 5 which respectively contained local fish meal, crayfish waste meal and grasshopper meal compared favourably with Diet 2 which contain Danish (imported) fish meal in terms of mean weight gain and feed-to-gain ratio. But significant difference ($p < 0.05$) was observed with their mean daily feed intake. Birds fed diets 4 and 5 significantly ($P < 0.05$) consumed more feed (94.69g; 97.82g) than birds fed diets 2 (85.26g) and 3 (82.74g).
The final body weight of the birds ranged from 1510-1877.8g while the feed-to-ratios recorded for the birds fed Diets 2(2.47), 3(2.64), 4(2.60) and 5(2.62) eliated some similarity.
The result of the organ proportions are shown in Table 4. The percentages of the gizzards, livers, kidneys and hearts to body weight were not significantly ($p > 0.05$) affected by dietary treatments. Table 5 shows the proximate composition of the carcass. There were significant differences ($p < 0.05$) in the percent crude protein, ether extract, ash, dry matter and gross energy but they followed no definite pattern.
The effect of dietary treatments on the percent nutrient utilization of the broilers are shown in Table 6. The percent nitrogen and energy retained were not significant ($p > 0.05$) but others were. Diet 2 had the least percent nitrogen retained (63.45 or 634.50g/ka^{-1}), whereas, the inclusion of Local fish meal, crayfish waste meal and grasshopper meal respectively, showed an increase in nitrogen retention. Birds fed Diet 1 had the highest value (929.70g/kg^{-1}).

Table 2: Composition of diets (gkg^{-1}) containing varying animal protein fed to broiler chicks from 0 to 49 days of age

	Diets				
	1	2	3	4	5
Yellow maize	343.0	343.0	343.0	343.0	343.0
Danish Fish meal (imported)	0.0	25.0	0.0	0.0	0.0
Locally processed Fish waste meal	0.0	0.0	25.0	0.0	0.0
Crayfish Waste meal	0.0	0.0	0.0	25.0	0.0
Grasshopper meal	0.0	0.0	0.0	0.0	25.0
Fullfat Soyabean meal	300.0	300.0	300.0	300.0	300.0
Palm Kernel meal	220.0	295.0	295.0	295.0	295.0
Bone meal	30.0	30.0	30.0	30.0	30.0
Vitamin Mineral premix[1]	2.5	2.5	2.5	2.5	2.5
Salt (NaCl)	2.5	2.5	2.5	2.5	2.5
D-, L-methionine	1.0	1.0	1.0	1.0	1.0
L-Lysine	1.0	1.0	1.0	1.0	1.0
Total					
Calculated analysis	1000.0	1000.0	1000.0	1000.0	1000.0
Crude protein ($g\ kg^{-1}$)	217.9	228.9	223.5	224.7	222.3
Metabolizable Energy ($kcal/kg^{-1}$)	2908.60	2971.03	2966.75	2965.38	2947.46
Determined analysis ($g\ kg^{-1}$ dry matter)					
Crude protein	238.2	212.1	208.7	218.8	209.6
Ether extract	79.8	57.6	61.2	58.1	62.3
Crude fibre	50.2	63.2	53.7	92.4	87.6
Ash	68.9	87.7	95.0	69.4	11.49
Nitrogen Free extracts	562.9	579.4	581.4	561.3	629.0

Vitamin Mineral Premix[1] provided (per kg of diet): Vitamin A, 1500IU; Vitamin D_3, 1600IU; Riboflavin, 9.9mg; biotin, 0.25; pantothenic acid, 11.0mg; Vitamin k, 3.0mg; Vitamin B_2, 2.5mg; Vitamin B_6, 0.3mg; Vitamin B_{12}, 8.0mg; nicotinic acid, 8.0mg; Iron, 5.0mg; manganese, 10.0mg; Zinc, 4.5mg; Cobalt, 0.02mg; Selenium, 0.01 mg.

Data on the economics of production are shown in Table 7. All the parameters considered, were significant ($p < 0.05$). Diet 4 gave the highest cost per kg feed (N) value (40.47) while Diet 1 gave the least value (N34.97). Cost per kg weight gain (N) was highest ($p < 0.05$) for birds fed diet 1; diet 5 gave the least, while diets 4, 3 and 2 were similar. Gross margin (N) was highest for birds fed diet 2 (N213.84) followed by diets 5(N206.64), 4 (N196.71), 3(N175.74) and 1 (N130.24) respectively.

Discussion

The ash content was higher for local fish meal than for the others. This agrees with the findings of Olomu and Nwachukwu, (1977). The percent ether extract was highest (15.86) for grasshopper meal, followed closely by local fish meal, crayfish waste meal and Danish fish meal, respectively. Generally, proximate composition of these ingredients are comparable to other related previous reports (Fanimo *et al.,* 1996; Rosenfeld, *et al.,* 1997; Fanimo *et al.,* 1998). However, source, mode of harvesting, processing and storage may have caused some of the differences observed in composition and gross energy content of all the test ingredients (Anderson *et al.,* 1968; Apandi *et al.,* 1974).

The absence of animal protein in diet 1 may have caused the depression obtained in the birds fed the diet. This finding agrees with the observation of Rajaguru *et al.* (1966) and Olomu (1976). This is a confirmation of the fact that animal protein inclusion in broiler ration is a necessary requirement. The birds might have increased their feed intake in order to meet their nutrient requirements (Hill and Dansky, 1954), yet the requirements were not met as shown by their poor mean daily weight gain (29.92g). This agrees with previous reports such as Olomu and Nwachukwu, (1977); Oluyemi and Roberts (1979) and Olomu (1995) who observed that Fish meal, apart from being fairly rich in all amino acids, also contain unidentified growth factors such as sulfate, polypeptide and some others (Pierson *et al.,* 1979) which can be used to rectify amino acid deficiency. Like other intact proteins, it has the additional advantages of furnishing minerals, vitamins and possibly essential fatty acids (Oluyemi and Roberts, 1979). This may have accounted for its numerical superiority over the other rations.

Contrary to the observations of Rosenfeld *et al.* (1997) and Fanimo *et al.* (1998), the high ash or mineral content (especially Ca: P ratio) of the Local fish meal could have contributed positively to the nutrient economy of the diet while crayfish waste meal and grasshopper

Table 3: Feed intake, body weight gain and feed efficiency of broiler chicks fed during 0-7 weeks on diets containing varying animal protein sources

Parameter	Diets					
	1	2	3	4	5	SEM
Mean daily feed intake (g per bird per day)	101.56^{a}	85.26^{b}	82.74^{b}	94.69^{a}	97.82^{a}	1.97
Mean total feed intake (g per bird)	4976.2^{a}	4128.9^{c}	4121.0^{c}	4639.8^{b}	4793.4^{ab}	79.39
Mean initial body weight (g)	43.67	43.34	43.34	43.35	43.34	0.01^{ns}
Mean final body weight (g)	1510.0^{b}	1722.3^{ab}	1583.3^{b}	1827.8^{a}	1877.8^{a}	62.08
Mean total weight gain (g)	1466.3^{b}	1678.9^{ab}	1540.0^{b}	1784.4^{a}	1834.5^{a}	62.08
Mean daily weight gain (g per bird per day)	29.92^{b}	34.26^{ab}	31.43^{b}	36.42^{a}	37.44^{a}	1.27
Feed-to-gain ratio	3.4^{a}	2.47^{b}	2.64^{b}	2.60^{b}	2.62^{b}	0.06

abcd: Figures within same row with different superscripts differ significantly ($p < 0.05$). SEM standard error of means.

Table 4: Organ Proportions of Broiler Chickens Fed Varying Animal Protein (0-7 weeks)

		Diets					
Parameter		1	2	3	4	5	SEM
Gizzard (g)	a*	44.20	44.20	46.10	48.40	53.53	2.63^{ns}
	b*	2.04	2.22	2.22	2.30	2.49	0.14^{ns}
Liver (g)	a*	31.73	34.10	36.17	33.03	36.73	1.92^{ns}
	b*	1.46	1.71	1.74	1.57	1.71	0.12^{ns}
Proventriculus (g)	a*	7.10	6.87	6.63	5.67	6.73	0.41^{ns}
	b*	0.33	0.35	0.32	0.27	0.31	0.08^{ns}
Kidney (g)	a*	12.90^{ab}	10.97^{ab}	10.01^{b}	11.47^{ab}	13.77^{a}	0.88
	b*	0.59	0.55	0.48	0.54	0.63	0.08^{ns}
Heart (g)	a*	7.23	7.97	5.97	7.23	8.00	0.85^{ns}
	b*	0.36	0.40	0.29	0.34	0.36	0.03^{ns}

ab Figures within same row with different superscript differ significantly ($p < 0.05$). a* organ weight (g). b* organ weight (% body weight)

Table 5: Determined composition (g/kgDm) of the Broiler Carcass (meat) fed varying animal protein (0-7 weeks)

	Diets					
Measurement	1	2	3	4	5	SEM
Crude protein	380.0^{a}	377.9^{bc}	386.9^{ab}	389.3^{a}	376.6^{c}	0.0528
Ether extract	64.80^{a}	59.90^{d}	63.40^{b}	62.30^{c}	64.80^{a}	0.0037
Crude fibre	0.00	0.00	0.00	0.00	0.00	0.000
Ash	92.50^{b}	91.10^{c}	87.3^{d}	94.90^{a}	92.50^{b}	0.0044
Gross energy (kcal kg^{-1})	2580.00^{bc}	2600.00^{ab}	2590.00^{bc}	2580.00^{c}	2600.00^{a}	0.0087

abcd Figures within same row with different superscripts differ significantly ($p < 0.05$).

Table 6: Apparent digestibility (g/kgDM) of Nitrogen, Crude fibre, ether extract (fat), ash and energy of Broilers fed varying animal protein (0-7 weeks)

	Diets					
Measurement	1	2	3	4	5	SEM
Nitrogen retained	652.10	634.50	683.40	716.50	712.60	34.10^{ns}
Crude fibre digestibility	423.00^{c}	451.6^{bc}	409.00^{c}	675.60^{a}	639.60^{ab}	51.20*
Fat digestibility	929.70^{a}	880.00^{b}	820.90^{a}	915.80^{ab}	910.80^{ab}	8.40*
Ash digestibility	339.2^{b}	296.1^{b}	590.20^{a}	296.9^{b}	636.0^{a}	41.3*
Energy retained	850.3	817.7	866.8^{c}	865.4	860.4	15.7*

abcd Figures within same row with different superscripts differ significantly ($p < 0.05$).

meal, whose protein content is mostly chitin could also have enhanced the birds performance. According to Ramachandran *et al.* (1987), Chitin is known to have a growth promoting effect at low levels by producing glucosamine during its digestion through chitinase enzyme secreted by intestinal bacteria.

Table 7: Economics of feeding varying animal protein to broilers (0-7 weeks)

	Diets					
Measurement	1	2	3	4	5	SEM
Cost per kg feed (N)	34.97^{d}	39.97^{d}	39.97^{d}	40.47^{a}	35.72^{c}	0.0079
Cost of total feed consumed per bird (N)	174.02^{b}	165.03^{bc}	160.02^{c}	187.77^{a}	171.22^{bc}	15.85
Cost per kg weight gain (N)	118.94^{a}	98.63^{bc}	104.13^{b}	105.25^{b}	93.51^{c}	6.76
Revenue (N)	304.28^{b}	378.88^{a}	335.76^{ab}	384.48^{a}	379.85^{a}	12.55
Gross margin (N)	130.24^{b}	213.84^{a}	175.74	196.71^{a}	206.64^{a}	10.93

abc Figures within same row with different superscripts differ significantly ($p < 0.05$). Note:- \$ = N120.00

Furthermore, chitinous material at lower levels supports the growth of bifidobacterium, thus stimulating improved gains (Spreen *et al.,* 1984). The significantly higher feed intake obtained when diets 4 and 5 were fed agrees with the findings of Ravinder *et al.* (1996) who observed an increase in feed intake as the incorporation of squilla (*Orato squilla nepa* - a stomatopod crustacean) increased.

The final body weights obtained in this trial are comparable with the values given by Oluyemi and Roberts (1979) while the similarity in the feed-to-gain ratios shows that the diets were equally efficient in weight gain and this favours complete substitution of Danish fish meal with Local fish meal, crayfish waste meal and grasshopper meal.

Similar observation had been documented (olomu and Nwachukwu, 1977). This is an indication that the test ingredients used in this trial are not in any way harmful to the birds. It is also an indication that satisfactory animal protein could be prepared from Locally sourced fishes, crayfish wastes, and grasshopper meal. Non-occurrence of mortality among the treatment groups might also be an indication of the safety of local fish meal, crayfish waste meal and grasshopper meal as a complete substitute for fish meal in the diets of broiler chickens.

Fishmeal exhibited no superiority over any of the other diets in terms of carcass quality of broiler chicken produced. The percent carcass fat obtained (Table 5) falls within 1.0 to 17.4% (10-174.0g/kg^{-1}DM) observed by Demby and Cunningham (1980) but percent protein and ash values obtained were higher than their values. These variations, apart from the treatment effect, could be due to sex, protein: calorie ratio (Tzeng and Becker, 1981), strain of birds and interactive effects of the dietary ingredients (Mcleod, 1982). For fat retention while D3 had the least value (820.9g/kg^{-1}). The practical significance of the result of the dietary effect on the percent utilization by the birds chickens can be seen in the comparable rate of growth observed with the broiler chickens in this trial.

The improved saving (N213.84) obtained with the use of Danish fish meal is not unexpected. For instance, while the others have protein content which ranged from 35.76 to 45.28%, Fish meal had 61.34% with a better quality protein profile (Olomu, 1995). Less feed was also consumed when compared with birds fed diets 1, 4 and 5 respectively. This also led to a considerably lower cost per kg weight gain (N98.63), which is numerically higher than for birds fed diet 5 (Grasshopper meal). The least cost per kg feed observed for diet 5 is a result of lower cost of grasshopper meal which also resulted in least cost per kg weight gain (N93.51) and a gross margin of N206.64, second only to birds fed diet 2. Diet 1 gave the poorest gross margin (N130.24), an indication that animal protein is an essential ingredient for a profitable broiler production. (Rajaguru *et al.,* 1966; Olomu, 1976; Ojewola *et al.,* 2002).

Conclusion: In conclusion, the present results indicate that the nutritive quality of Soyabean meal-based rations was improved by the inclusion of the various animal protein sources in broiler ration and that there is a need to supplement cereal based rations with a high quality animal protein. Since the replacement of fish meal with either local fish meal, crayfish waste meal, or grasshopper meal did not hamper productive performance in broilers, their production and utilization in feed formulation could be encouraged. This is expected to bring about a reduction in the price of poultry meal products to a level affordable by majority of consumers. It is further expected that such replacements would reduce competition between man and animals for fish as feed ingredient with a consequent reduction in the market price of fish.

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