

Full Length Research Paper

Nutritive potentials and utilization of garden snail (*Limicolaria aurora*) meat meal in the diet of *Clarias gariepinus* fingerlings

Sogbesan, O. A.¹, Ugwumba A. A. A.^{2*} and Madu C. T.¹

¹National Institute for Freshwater Fisheries Research, New-Bussa, Nigeria.

²Department of Zoology, University of Ibadan, Ibadan, Nigeria.

Accepted 31 August, 2006

The possibility of using garden snail (*Limicolaria aurora*) meat meal as a protein source in fish feeds was tested in *Clarias gariepinus* fingerlings. Five isonitrogenous (43% crude protein) diets in which garden snail meat meal was used to replace fish meal at 0%, (control diet), 25, 50, 75 and 100% inclusion levels were used for the study. The fish were fed *ad-libitum* for 8 weeks. Garden snail meat meal used had a crude protein content of 66.76% and ash content of 4.10%, while crude protein and ash content of fishmeal used were 72.46% and 18.22% dry weight, respectively. The lipid content of garden snail meat meal and fishmeal; 7.85% and 7.97%, respectively, was not significantly different ($p \leq 0.05$). The mean weight gain, relative growth and specific growth rates were highest in fish fed 25% garden snail meat meal diet. The best food conversion ratio (1.21) and protein efficiency ratio (3.69) were also recorded in fish fed 25% garden snail meat meal diet. Visceral somatic indices (2.71-17.24%) increased significantly ($p \leq 0.05$) with increase in the garden snail meat meal inclusion in the diets.

Key words: Snail meat meal, *Limicolaria aurora*, fishmeal, growth, nutrient utilization, *Clarias gariepinus*, fingerlings.

INTRODUCTION

The cost of fish feed has been recognized as a major factor affecting the development and expansion of aquaculture enterprise in African countries (Olomola, 1990). Feed ingredients such as fish meal, soybean meal, groundnut cake etc, which are available for human consumption, are also being competed for by the livestock industry. This situation has contributed to the drastic decline in fish and livestock production (due to high cost of feeding) with a resultant short fall in protein intake of the people in many developing countries (Adejinmi, 2000). The high cost and scarcity of fish meal in formulated feeds has led to the use of other protein sources such as earthworms, insects, snail, mussels, periwinkle, lizard, maggot, frog and plants in fish feeds (Bonderi and Shepherd, 1981; Tacon et al., 1983; Guerrero, 1985; Faturoti and Akinbote, 1986; Lim and Dominy, 1989; Anune, 1990; Falaye, 1990; Fagbenro,

1993; Gommes et al., 1995; Alegbeleye and Oresegun, 1998; Seira, 1998; Akegbejo-Samson, 1999; Ugwumba et al., 2001; Akinwande et al., 2002, Omoyinmi et al., 2005).

Mollusca has been ranked the second largest phylum in the animal kingdom having about 100,000 living species (Odaibo, 1997). *Limicolaria* has a low monetary value compared to *Archachatina* and *Archatina*, because the demand for direct human consumption is relatively low in Nigeria. This natural resource could be diverted as a supplement for fishmeal in fish feeds. Knowledge of nutrient value of various feedstuffs used in formulating warm-water fish diet is desirable so that effective substitution of one ingredient for another may be achieved and this is important in the development of least-cost diets (Sadiku, 2003; Wee, 1998). There is dearth of information on the nutrient composition of the garden snail, *Limicolaria aurora* which is very useful for its utilization as a fish feed ingredient.

Clariidae (mudcatfish) are widely distributed throughout Africa. They inhabit tropical swamps, lakes and rivers

*Corresponding authors E-mail: adiaha4me@yahoo.co.nz.

(Olaosebikan and Raji, 1998). *C. gariepinus* is the most popularly cultured species in Nigeria. It has the ability to feed on a variety of food items in the wild ranging from minute zooplankton to fish (Olaosebikan and Raji, 1998). It has been shown that carnivorous fish require high dietary protein which is the most expensive nutrient in feed formulation (Eyo and Olatunde, 2001). Protein from fishmeal is the most suitable for fish feed. Due to its high cost, adequate substitution of this ingredient will significantly reduce operating cost in fish farms. This study is aimed at investigating the nutritive potential of garden snail meat meal as an alternative ingredient to fishmeal in feeds of *C. gariepinus* fingerlings.

MATERIALS AND METHODS

Experimental set-up

A total of ten (10) experimental indoor mini flow through system with plastic tanks of fifty litres capacity were used for the trials, carried out in the Fish Nutrition Laboratory of the Aquaculture and Biotechnology Division, National Institute for Freshwater Fisheries Research (NIFFR), New-Bussa, Nigeria. The tanks were cleaned, disinfected and allowed to dry for 24 h, after which they were filled with dechlorinated tap water to two-third of the size of the tanks and were covered with a net of 3 mm mesh size to protect the fish from predators. Two tanks were used for each experimental diet.

Experimental fish

Two hundred (200) *C. gariepinus* fingerlings of weight range, 2.32-3.22 g (mean, 2.77±0.45 g) and standard length range of 3.9-7.5cm (mean, 5.7±1.8 cm) were procured from the Hatchery Unit of NIFFR. They were acclimatized for one week in aerated plastic holding tanks of 2.0 m x 0.5 m x 0.4 m in the laboratory and fed a compounded NIFFR feed of 35% crude protein during this period. Prior to stocking, the fingerlings were starved overnight, then randomly sorted, weighed and stocked into the experimental tanks at the rate of fifteen (15) fingerlings per tank. The tanks were monitored for fish mortality daily. Dead fish were removed, counted and the number recorded.

Experimental diets

The various diets were formulated using Algebraic Method along with Least Cost Formulae (LCF) (Falayi, 2003). The diets were prepared using garden snail meat meal to replace fishmeal at various inclusion levels of 0, 25, 50, 75 and 100% garden snail and were coded GS1 (control diet) to GS5, respectively. All diets were isonitrogenous and isocaloric at calculated 42.5% crude protein and 425 kcal gross energy/100 g feed as shown in Table 1. Appropriate quantities of ingredients for each diet were measured using electric sensitive weighing balance (OHAUS-LS 2000 Model), milled into particulate and thoroughly mixed using a combined ASEFAC grinder and mixer.

The feeds were pelleted wet using pelleting machine (INSRA PRO, 600). The pelleted dough was collected in flat trays and sun dried to constant weight after which the feeds were crushed into crumbs with pestle and mortar (for easy ingestion by the fingerlings) and then stored in jute bags at room temperature. The garden snail meat meal, fish meal and experimental diets were analysed for the

proximate composition following Association of Official Analytical Chemists methods (A.O.A.C, 2000). Moisture content was determined by drying in an oven at 85°C to constant weight. Gross energy content was determined using a Gallenkamp Ballistic Bomb Calorimeter by measuring the amount of heat released during combustion of the sample following the procedure in the calorimeter manual. The fingerlings were fed ad-libitum daily for a period of eight weeks.

Monitoring of water quality

Temperature was taken daily before feeding at 07.00-08.00 h with Mercury-in-glass Thermometer. Dissolved oxygen was determined using the Winkler Method described by Boyd (1981) and pH with a pH meter (E251) weekly.

Determination of growth and nutrient utilization

The weekly weights recorded and feed supplied were used to compute the growth and nutrient utilization parameters and visceral somatic index as follows:

Mean weight gain = $(w_f - w_i)/n$

(where w_i = initial body weight, w_f = final body weight, n = number of fish and t = duration of experiment in days).

Relative growth rate = Weight gain / Initial body weight x 100

Specific growth rate = $(\text{Log}w_f - \text{Log}w_i) / t \times 100$

Food conversion ratio = Feed supplied (g) / Weight gain (g)

Protein efficiency ratio = Mean weight gain (g) / Mean protein intake (where mean protein intake = feed supplied x % protein of diet)

Visceral somatic index = Visceral weight (g) / Total body weight (g) x 100.

Survival rate = Number of fish at end of experiment / Number of fish stocked x 100

Statistical analysis

All data collected were subjected to Analysis of Variance (ANOVA). Least Significant Difference (LSD) was used to determine the level of significance among treatments.

RESULTS

The values of water quality parameters were temperature, 27.85±0.35°C; dissolved oxygen, 5.8±0.32 mg/l and pH range of 7 – 8. The crude protein, ether extract, and nitrogen free extract for the fish meal and garden snail meat meal used to compound the diets were 72.46, 7.97, 3.17 and 66.76, 7.85 and 5.81%, respectively (Table 2). The control diet had the highest crude protein and ether extract as well as the lowest gross energy of 43.53%, 10.64% and 422.40 kcal/100 g, respectively. While the diets with 50% and 100% snail meat meal inclusion had the lowest crude protein and ether extract. Ether extract was lowest (10.0%) in 50% snail meat diet and energy was highest (432.35 kcal/100 g) in 100% snail meal diet. There was no significant difference ($p \geq 0.05$) between the crude protein and energy compositions of all the experimental diets.

Table 1. Composition of the experimental fish diets.

Ingredients (g/100 g drydiet)	0% garden snail meal (control)	25% garden snail meal	50% garden snail meal	75% garden snail meal	100% garden snail meal
Fishmeal	30.0	22.5	15.0	7.5	0.0
Snail meat meal	0.0	7.5	15.0	27.5	30.0
Yellow maize	28.7	28.4	27.2	25.9	24.7
Groundnut cake	11.7	12.1	12.9	13.7	14.3
Soybean meal	12.6	12.5	12.9	13.4	14.0
Blood meal	10.0	10.0	10.0	10.0	10.0
*Vitamin and mineral premix	2.0	2.0	2.0	2.0	2.0
Palm oil	2.5	2.5	2.5	2.5	2.5
Common salt	0.5	0.5	0.5	0.5	0.5
Bone	1.0	1.0	1.0	1.0	1.0
Binder	1.0	1.0	1.0	1.0	1.0
Total	100.0	100.0	100.0	100.0	100.0
Calculated crude protein %	42.5	42.5	42.5	42.5	42.5
Calculated Gross Energy kcal/100g	425.0	425.0	425.0	425.0	425.0

*Vitamin A, 10,000,000 I.U.D.; D3, 2,000,000 I.U.D.; E, 23,000 mg; K3, 2,000 mg; B1, 3000 mg; B2, 6000 mg; niacin, 50,000 mg; calcium pathonate, 10,000 mg; B6, 5000 mg; B12, 25.0 mg; folic acid, 1,000 mg; biotin, 50.0 mg; choline chloride, 400,000 mg; manganese, 120,000 mg; iron, 100,000 mg; copper, 8,500 mg; iodine, 1500 mg; cobalt, 300 mg; selenium, 120 mg; antioxidant, 120,000 mg.

Table 2. Proximate composition of garden snail meat meal, fishmeal and experimental diets (g/100 g dry matter) used for the experiment.

Parameters	Garden snail meat meal	Fishmeal	0% garden snail meal	25% garden snail meal	50% garden snail meal	75% garden snail meal	100% garden snail meal
Crude protein (%)	66.76 ^b	72.46 ^a	43.53 ^c	43.21 ^c	43.18 ^c	43.20 ^c	43.18 ^c
Ether extract (%)	7.85 ^a	7.97 ^b	10.64 ^f	9.81 ^c	10.07 ^d	10.38 ^c	10.60 ^f
Ash (%)	4.10 ^b	18.82 ^c	3.36 ^a	3.50 ^a	3.66 ^a	3.19 ^a	3.99 ^a
NFE (%)	5.81 ^c	3.17 ^d	18.33 ^b	20.42 ^a	20.54 ^a	20.56 ^a	21.38 ^a
Dry matter (%)	91.0	90.22	84.28	84.3	84.43	85.48	84.59
Gross Energy kcal/100g	478.35 ^b	501.42 ^a	422.40 ^c	421.11 ^c	423.87 ^c	427.09 ^c	432.35 ^{cd}

*All treatments on the same row with dissimilar superscripts are significant difference at $p \leq 0.05$.

The inclusion of garden snail meat meal in the experimental diets positively affected the growth of fish in this study as shown in Figure 1. There was a steady increase in growth rate from the beginning (2.77 g/fish) to the end (5.38-6.94 g/fish) of the experiment. A summary of the growth performance and nutrient utilization of the fingerlings are shown in Table 3. Fish fed 25% garden snail meat meal diet had the highest mean weight gain of 4.17 g/fish while the lowest value (2.61 g) was recorded in fish fed 75% garden snail meat meal. Similarly, highest specific growth rate (0.71%) was also recorded in fish fed 25% garden snail meat meal diet and this significantly differed ($p \leq 0.05$) from specific growth rate (0.51-0.58) of all the other diets. The lowest specific growth rate was also recorded in 75% snail meat meal diet.

Nutrient utilization was best in fish fed 25% garden snail meat meal diet. Food conversion ratio and protein efficiency ratio were 1.21 and 3.69 respectively (Table 3) for this diet. The visceral somatic indices (2.17-17.24)

increased with increase in garden snail meat meal in the diets. Survival rate was high in all the diets, about 94-98%. The highest value was recorded in the control and

DISCUSSION

Protein of either plant or animal origin in fish feed acts as both structural and energy components (Brett and Grooves, 1979) which quality and quantity have decisive influence on the growth rate of fish provided that all other physiological requirements are satisfied (Steffens, 1981). The crude protein for garden snail meat meal reported in this study was close to crude protein reported by Seira (1998) and Odaibo (1997) for golden snail (62%) and African giant snail (60-70%), respectively, but higher than the crude protein of 31.28% reported by Omoyinmi et al. (2005) for garden snail. The lipid content of garden snail meat meal in this study is also close to the value 8.3% reported by Seira (1998) for golden snail meat but

Table 3. Growth performance and nutrient utilization of *C. Gariepinus* fingerlings fed garden snail meat meal as a supplement for fish.

Parameters	0% garden snail meal	25% garden snail meal	50% garden snail meal	75% garden snail meal	100% garden snail meal
Mean Initial weight (g/fish)	2.77	2.77	2.77	2.77	2.77
Mean final weight (g/fish)	5.53	6.94	5.88	5.38	5.82
Mean weight gain(g/fish)	2.76 ^c	4.17 ^a	3.11 ^b	2.61 ^c	3.05 ^b
Relative growth rate (%)	99.64 ^c	150.54 ^a	112.27 ^b	94.22 ^c	110.11 ^b
Specific growth rate (%/day)	0.54 ^b	0.71 ^a	0.58 ^b	0.51 ^b	0.58 ^b
Feed Conversion Ratio	1.39 ^c	1.21 ^a	1.31 ^b	1.39 ^c	1.44 ^d
Protein Efficiency ratio (PER)	3.21 ^b	3.69 ^a	3.02 ^c	3.21 ^b	3.26 ^b
Visceral somatic index (%)	2.71 ^c	8.57 ^d	10.52 ^c	15.76 ^b	17.24 ^a
Survival (%)	97.5 ^a	96.0 ^b	94.5 ^c	94.0 ^c	97.5 ^a

*All treatments on the same row with dissimilar superscripts are significant difference at $p \leq 0.05$.

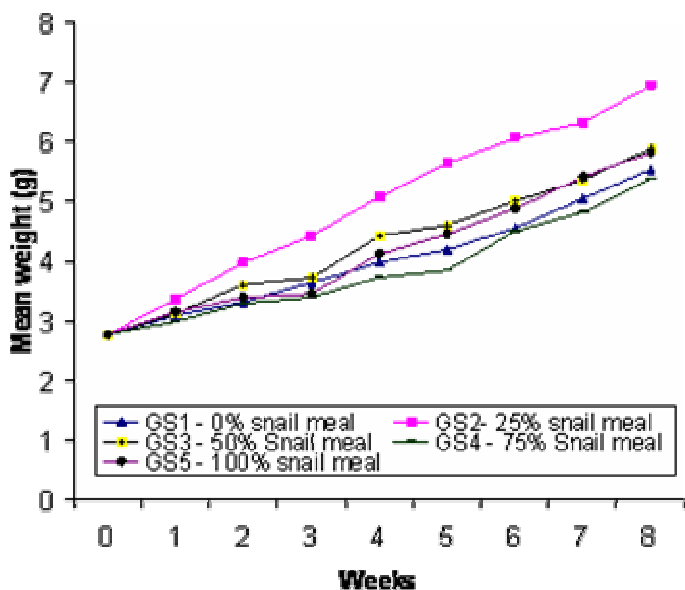


Figure 1. Weekly growth pattern of *C. gariepinus* fed the experimental diets for 56 days. 100% snail meal diets and this was significantly different ($p \leq 0.05$) from the survival rates of all the other diets.

higher than 5.0% reported by Omoyinmi et al. (2005) for garden snail meat.

The weekly growth pattern revealed that generally *C. gariepinus* fingerlings performed better on snail meat meal than fish meal in this study. It has been documented that 50% replacement of fish meal with snail meal on broiler diet showed no depression in growth or unfavourable food conversion ratio (Seira, 1998) and that the best growth performance was recorded in layers fed 10% snail meal. This study shows that *C. gariepinus* can utilize snail meat meal better than broiler because even at 100% replacement of fish meal, higher weight gain was observed over the control without snail meal.

However from the present study visceral somatic indices of the snail-based diets was about 300-600% more than that of the control indicating that there will be more 'trash' from the fingerlings fed the snail-based diets. Seira (1998) further reported a replacement level of 75% golden snail meal for fish meal without depressing growth in tilapia. In the present study the best growth performance and nutrient utilization were recorded in fingerlings fed 25% garden snail meat meal. This implies that low inclusion levels of garden snail meat meal in the diet of *C. gariepinus* favours enhanced growth rate. This is unlike in duck and tilapia that had the best growth performance at 50% and 75% snail meal inclusion levels respectively (Seira, 1998).

The differences in growth observed with the mixed animal protein diets of 25 – 75% snail meat meal (though the diets were isonitrogenous) are indications of the variation in the feed utilization. The reports of Chang et al. (1983) and Akiyama et al. (1984) for silkworm pupa meal fed to grass carp and chum salmon fry, respectively, were reverse to the report of this study. These workers recorded better-feed conversion ratio and feed acceptability in the control diet without silkworm. The acceptance of garden snail meat meal by fish and the high nutrient value of this ingredient indicate that their commercial exploitation could be profitable to fish farmers and feed industries.

Ability of an organism to convert nutrient especially protein will positively influence its growth performance. This is justified by the best protein efficiency ratio and growth performance in 25% garden snail meat meal fed-fingerlings. Lower feed conversion ratio indicates better utilization of the feed by the fish fed this diet. Food conversion ratio has been reported to range between 1.2-1.5 for fish fed carefully prepared diets (De Silva and Anderson, 1995) and the results from this study falls within the reported range by these authors. These authors also reported that protein efficiency ratio is a measure of how well the protein sources in a diet could provide the essential amino acid requirement of the fish

fed. Furthermore, that this index has been associated with fat deposition in fish muscle and that higher protein efficiency ratio is also an indication of diet that produces fatty fish. Hence the range of protein efficiency ratio (3.02-3.6) recorded in this study could favour fat deposition in catfish.

The high survival rates recorded indicate that feeding *C. gariepinus* fingerlings with snail meat meal diet could enhance survival of fish. This may probably be due to better feed conversion and utilization as well as superior growth of fish on the snail-based diets especially at lower levels of inclusion (25%). Holm and Torrissen (1987) reported that living organisms or animal feeds do enhance survival and healthy state of fish at their early stages. The physicochemical parameters monitored were within suitable range for tropical fish indicating that environmental conditions of the fish during the experimental period were adequate.

Based on the results of this study, garden snail meat meal can be used to replace fish meal in practical diets of *C. gariepinus* fingerlings. Furthermore 25% inclusion of garden snail meat meal is preferable by the fingerlings for optimum growth and nutrient utilization.

REFERENCES

- Adejinmi OO (2000). The chemical composition and Nutritional potential of soldier fly larvae (*hermetia elucens*) in poultry rations. University of Ibadan, Ph.D. Thesis, 292pp.
- Akegbojo-Samson Y (1999). Growth response and Nutrient Digestibility by *Clarias gariepinus* fed vary level of Dietary Periwinkle flesh as replacement for fishmeal in low-cost diet. *Appl Trop. Agric.* 4 (1): 37-43.
- Akinwande AA, Ugwumba AAA, Ugwumba OA (2002). Effects of replacement of fish meal with maggot meal in the diet of *Clarias gariepinus* (Burchell 1822) fingerlings. *The Zoologist* 1(2): 41-46.
- Akiyama T, Murai T, Hirasuwa Y, Nose T, (1984). Supplementation of various meals to fish meal diets fro chum salmon fry. *Aquaculture* 37: 217-222.
- Alegbeleye WO, Oresegun A (1998). Nutritive value of three terrestrial lumbrid worms for *Oreochromis niloticus*. In *Sustainable Utilization of Aquatic/Wetland Resources*, pp165-176. Selected Papers from 9th/10th Annual Conference of the Nigerian Association for Aquatic Sciences (1995).
- Anune PA (1990). Preliminary investigation on the suitability of toad meal, *Bufo regularis* in the diet of catfish, *Clarias lazera*. *J. Aquat. Sc.* 5: 37-42.
- Association of Analytical Chemists (2000). *Official Methods of Analysis*. 17th Edition, Washington, DC, USA
- Bonderi K, Shepherd DC (1981). Soldier fly larvae as feed in commercial fish production. *Aquaculture* 24:103-109.
- Boyd CE (1981). *Water Quality in warm water fish ponds*. Craftmaster Printers Inc. Alabama, 359pp.
- Brett JR, Grooves TDD (1979). *Physiology Energetics*. In Hoar WS, Randall DJ, Brett JR (eds) *Fish Physiology*, Academic Press, NY 8: 279-352.
- Chang WYB, Diana JS, Chaupeoutiuk WL (1983). *Workshop report to Agency for international development*, 19-29 April 1983. Strengthening of south east Asian Aquaculture Institute, 30pp.(Mimeo).
- De Silva SS, Anderson TA (1995). *Fish Nutrition in aquaculture*. Chapman and Hall Aquaculture Series, 319pp.
- Eyo AA, Olatunde AA (2001). Protein and amino acids requirements of fish with particular reference to species cultured in Nigeria. In Eyo A. A. (ed.) *Fish Nutrition and Fish feed Technology*. Published by Fisheries Society of Nigeria pp 59-74
- Fagbenro OA (1993). Observation in macadana press cake as supplemental feed for monosex *Tilapia guineensis* (*Pisces:Ceichlidae*). *J. Aqua. Trop.* 7. 91-94.
- Falaye AE (1990). Evaluation of the chemical and nutrient composition of cocoa husk (*Theobroma cacao*) and its potential as a fish feed ingredients. *Nig. J. Basic Appl. Sci.* 4(1/2): 157-160.
- Falayi BA (2003). Techniques in Fish Feed Manufacture. In Eyo, A.A. (ed) *Proceeding of the Joint Fishery Society of Nigeria / National Institute for Freshwater Fisheries Research Special Programme for Food Security National Workshop on Fish Feed Development and Feeding Practices in Aquaculture Held at National Institute for Freshwater Fisheries Research, New-Bussa. 15th – 19th September 2003*, pp 43-55.
- Faturoti EO, Akinbote OA (1986). Growth response and nutrient utilization in *Oreochromis niloticus* fed varying levels of dietary cassava peel. *Nig. J. Appl. Fish. Hydrobiol.* 1: 47-50.
- Gommes EF, Rema P, Kaushik SJ (1995). Replacement of fish meal by plant proteins in the diet of rainbow trout (*Onchorynchus myskiss*): digestibility and growth preference. *Aquaculture* 130: 177-180.
- Guerrero RD (1985). The culture and use of *Perionyx excavatus* as a protein source in Philippines. In *Earthworm Ecology*. Stachell J. E. (ed), Chapman and Hall, London. pp 309-313
- Holm JC, Torrissen KR (1987). Growth depression and acclimatization if protease in Atlantic salmon first-feeding fry responding to a diet supplemented with Zooplankton. *Aquaculture* 65: 171-174.
- Lim C, Dominy W (1989). Utilization of plant protein by warm water fish. In Wilson R.P. (eds), *Proc. Of World Cong. Onve. Prot. Utilization in human food and animal feedstuff*, pp 245-251.
- Odaibo, B. A. (1997). *Snail and Snail farming, Nigeria Edible land snail*. University Press Ltd. Ibadan, Nigeria, 29pp.
- Omoyinmi GAK, Fagade SO, Adebisi AA (2005). Nutritive value invertebrates cultured under laboratory conditions. *The Zoologist* 3: 33-39.
- Olomola A (1990). *Capture Fisheries and Aquaculture in Nigeria. A comparative Economic Analysis*. Africa Rural Social Science Series report. No.13.
- Olaosebikan BD, Raji A (1998). *Field guide to Nigerian Freshwater Fishes*. Decency Printers and stationery limited, Ilorin, 52pp
- Sadiku SOE (2003). Least-cost feed formulation. In Eyo, A.A. (ed) *Proceeding of the joint Fishery society of Nigeria/National Institute for freshwater Fisheries research/ Special programme for food security National workshop on Fish feed development and Feeding Practices in Aquaculture, Held at National Institute for Freshwater Fisheries Research, New-Bussa. 15th-19th September, 2003*, pp 56-59.
- Seira AB (1998). The use of golden snail (*Pomacea* sp) as animal feed in the Philippines. *Voedings magazine* 11(6): 40-43
- Steffens W (1981). Protein utilization by Rainbow trout (*Salmo gairdineri*) and Carp (*Cyprinus carpio*): A brief review. *Aquaculture* 23: 337-345.
- Tacon AGJ, Jauncey K, Falaye AE, Pantha M, MacGowon F, Stafford AE (1983). The use of meat and bone meal, hydrolysed feather meal and soybean in practical fry and fingerling diet for *Oreochromis niloticus*. In Fishelson L. (ed) *Proceedings of International Symposium on tilapia in Aquaculture, Nazareth, Israel, 8-13 May, 1983*, pp 356-365.
- Ugwumba AAA, Ugwumba OA, Okunola AO (2001). Utilization of live maggot as supplementary feed on the growth of *Clarias gariepinus* (Burchell) fingerlings. *Nig. J. Sc.* 35(1): 1-7.
- Wee KL (1988). Alternative feed resources for finfish in Asia. In De Silva S.S. (ed.) *Finfish Nutrition in Asia*, pp 25-41.