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# Nutritional Evaluation of Snail Offal Meal as Animal Protein Supplement in the Diets of *Clarias gariepinus* (Burchell, 1822) Fingerlings

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**Abstract:** A total of 300 *Clarias gariepinus* fingerlings (average weight of 6.77 ± 0.02g) was used to determine the effects of fishmeal replacement with snail offal meal (SOM). Completely randomized design was used for the ten-week feeding trial with five treatments diets 1 to 5 in which fishmeal fraction of the diets was replaced at 0, 25, 50, 75 and 100% with SOM. The parameters taken were weight gain (WG), feed conversion rate (FCR), protein efficiency rate (PER) for assessing fish growth performance and total cost of production, profitability of fish produced were calculated. Fish showed significantly ($p<0.05$) different WG, FCR and PER which were superior in fish fed diets 1, 2 and 3 to others at inclusions above 50%. Profitability assessment indicated that fish fed dietary 50% SOM had highest rate of return with superior profit index to 0 and 25% SOM inclusions and all are significantly($p<0.05$) higher than values in other treatments. The inclusions of SOM seem to have adverse effect on fish as survival rate decline at SOM inclusion beyond 50%. In conclusion, based on the present results snail offal could replace fishmeal in fish diet at 50% inclusion rate thereby reduce cost of feeding and promotes successful aquaculture.

**Key words:** Snail offal meal % Fishmeal % Replacement % Profitability % Aquaculture

## INTRODUCTION

The incorporation of fishmeal in fish feed for intensive fish production has been reported to be largely responsible for the high cost of aquaculture production [1-3]. Consequently, it has been prescribed that aquaculturists and fish nutrition experts be in continuous search for alternative sources of animal protein which is affordable and available for the replacement of fishmeal in aquafeed production [4]. With the increasing rate in the establishment of fish farms in Nigeria, it is obvious that the quest for fish feed ingredients, especially fishmeal will continue to persist meaning that economically viable fish farming activities would depends on availability of least-cost, nutritionally-balanced diets. Researchers have revealed that animal by-products and wastes have appreciable high quality protein which can be used in the production of least-cost fish feed for profitable fish farming [5, 6]. The works of Tacon *et al*. [7] on earthworm meal, Tatterson and Windsor [8] on fermented fish silage, Nwanna [9] on shrimp waste meal, Sogbesan and Ugwumba [10] on termite meal and Sotolu [11] on fish waste meal have all indicated a resounding hope for the aquaculture industry due to the reported effective utilization of various animal waste products. Snail have been reported to be capable of reducing risk of hypertension in obsessed persons [12,13] apart from being a good source of high protein value in the culture of many fish species and crustaceans of commercial importance such as tilapia [14] and giant freshwater prawn (*Macrobrachium rosenbergii*) [15]. Snail farming is presently on the increase in Nigeria as a practical way of sustainable livelihood [16] and due to its high nutritional values [17]. The utilization of snail meat for human consumption is however, accompanied by the production of offal which requires immediate disposal before emitting offensive odour [18, 19]. Utilization of SOM has not been adequately investigated in fish production. This study therefore, attempted to evaluate the nutritional values of SOM as a least-cost feed input in aquaculture production, especially when considering the increasing rate in the establishment of fish farms in

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Nigeria. The best replacement value of fishmeal with snail offal meal (SOM) that favours profitable catfish production being the most widely acceptable farmed fish species in Nigeria was therefore investigated.

## MATERIALS AND METHODS

**Processing of Snail Offal and Preparation of Experimental Diets:** Snail offal mostly of the species *Achatina achatina* and *Archachatina marginata* was collected from Oje market in Ibadan in one market day. The offal consists of heart, kidney and loop of intestine and reproductive tracts as well as snail eggs. The offal was boiled in hot water for 10 minutes to dryness and macerated to pastes. The paste was sundried homogenously on a slab in the Department of Wildlife and Fisheries Management, University of Ibadan, Nigeria for 3 days. The sun-dried meal was milled in Thomas Willey and sample was analyzed for its proximate composition [20]. Five isoproteic (40% Crude Protein) diets were formulated for catfish fingerlings replacing fishmeal at 0, 25, 50, 75 and 100% inclusion level to give diets from number 1 to 5, respectively. All test diets were chemically analyzed for crude protein, crude fibre, fat, ash, moisture and nitrogen free-extract using the methods of A.O.A.C [20]. A total of 300 Catfish (*Clarias gariepinus*) fingerlings (average weight of 6.77 ± 0.02g) was collected from the hatchery of the Departmental fish farm and were allowed to acclimate for 7 days in the laboratory.

**Design of Experiment and Feeding Trial:** Experimental fish were randomly distributed into the five treatments in triplicates. Each experimental plastic aquarium of 140 liters of water capacity was stocked with 20 fingerlings and supplied with deep well water via overhead plastic tank throughout the 70-day feeding trial. Fish were manually fed dietary SOM 5% of their body weight in two portions per day at 09:00 and 15:00 h. The quantity of ration fed each tank was adjusted forthnightly based on weight changes and the feeds were completely consumed by fish. Water quality of culture media were regularly changed with siphoning of solid wastes before first feeding daily to ensure that parameters such as pH, dissolved oxygen, ammonia, nitrate and nitrite level conform to the recommendations of Boyd [21] for freshwater fish culture.

**Data Collection and Computation:** Fish growth and performance were determined based on the forthnight record of feed consumption and weight changes in fish in triplicates. The growth parameters and nutrient utilization indices were expressed as: Weight gain (WG) = $W_2$g-$W_1$g; $W_2$ = final weight of fish, $W_1$ = initial weight (g) of fish; Specific growth rate (SGR) (%/day) = (Log $W_2$ – Log $W_1$/$T_2$ – $T_1$) x 100; $T_2$ = end of experiment and $T_1$ = beginning of experiment (in days); while Feed intake (F. Intake), Protein intake (P. intake) = Feed fed x crude protein of the feed, Feed conversion rate (FCR) = Total feed intake/Weight gain (g) and Protein efficiency rate (PER) = Weight gain (g)/Protein intake (g). Fish survival was also monitored in tanks to determine their survival rates (SR) (Initial no. of fish stocked – mortality)/Initial no. of fish x 100. Economic evaluation of fish production in terms of investment cost analysis; profit index (PI), incidence of cost (IC) [22] and rate of return (RR) [11]. PI= Value of fish (N)/Cost of feed consumed (N); IC= Cost of feed consumed (N)/Weight gain of fish (g); RR= PI/IC.

**Statistical Analysis:** The experiment was conducted in a Completely Randomized Design (CRD) form. All data collected during the experiment were subjected to the one-way analysis of variance (ANOVA) test using the SPSS version 10.0 for windows on PC according to the methods of Steel *et al*. [23] and significant mean difference were separated at 5%.

## RESULTS

Table 1 gives the gross composition of dietary snail offal meals (SOM) and the proximate composition of the SOM used in the formulation of the test diets as well as the formulated diets are presented in Table 2. It is generally observed that the inclusion of SOM in the diet of *Clarias gariepinus* produced significant ($p<0.05$) effect on fish growth rate and nutrient utilization efficiency during the study. Results indicated that SOM used in the study is capable of providing quality nutrients (protein and lipids) for fish good growth and performance. The effect of SOM diets on growth performance and nutrient utilization of *Clarias gariepinus* are shown in table 3 and mortality observed during the study ranged between 83.33% in treatment 4 and 98.33% in treatment 1. The highest weight gain were observed in catfish fed diets 1, followed by fish fed diet 2 and diet 3 which did not differ significantly ($p>0.05$). SGR was also highest in fish fed diet 1 which was only marginally different from fish fed diet 2 but they are significantly different ($p<0.05$) from the SGRs of the other treatments. Feed conversion ratio (FCR) was the most efficient in fish fed diets 1, 2 and 3 despite the inclusion of SOM in the diets up to 50% which is

Table 1: Gross composition of Experimental Diets

| | Experimental Diet No. | | | | |
|---|---|---|---|---|---|
| Ingredients (g/100g/DM) | 1 (0%) | 2 (25%) | 3 (50%) | 4 (75%) | 5 (100%) |
| Fishmeal | 38.30 | 28.73 | 19.15 | 9.65 | - |
| SOM | - | 12.24 | 24.49 | 36.72 | 48.96 |
| SBM | 17.55 | 17.55 | 17.55 | 17.55 | 17.55 |
| Wheat offal | 15.62 | 15.62 | 15.62 | 15.62 | 15.62 |
| Maize | 24.53 | 21.86 | 18.84 | 14.46 | 13.86 |
| Bone meal | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| Vit-Premix* | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Palm oil | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |

*Biomix fish vitamin/mineral providing per kg of diet at 5kg per tonne inclusion: 20,000 iu, vitamin A, 200 i.u, Vit. D3, 200 mg Vit E, 8 mg Vit k3, 20mg Vit B1, 30 mg Vit B2, 12 mg Vit B6, 50 mg Pantothenic acid, 0.8 mg Biotin, 150 mg Niacin, 0.05mg Vit B12, 160mg Vit. C, 4.0mg Cobalt, 40 mg Iron, 5.0 mg Iodine, 30 mg Manganese, 4 mg Copper, 40 mg Zinc, 0.2 mg Selenium, 100 mg Lysine, 100 mg Methionine, 100 mg Anti-oxidant.

Table 2: Proximate Composition of SOM (g/kg dry matter) and Experimental Diets

| | | Experimental Diet No. | | | | |
|---|---|---|---|---|---|---|
| Parameters (%) | SOM | 1 (0%) | 2 (25%) | 3 (50%) | 4 (75%) | 5 (100%) |
| Crude Protein | 50.85 | 40.17 | 40.18 | 40.20 | 40.17 | 40.15 |
| Crude fibre | 4.27 | 4.40 | 4.52 | 4.42 | 4.57 | 4.76 |
| Fat | 9.73 | 5.21 | 4.66 | 5.27 | 5.63 | 5.80 |
| Ash | 9.74 | 18.80 | 18.56 | 17.40 | 18.47 | 17.29 |
| NFE | 25.41 | 31.42 | 32.08 | 32.71 | 31.16 | 32.97 |

Table 3: Nutrient utilization, growth and survival of *Clarias gariepinus* fed different levels of SOM inclusion diets

| | Experimental Diet No. | | | | |
|---|---|---|---|---|---|
| Parameter | 1 (0%) | 2 (25%) | 3 (50%) | 4 (75%) | 5 (100%) |
| Initial wt (g) | 6.77 | 6.76 | 6.77 | 6.75 | 6.77 |
| Final wt (g) | 29.36 | 28.74 | 28.24 | 24.57 | 24.18 |
| MWG (g) | $22.59\pm1.43^{a}$ | $21.98\pm0.89^{a}$ | $21.47\pm1.16^{a}$ | $17.82\pm1.07^{b}$ | $17.41\pm1.15^{b}$ |
| F. Intake (g) | $46.63\pm4.22^{a}$ | $44.21\pm4.10^{a}$ | $44.73\pm3.76^{a}$ | $41.04\pm3.20^{b}$ | $40.35\pm2.17^{b}$ |
| P.IntakeX10 $^{2}$ | $18.73\pm3.18^{a}$ | $17.76\pm2.69^{a}$ | $17.98\pm2.87^{a}$ | $16.48\pm3.15^{b}$ | $16.20\pm3.05^{b}$ |
| SGR (%/day) | $0.91\pm0.13^{a}$ | $0.90\pm0.07^{a}$ | $0.87\pm0.10^{b}$ | $0.80\pm0.05^{c}$ | $0.79\pm0.04^{c}$ |
| PER | $1.21\pm0.06^{a}$ | $1.24\pm0.10^{a}$ | $1.19\pm0.04^{b}$ | $1.08\pm0.02^{c}$ | $1.07\pm0.09^{c}$ |
| FCR | $2.06\pm0.03^{b}$ | $2.01\pm0.03^{b}$ | $2.08\pm0.03^{b}$ | $2.30\pm0.03^{a}$ | $2.32\pm0.03^{a}$ |
| SR (%)* | 98.33 | 97.50 | 91.67 | 83.33 | 86.67 |

Values with different superscripts along the same row are significantly different ($p<0.05$)

*Values in the row not statistically analyzed

Table 4: Economic evaluation of fish production using SOM based-diets for 70 days

| | Experimental Diet No. | | | | | |
|---|---|---|---|---|---|---|
| Parameters | 1 (0%) | 25% | 50% | 75% | 100% | SEM* |
| Mean weigh of fish (g) | 22.59a | 21.98a | 21.47a | 17.82b | 17.41b | 1.43 |
| Value of fish (N'00) | 2.03a | 1.98 a | 1.93b | 1.60c | 1.57c | 1.04 |
| Feed intake (Kg) | 46.63a | 44.21a | 44.73a | 41.04b | 40.35b | 3.18 |
| Cost of feeding (N) | 99.83a | 98.96a | 87.74b | 84.50b | 78.84b | 0.49 |
| Total expenditure (N) | 149.83a | 144.96a | 137.74b | 135.50b | 128.84c | 7.03 |
| Net Profit (N) | 53.17a | 53.04a | 55.26a | 24.50b | 28.16b | 2.11 |
| Profit index | 2.03b | 2.00b | 2.20a | 1.89c | 1.99b | 0.14 |
| Incidence of cost | 4.42b | 4.54b | 4.09c | 4.74a | 4.53b | 0.16 |
| Rate of returns | 0.46b | 0.44b | 0.54a | 0.40c | 0.44b | 0.03 |

Values with different superscripts along the same row are significantly different ($p<0.05$)

SEM*: Standard error of the means from the ANOVA.

significantly ($p<0.05$) superior to other treatments while feed utilization efficiency was significantly ($p<0.05$) highest in fish fed diets 1 and 2. In the cost evaluation of dietary SOM utilization (Table 4), net profit was marginally different among fish fed diets 1, 2 and 3 (>0.05), profit index and incidence of cost were only marginally different between treatment 1 and 2 and the least values are observed in fish fed diets 4 and 5. Total expenditure (cost of production) was significantly ($p<0.05$) higher in fish fed diets 1 and 2 while the highest rate of return (RR) was found in fish fed diet 3 (50% SOM). Fish fed 50% SOM inclusion appear to be more promising than those fed diets 1 and 2 based on its superior RR value.

## DISCUSSION

The present study showed that utilization of snail offal meal as animal protein source in the production of least-cost nutritionally balanced diets offers high potential towards sustainable growth and the development of the aquaculture industry, especially in Low Income Food-Deficit Countries (LIFDCs) such as Nigeria. However, the utilization of SOM by catfish appear to have limitations considering the quietly inferior feed utilization efficiency exhibited by the experimental fish at higher inclusion levels, especially beyond 50%. Such poor utilization level of diets may be due to the presence of certain antinutritional substances [24, 25]. Mucus in snails has been reported to contain some chemicals that are proteinous in nature which may not be easily digestible [18, 26, 27]. In spite of the high nutritive value of the snail offal meal (50.85% crude protein and 9.73% crude fat) which is similar to 48.12% crude protein reported by Ebenso *et al*. [28] the relatively poor growth rate and low survival rates of fish fed dietary SOM inclusions greater than 50% may be due to the presence of the antinutritional substance (mucous) beyond its threshold level in the feeds. This is contrary to the observations made by Nwanna *et al*. [29] and corroborated by Sotolu and Byanyiko [30] who observed 100% survival rates in fish fed dietary shrimp meal and parkia pulp meal, respectively despite the presence of various antinutritional factors in the diets and consequent poorly utilized by fish even at high consumption rate. Protein is an essential nutrient that must be included in the diet at appropriate levels to ensure adequate growth and health of fish. This however, has been emphasized to be of high quality in order for it to be efficiently utilized [31, 32]. The superior nutrient composition of fishmeal to the SOM used in the study could be responsible for the poor feed utilization exhibited by fish at higher SOM inclusion. It appears that feed intake is directly proportional to protein intake from this study which, could imply that feed palatability had significant effect on feed intake. This is in line with the results of Aderolu *et al.* [33] on the performance of catfish juvenile fed dietary sorghum meal and Sotolu and Byanyiko [30] on the utilization of parkia pulp meal by *Clarias gariepinus* juveniles. Since feed conversion ratio (FCR) is a function of feed intake to weight gain therefore, significantly different feed intake recorded in this study could be attributed to the significantly different weight gain and specific growth rate by fish [34, 35] in their respective studies. Economic analysis in the study revealed that, replacement of fishmeal by SOM for maximum fish performance could be achieved at 50% substitution level. The highest cost of expenditure (Cost of production) demonstrated by 0 and 25% SOM fed fish could be due to the highest inclusion levels of fishmeal which attracted more costs and this may be an affirmation of the reports of Faturoti and Lawal [22]. Profit index (PI), Incidence of cost (IC) and Rate of return (RR) were all superior in 25% SOM inclusion level compared to 0 and 50% dietary SOM inclusions. The results showed comprehensive overall superior profit margins for SOM utilization which appear better for sustainable aquaculture. The observation is slightly different from the previous results of Sogbesan and Ugwumba [10] and Sotolu and Adejumoh [36] whereas only few evaluation indices were in agreement. Based on similar instances such as Sogbesan and Ugwumba [10] and Sotolu and Adejumoh [36], the utilization of PI and IC seem limited in use. However, RR or Benefit cost ratio usually tends to harmonize the seemingly existing divergent points [36] in PI and IC for better assessment. In conclusion, snail offal meal is a rich source of animal protein that could replace fishmeal for efficient and maximum growth performance. The inclusion at 50% in fish diets offers high potential for profitable fish production. Hence, the possible production of least-cost feed that is nutritionally balanced via snail offal meal incorporation in fish diet provides useful information in sustaining fish production system for the growth and development of the aquaculture industry.

## REFERENCES


1. Bureau, D.P., A.M. Harris and C.Y. Cho, 1999. Apparent digestibility of rendered animal protein ingredients for rainbow trout (*Onchorychus mykiss*). Aquaculture, 180: 345-358.

2. Otubusin, S.O., 1987. Effects of different levels of blood meal in pelleted feeds on Tilapia, *Oreochromis niloticus* production in floating bamboo net-cages. Aquaculture, 65: 263-266.
3. Fasakin, E.A., 2008. Fish as food yesterday, today and forever, Inaugural Lecture series 48, The Federal University of Technology, Akure, pp: 52.
4. Alceste, C.C. and D.E. Jory, 2000. TILAPIA-Alternative Protein Sources in TilapiaFeed Formulation. Aquaculture Magazine Jul/Aug 2000, 26(4): 3.
5. Falaye, A.E., 1992. Utilization of agro-industrial wastes as fish feedstuffs in Nigeria. Proc. Of the 10th Annual Conf. FISON, Abeokuta, 16-20 November, pp: 47-56.
6. Omoregie, E. and F.I. Ogbemudia, 1993. Effect of substituting fishmeal with palm kernel on growth and food utilization of the Nile Tilapia, (*Oreochromis niloticus*). Israeli J. Aquacult., 43: 113-119.
7. Tacon, A.G.J., J.L. Webster and C.A. Martinez, 1984. Use of solvent extracted sunflower seed meal in complete diets for fingerling of rainbow trout (*Salmo gairdneri*). Aqua., 43: 381-389.
8. Tatterson, I. and M. Windsor, 1974. Torry test 29. Practical value of fish silage. J. Sci. Food and Agri., 25: 25-26.
9. Nwanna, L.C., 2003. Nutritional value and digestibility of shrimp head waste meal by Africa Catfish *Clarias gariepinus*. Pak. J. Nut., 2(6): 339-345.
10. Sogbesan, A.O. and A.A.A. Ugwumba, 2008. Nutritional evaluation of termite (*Macrotermes subhyalinus*) meal as animal protein supplements in the diets of *Heterobranchus longifilis* (Valenciennes, 1840) fingerlings. Turk J. Fish Aqua. Sci., 8: 149-157.
11. Sotolu, A.O., 2009. Comparative Utilizations of Fish Waste Meal with Imported Fishmeal by African Catfish (*Clarias gariepinus*). American-Euras J. Sci. Res., 4(4): 285-289.
12. Odunaiya, O. and A.A. Akinyemi, 2008. Performance of Two Snail Species – *Archachatina marginata* (S) and *Achatin*a *achatina* (L) reared under the same management practice. Nig. J. Anim. Prod., 35(2): 224-229.
13. Imevbore, E.A. and A.A. Ademosun, 1998. The Nutritive Value of the African Giant Land Snail (*A. marginata*). J. Anim. Prod. Res., (8)2: 76-87.
14. Shafiei, T.M. and H.H. Costa, 1989. An evaluation of the flesh of the terrestrial snail *Achatina fulica* as food for the fingerlings of *Oreochromis mossambicus* (Peter): J. Aqua. Trop., 4: 15-19.
15. Costa, H.H., 1980. Preliminary studies on the breeding of the giant freshwater prawn (*Macrobrachium rosenbergii*) using locally available diets. Proc. World Conf. on the giant prawn, June 1980, Bangkok, Thailand.
16. Ayodele, I.A., 1992. Snail propagation; A cheap source of lean meat for the household. *Proc. Training of trainers' workshop on small livestock production under the household security and nutrition UNICEF publication*.
17. Yusuf, M.B., 1998. Utilization of snail meal in the diet of fingerlings of *Clarias gariepinus*. Unpublished M.Sc. thesis of the Department of Wildlife and Fisheries Management, University of Ibadan.
18. Denny, M.W., 1989. Invertebrate mucus secretions: functional alternatives to veterbrate paradigms. In: mucus and related topics, E. Chantler and N.A. Ratcliffe (eds). Experimental Biol., 43: 337-366.
19. Lincoln, B.J., T.R.E. Simpson and J.L. Keddie, 2004. Water vapour sorption by pedal mucus trail of a land snail. Colloids and Surface (Biointerface), 33(3-4): 251-258.
20. A.O.A.C., 2000. Association of Official Analytical Chemists International (AOAC). Official Methods of Analysis, 17th edition. AOAC International, Gaithersburg, Maryland.
21. Boyd, C.E., 1990. Water quality in ponds for aquaculture. Alabama agricultural experimental station. Aurburn University, Alabama, pp: 483.
22. Faturoti, E.O. and L.A. Lawal, 1986. Performance of supplementary feeding and organic manuring of the production of *Oreochromis niloticus*, J. West Africa Fisheries, 1: 25-32.
23. Steel, R.G., J.H. Torrie and D.A. Dickey, 1997. Principles and Procedures of Statistics, A Biometric Approach, 3rd edition. McGraw-Hill Companies Inc., New York, USA: 121.
24. Tacon, A.G.J., M.R. Hasan and R.E. Subasinghe, 2006. Use of fishery resources as feed inputs for aquaculture development: trends and policy implications. FAO Fisheries Circular No. XXX Rome, FAO, pp: 100.
25. Piedecausa, M.A., M.J. Mazon, B. Garcia-Garcia and M.D. Hernandez, 2007. Effects of total replacement of fish oil by vegetable oils in the diets of Sharpsnout seabream (*Diplodus puntazzo*), Aquaculture, oi:10.1016/j.aquaculture.2006.09.39.
26. Aboua, F., 1995. Proximate analysis and mineral content of two giant African snail consumed in tropics. Tropical Science, 35: 220-222.

27. Davis, M.S. and J. Hawkins, 1998. Mucus from molluscs. Advances in Marine Biol., 34: 1-71.
28. Ebenso, I.E., S.E. Ekanem and A.D. Ologhobo, 2010. Biochemical composition of pedal trail mucus from edible Tropical land snails. Proc. 35th Conf., Nig. Soc. for Anim. Prod. 14- 17 March, 2010, Univ. of Ibadan, Nigeria, pp: 201-202.
29. Nwanna, L.C., A.E. Falaye and A.O. Sotolu, 2008. Water hyacinth (*Eichhornia crassipes* Mart) Somls: A sustainable protein source for fish feed in Nigeria. (Food, Health and Environmental Issues in Developing Countries: The Nigerian Situation (Eds. Adebooye O.C, Taiwo K.A and Fatufe A.A) Alexander Von Humboldt Foundation, Bonn-Germany, pp: 187-194 .
30. Sotolu, A.O. and S.Y. Byanyiko, In Press. Nutritive potentials of *Parkia iglobosa* pulp meal in partial replacement for maize in the diets of African catfish (*Clarias gariepinus*) juveniles.
31. Steffens, W., 1989. Principles of Fish Nutrition. Ellis Horwood, Chichester (Eds.), pp: 384.
32. Watanabe, T., V. Kiron and S. Satoh, 1997. Trace minerals in fish nutrition. Aquaculture, 151: 185-207.
33. Aderolu, A.Z., M.P. Kuton and S.G. Odu-Onikosi, 2009. Substitution effect of sorghum meal for maize meal in the diet of catfish (*Clarias gariepinus*, Burchell, 1822) juvenile. Res. J. Fis. Hyd., 4(2): 41-45.
34. Gunasekera, R.M., K. Leelarasamee and S.S. De Silva, 2002. Lipid and fatty acid digestibility of three oil types in the Australian shortfin eel, *Anguilla australis*. Aquaculture, 203: 335-347.
35. Ogunji, J., R.S. Toor, C. Schulz and W. Kloas, 2008. Growth performance, nutrient utilization of Nile tilapia *Oreochromis niloticus* fed housefly maggot meal (Magmeal) diets. Turkish J. Fisheries and Aquatic Sci., 8: 141-147.
36. Sotolu, A.O. and M.I. Adejumoh, 2009. Nutrient values and utilization of rumen epithelia meal in the diet of *Clarias gariepinus* (Burchell, 1822). Prod. Agric. Technol., 5(1): 144-153.