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Full Length Research Paper

Comparative utilization of biodegraded and undegraded rice husk in *Clarias gariepinus* diet

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Possible improvement in the nutritional composition of rice husk (RH) was attempted through Solid State Fermentation with the use of the fungus, *Trichoderma viridii*. A comparative utilization of the fermented RH (FRH), raw RH and a control diet was studied using parameters like performance and nutrient utilization alongside some economic indicators to arrive at conclusion that isonitrogenous diets were produced using graded levels of RH (5.0, 75 and 10%) of both raw and the fermented which were compared to a control diet. The process of fermentation resulted in improvement in the crude protein value of RH by 97% and reduction in the crude fibre composition by 45%. Probably as a result of the fermentation process, fishes fed FRH had better Food Conversion Ratio (FCR), Protein Efficiency Ratio (PER) and Specific Growth Rate (SGR) than their counterparts fed raw RH. The Feed Intake (FI), Feed Conversion Ratio (FCR) and Protein Intake (PI) increased as level of inclusion of the RH increases. The same observation is equally true for the Profit Index, Benefit Cost Ratio and the Incidence Cost.

Key words: Biodegraded, rice husk, *Clarias gariepinus*, fungus.

INTRODUCTION

Agriculture development is given serious impetus by the present government in Nigeria but the realization of this dream is seriously impaired by inadequate supply of feedstuffs particularly the protein sources. The issue of prices and supply regularity of fish meal is very disturbing and the current trend of scientific thinking is an alternative that can partially or fully replace aqua feeds. Serious attention has been given to the use of plant proteins especially legume seeds but problems like presence of anti-nutritional factors, competition with utilization by man and other livestock and amino acid imbalance have to be tackled. However, cereals bran and offals like rice bran, maize and wheat bran unlike legume seeds which are presently not being consumed by man and they are produced in abundance.

Rice husk (RH) is the dry outer covering of rice grain, which is always removed during the milling of rice. It is of no direct nutritional value to man and in most mills it is often discarded or allowed to rot away. In some areas however, it may be collected and used as litter material or used in fire making. Since rice offal makes up to 40% of parboiled rice, Nigeria has the potential to produce about 200,000 metric tones annually (Wudiri, 1992).

In spite of RH abundance, nutritionists have neglected the use of RH in monogastric animals feed production because of its fibre content, poor nutritive value and bulkiness (El-hag and Kudi, 1986; Longe and Ogedenge, 1989; Dafwang and Shwaren, 1996). RH contains 2.9 – 3.6% crude protein, 0.8 – 1.2 ether extract, 39-42% crude fibre and 15-22% ash (Oyenuga, 1968).

Attempts at increasing the utilization of fibrous feed ingredients like RH include adequate fortification with micro nutrients (Onifade, 1993), supplementation with high quality protein and amino acids (Delorme and Wojak, 1982), physical and chemical pre-treatments and the use of microbial enzymes and antibiotics (Onilude, 1994; Wing-Keong et al., 2002).

Research on the utilization of RH in fish diet is not common as far we know but its utilization in chicken has been well researched into (Longe, 1988; Onifade, 1993; Aderolu et al., 2004). The use of rice bran on the other hand in fish diet has been well documented. Unlike RH, rice bran is less fibrous and higher in protein and oil con-

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Table 1. Nutrient composition of raw and fermented rice husk (RH) (% on dry basis).

Nutrient	Raw RH (%)	Fermented RH (%)
Crude Protein	3.06	6.04
Crude Fibre	36.50	20.25
Ether Extract	5.70	1.75
Ash	20.40	15.70
Nitrogen-Free Extract	40.30	56.25
Nutrient Detergent Fibre	69.43	53.18
Acid Detergent Fibre	49.13	39.89
Hemicellulose	20.26	13.32
Acid Detergent Lignin	13.28	11.34
Cellulose	35.89	28.52

The feed composition and the experimental diets are shown in Table 2. The diets were isocalorific and isonitrogenous.

tent (Fagbenro, 2002).

The present study sought to enhance the nutritive value of RH by pre-heating with microbial enzyme to digest the non-soluble polysaccharide (NSP) so as to improve the bioavailability of nutrients and increase the protein content by solid-state fermentation with the fungus, *Trichoderma viridii* (Cheah et al., 1989). Aderolu (2000) had earlier reported significant increase nutrient availability with different species of *Trichoderma* fungus on some fibrous feedstuffs but the final product has only been tested on meat and egg type chicken but not yet on fish (Aderolu, 2004; Aderolu et al., 2004)

The effects of raw and fermented RH on performance, nutrient utilization and economy of production of *Clarias gariepinus was* investigated in this present study. It was hoped that enhancing the nutritive value of RH through fungi fermentation could result in RH being incorporated at higher levels in *C. gariepinus* feeds.

MATERIALS AND METHODS

Rice husk was collected from a local rice mill in (Abeokuta, Ogun State) Nigeria. Adequate quantity was collected to avoid problems associated with different batches (Aderolu, 2000).

The fungus, *T. viridii* was collected from the culture collection department of Botany and Microbiology, University of Ibadan. It had earlier been worked on and confirmed by Onilude (1994) and Aderolu (2000) as having a very high celluloytic enzyme secretion on RH compared to other species of *Trichoderma*.

Fermentation procedure

The process of biodegradation which lasted for 10 days followed the procedure below. 10 kg of RH was autoclaved at 70℃ for 30 min, allowed to cool and was later inoculated with vibrant culture of the fungus.

A broth solution was prepared using 1.5 g of KH_2PO_4 with 3 g of malt agar and 2 g of sucrose all dissolved in 1,500 ml of distilled water plus the fungus. Autoclaved RH was then inoculated with spore suspension of *T. viridii* packed in an aluminium container, well covered and left at room temperature (28 - 33℃).

At the end of the tenth day, the fermented RH was oven-dried at 80℃ for 24 h in a forced-air oven in order to terminate the growth of the fungus. Proximate and detergent fibre analyses were later carried out on both the fermented and the raw RH (Table 1) according to the method of A.O.A.C (2000).

Diet formulation and experimental procedures

Seven experimental diets of approximately isonitrogenous and isocalorific nutrient levels were formulated. The control diet had neither the raw nor the fermented RH, while Diets 2-4 had graded levels of the raw RH (5, 7.5 and 10% respectively). The same graded levels of RH as in the diets 2-4 were included in diets 5-7 but the RH contents of these feeds were fermented with *T. viridii* for a period of 10 days (Table 2). The test ingredients were thoroughly mixed with the ingredients in a Hobart A-200T mixing and pelleting machine to obtain a homogeneous pellet which was later analysed to the right size the juvenile fishes could pick easily. The pelleted diets were then sun-dried at 31 - 35℃ for 3 days and stored in air-tight polythene bags prior to use.

Experimental procedure

The feeding trial was conducted in a flow-through aquarium dimension 55 cm x 35 cm x 31 cm containing 40% of dechlorinated water. Water quality parameters in each tank were monitored each week throughout the experimental period. It ranges between 27 - 29℃, 7.5 - 7.8 and 4.2 - 4.4 mg/l for temperature, pH and dissolved oxygen, respectively. 70 *Clarias* juveniles obtained from a local fish dealer were acclimatized to laboratory condition for a period of 14 days and fed 2 mm coppens feed during the period. Each experimental tank had 5 fishes and each diet was duplicated. The tanks were aerated and dechlorinated water was supplied every 3 days.

The fishes were fed at a feed rate of 4% their body weight per day and twice daily (9:00 and 16:00 h). Weighing of the fish was adjusted to the new weight. The mean weight data were used to assess the growth performance as follows:

Mean Weight Gain (MWG) = Final body weight – Initial body weight (Castell and Tiaus, 1980).

Specific Growth Rate (SGR) = [(W2 – W1)/(T2-T1)] x 100

Where W1, W2 are initial and final weights and T1, T2 are initial and final periods, respectively.

Food Conversion Ratio (FCR) = Total dry feed fed / Total weight gain

Protein Efficiency Ratio (PER) = Weight gained / Protein fed

Protein Intake (PI) = Weight of feed fed x Protein content of feed

Economy of feed production and raising of fishes

The cost was based on current prices of feed ingredients in the experimental locality (Nigeria) as of the time of the experiment. The economic evaluations of the diets were calculated from the method of New (1989) as:

Estimated Investment Cost Analysis = Cost of feeding ($) + Cost of juveniles stocked ($).

Table 2. Feed composition of experiment diets.

Ingredient	Control	Diet 1 (5% RRH)	Diet 2 (7.5% RRH)	Diet 3 (10% RRH)	Diet 4 (5% FRH)	Diet 5 (7.5% FRH)	Diet 6 (10% FRH)
Fish meal (72%)	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Soybean meal	36.00	36.00	36.00	36.00	36.00	36.00	36.00
Maize	32.00	30.00	27.50	25.00	30.00	27.50	25.00
Wheat Offal	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Rice Husk (raw)	-	5.00	7.50	10.00	-	-	-
Rice Husk (fermented)	-	-	-	-	5.00	7.50	10.00
Dicalcium phosphate	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Soy oil	1.50	1.40	1.30	1.20	1.40	1.30	1.20
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25

RRH = Raw Rice Husk; FRH = Fermented Rice Husk.

Table 3. Performance and nutrient utilization of *Clarias gariepinus* juvenile fed raw and fermented rice husk (RH).

Parameter	Control	Diet 1 (5% RRH)	Diet 2 (7.5% RRH)	Diet 3 (10% RRH)	Diet 4 (5% FRH)	Diet 5 (7.5% FRH)	Diet 6 (10% FRH)
Mean Final Weight	44.00	39.50	30.16	31.50	45.25	35.34	41.00
Mean Initial Weight	10.30	10.50	9.70	8.70	11.70	10.20	10.50
Mean Weight Gain	33.70	29.00^{b}	20.46^{d}	22.80^{d}	33.50^{a}	25.14^{c}	30.50^{b}
Average Feed Intake	25.40^{d}	28.29^{b}	30.12^{b}	34.47^{a}	26.86^{c}	27.76^{bc}	29.80^{b}
Feed Conversion Ratio	0.75^{c}	0.98^{b}	1.04^{b}	1.51^{a}	0.80^{c}	1.10^{b}	0.98^{b}
Protein Intake	9.36^{d}	10.41^{c}	11.04^{b}	12.57^{a}	9.93^{cd}	10.23^{c}	10.96^{bc}
Protein Efficiency Ratio	3.6^{a}	2.79^{b}	1.85^{c}	1.81^{c}	3.38^{a}	2.46^{b}	2.78^{b}
Specific Growth Rate	2.07^{a}	1.90^{a}	1.63^{d}	1.84^{b}	1.93^{a}	1.74^{c}	1.94^{a}

Profit Index = Value of fish ($) / Cost of feeding ($)

Net Profit = Sales – Expenditure

Benefit Cost Ratio (BCR) = Total Sales / Total Expenditure (Mazid et al., 1997)

Incidence of cost (I.C) = Cost of feed / Kg of fish produced

Statistical analysis

All the results were subjected to analysis of variance (ANOVA), Ducan Multiple Range Test (Ducan, 1985) was used to evaluate the mean differences among individuals diets at 0.05 significant level.

RESULTS

The treatment of the RH with fungus, *T. viridii*, almost double the value of crude protein. The solid state fermentation resulted in the hydrolysis of the Non-Soluble Polysaccharide (NSP) which is attested to by the drop in values of the Acid and Neutral detergent fibre, hemicellulose and the cellulose content of the RH (Table 1). The biodegradation process also resulted in reduction in the value of ether extract and ash from 5.70 to 1.75% and 20.40 to 15.70, respectively.

Data regarding growth and performance nutrient utilization by *C. gariepinus* juvenile fed experimental diets are presented in Table 3. The average final weight of fishes fed the fungus-treated rice.

There was no significant difference between fishes on control diets and those fed 5% treated RH (0.05). The Feed Intake (FI), Feed Conversion Ratio (FCR) and the Protein Intake (PI) values increased significantly ($P < 0.05$) across the graded levels of the test ingredients. A comparison of the treated and raw test ingredients at same inclusion level also showed some level of significant difference with the fishes on treated ingredient showing better performances in the parameters mentioned above.

On the other hand, the SGR and Protein Efficiency Ratio (PER) decrease as the inclusion level of the RH increases. Significant difference was observed in the SGR and PER. The Protein Efficiency Ratio values were higher for the treated RH compared to the raw RH diets.

The mean cost of feeding and the estimated investment cost increased significantly across the graded levels of the test ingredients. Despite the decrease in cost of feed

Table 4. Economic analysis of *Clarias gariepinus* Juvenile graded levels of raw and fermented rice husk (RH).

Parameter	Control	Diet 1 (5% RRH)	Diet 2 (7.5% RRH)	Diet 3 (10% RRH)	Diet 4 (5% FRH)	Diet 5 (7.5% FRH)	Diet 6 (10% FRH)
Mean cost of feeding	0.023^{c}	0.025^{bc}	0.026^{b}	0.030^{a}	0.024^{c}	0.024^{c}	0.026^{b}
Mean cost of juvenile	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Estimated investment cost	0.173^{c}	0.175^{bc}	0.176^{a}	0.180^{a}	0.174^{c}	0.174^{c}	0.176^{b}
Mean yield	0.254^{a}	0.238^{b}	0.212^{d}	0.219^{cd}	0.252^{a}	0.226^{c}	0.242^{b}
Net profit	0.081^{a}	0.063^{b}	0.039^{d}	0.039^{d}	0.078^{a}	0.052^{c}	0.062^{b}
Profit index	11.04^{a}	9.52^{b}	7.30^{d}	7.30^{d}	10.50^{a}	9.42^{b}	9.31^{b}
Benefit cost ratio	1.47^{a}	1.36^{b}	1.22^{d}	1.22^{d}	1.45^{a}	1.30^{c}	1.38^{b}
Incidence cost	0.68^{d}	0.86^{c}	1.32^{a}	1.32^{a}	0.72^{d}	0.96^{b}	0.85^{c}

production as inclusion rate of the RH increases (Table 4).

In all economic production parameters studied, there was no significant difference between the control diet and the 5% treated RH diet. It was also observed that the result from the diet containing 10% RH treated, competed favourably with the 5% raw RH diet.

Economic indicators like Incidence, Cost, Benefit Cost Ratio and Profit Index decreased at higher level of inclusion of the test ingredient but the values for the raw RH are higher than for the fermented RH.

DISCUSSION

The protein content of RH could be substantially increased by solid state fermentation with the fungus, *T. viridii*. This increase is due to microbial protein synthesis. Nevertheless, loss of lipid during the fermentation process was also observed and this nutrient was probably converted into the resultant fungi biomass (Cheah et al., 1989). According to Jones (1975), during fermentation, nutrient losses may occur as a result of leaching, destruction by light, heat and oxygen as microbial utilization. Similar reduction in crude fibre value was obtained by Ramachanidran et al. (2005) during the fermentation of *P. mungo* seed meal by Bacillus sp. The same author equally obtained reduction in anti-nutritional factors like Tanin and phytic acid due to solid state fermentation.

Similar results on RH fermentation were obtained by Belewu and Okhawere (1998) and Aderolu (2000). *T. viridii* species are well recognized as celluloytic fungi with a high level of cellulose activities (Halliwel et al., 1985; Onilude, 1994). The increase in weight as inclusion level of RH was also attested to by the contribution of Keembiychetty and De Silva (1993).

The ability of an organism to utilize nutrients, especially protein will positively influence its growth performance (Sogbesan and Ugwumba, 2006). This is justified by the best PER and low FCR, the decrease in the rate of weight gain and as inclusion level of RH increases could then be explained as thus; despite similar protein levels in all the diets, the quality of microbial protein could not be compared absolutely with fish meal. This could probably be due to the bitter taste of microbial protein, at high level inclusion, high nucleic acid and unbalanced amino acid composition (Hilton, 1983; Jauncey et al., 1984; Davies and Wareham, 1988). It could also be probably due to high fibre level which cumulates into increased cell wall materials and Non-Soluble Polysaccharides which invariably limit the rate of digestion and nutrient absorption. According to (Laplace et al., 1989; Sayer et al., 1991), high fibre diet result in increase in weight of excreta and poor nutrient absorption. The decrease in weight gain at high fibre load inclusion has also been reported by Keembiychetty and De Silva (1993). This could probably be due to the fermentation process which has drastically reduced the fibre load and the NSP content. The addition of microbial protein through the growth of the fungi could also be additional point.

Fishes fed diets containing fermented RH had better SGR, FCR and PER. Similar results were obtained by Mukhopadhyany and Ray (1999) when they fed fermented sesame seed meal to fish, and also Ramachandran and Ray (2007) when they fed fermented black seed to Rohu fingerlings. Other results on improved utilization of fermented feed ingredients include Ramachandran et al. (2005) when they fed up to 40% fermented grass pea seed to Rohu fingerlings.

Fermented PKM fed tilapia failed to bring better weight gain and FCR when compared to raw- and enzyme-treated counterpart (Wing-keong et al., 2002). The explanation given by the authors was probably the presence of mycotoxin in the fermented PKM as confirmed by Lim et al. (2001) from his fermented PKM with *Aspergillus flavus*. Other authors with similar experience of presence of anti-nutrients, the amino acid deficiency of fungi protein which limits its utilization as protein source include Dabrowski et al. (1980).

Despite the reduction in cost of feed as a result of the use of RH, economic evaluation revealed that the cost of producing fishes (IC) was significantly different between the treated RH and the control but marginal similarity was noticed between the control and 5% fermented RH.

In conclusion, results obtained from this investigation showed that 5% level of fermented RH can be incorporated into the diets of *C. gariepinus* without any adverse depression in growth and deleterious effects on health of the fish. Also that fermented RH when included in *C. gariepinus* juvenile gave better production and economic performances than the raw RH. This is an indication that it may be feasible to reduce the amount of expensive conventional feedstuffs such as fish meal and maize, invariably resulting in reduction in the cost of aquaculture production. Fishes fed diets containing fermented RH had better SGR, FCR and PER.

REFERENCES

Aderolu AZ (2000). Physico-Chemical Properties of Biodegraded Fibrous Feedstuffs as Energy Sources Using *Trichoderma spp*. M.Phill Thesis, Department of Animal Sciences, University of Ibadan, Nigeria.

Aderolu AZ, Iyayi EA, Ogunbanwo ST (2002). Nutritional Status of Palm Kernel Meal Inoculated with *Trichoderma harzanium*. Trop. J. Anim. Sci. 5(2): 103-108.

Aderolu AZ, Iyayi EA, Onilude AA, Emiola IA (2004). Biodegradable Rice Husks in Laying Birds Diet, Performance and Egg Quality Parameters. J. Livestock Res. Rural. Dev. 16: 11.

Association of Official Analytical Chemists (AOAC) (2000). Official Method of Analysis. 17th Edition, Washington D.C. U.S.A

Belewu MA, Okhawere OC (1998). Evaluation of Feeding Value of Fungi Treated Rice Husk to Ram. Proc. 25th Annual Conf. of Nigeria Society for Animal Production Held on March 21-26 at Gateway Hotel Abeokuta, Ogun State.

Castell JD, Tiaus K (Eds.) (1980). Report of the EIFAC, IUNS and ICES Working Groups on Standardization of Methodology. In: Fish Nutr. Res. EIPAC. t36, EIFAC/FAO, p. 24.

Cheah SC, Ooh LCL, Ong ASH (1989). Improvement in Protein Content of Palm Kernel Meal by Solid State Fermentation. In Proceedings of the World Congress on Vegetable Protein Utilization in Human Foods and Animal Feedstuffs. (Ed. by Applewhite TH). AocS Champaign, IL. pp. 96-99.

Dabrowski K, Hassard S, Quinn J, Pitcher TJ, Flinn AM (1980). Effect of *Geotrichum candidum* Protein Subtitution in Pelleted Fish Feed on the Growth of Rainbow Trout (Salmo gairdneri Rich) and Utilization of the Diet. Aquaculture. 21: 213-232.

Dafwang II, Shwaremen EBN (1996). Utilization of Rice Offal in Practical Rations for Broiler Chicks. Nig. J. Anim. Prod. 23(1): 21-23.

Davies SJ, Warehan H (1988). A Preliminary Evaluation of an Industrial Single Cell Protein in Practical Diets for Tilapia (Oreochromis mosambicus Peters). Aquaculture. 73: 189-199.

Delorme C, Wojak B (1982). Interaction of Dietary Protein with Cellulose in the Adaptation of Calorific Dilution by Weanling Rats. J. Nutr. 112: 12-28.

Ducan DB (1955). Multiple Range and Multiple F-Tests. Biometrics. 11: 1-42.

Halliwel G, Wahab MNBA, Patel AH (1985). The Contribution of Endo-1-,4-ß-d-gluconase to Celluloysis in *Trichoderma konngii*. J. Appl. Biochem. 7: 43-54.

Hilton JW (1983). Potential of Freeze-Dried Worm Meal as a Replacement for Fish Meal in Trout Diet Formulations. Aquaculture. 32: 277-283.

Jauncey K, Tacon AGJ, Jackson AJ (1984). The Quantitative Essential Amino Acid Requirements of Oreochromis mossambicus. In: Fishelson L, Taronarith Z, Isreal. Tel Aviv University Press, Isreal. pp. 328-337.

Keembiychetty CN, De Silva SS (1993). Performance of Juvenile *Oreochromis niloticus* (L) Reared on Diets Containing Cowpea, *Vigna catiang* and Black Grain, *Phaseolus mungo* Seeds. Aquaculture, 112: 207-215.

Laplace JP, Beatrice DV, Perez JM, Henry Y, Sylive G, Suawant D (1989). Associative Effects between Two Fibre Sources on Ilea and Overall Digestibility of Amino Acids Energy and Cell Wall Components in Growing Pigs. J. Nutri. 61: 75-78.

Lim HA, Ng WK, Lim SL, Ibrahim CO (2001). Contamination of Palm Kernel Meal with *Aspergillus flavus* which affects its Nutritive Value in Pelleted Feed for Tilapia, *Orechromis mosambicus*. Aquac. Res. 32: 895-956.

Longe OG (1988). Meeting the Energy Needs of Non-Ruminants from Non-Conventional Feed Resources in Nigeria. Paper Presented at Rural Management. Management Institute (ARMTI), Ilorin, Nigeria. Nov. 21-28, (1998).

Longe OG, Ogedenge NEE (1989). Influence of Fibre on Metabolizable Energy of Diet and Performance of Growing Pullets in the Tropics. Br. Poult. Sci. 30: 193-195.

Mazid MA, Zaher M, Begum NN, Aliu MZ, Nahar F (1997). Formulation of Cost-effective Feeds from Locally Available Ingredients for Carp Polyculture System for Increased Production. Aquaculture, 151: 71-78.

Mukhopadhyany N, Ray AK (1999). Effect of Fermentation on Nutritive Value of Sesame Seed Meal in the Diets for Rohu, *Labeo rohita* (Hamilton) Fingerlings. Aquac. Nutr. 5: 229-236.

New MB (1989). Formulated Aquaculture Feeds in Asia: Some Thoughts of Comparative Economics, Industrial Potential, Problems and Research Needs in Relation to Small-Scale Famers. In Report of the Workshop on Shrimps and Finfishes Feeds. (Badru JE Edn) ASEAN/SF/89/GGEN.

Onifade AA (1993). Comparative Utilization of Three Dietary Fibre Sources by Broiler Chickens. Ph.D. Thesis Department of Animal Sciences, Ibadan, p. 244.

Onilude AA (1994). Production, Characterization and Utilization of Some Dietary Fibre Degrading Enzymes as Additives in Broiler Diets. Ph.D. Thesis Department of Microbiology, University of Ibadan, Nigeria, p. 118.

Oyenuga VA (1968). Nigeria Feeds and Feeding Stuffs. Ibadan University Press. 3rd Edition.

Ramachandran S, Barragi A, Ray AK (2005). Improvement of Nutritive Value of Grass pea (*Lathyrus sativus*) Seed Meal in the Formulated Diets for Rohu, *Labeo rohita* (Hamilton) Fingerlings after Fermentation with a Fish Gut Bacterium. Bioresour. Technol. 96: 1465-1472.

Ramachandran S, Ray AK (2007). Nutritional Evaluation of Fermented Black Grain (*Phaseolus mungo*) Seed Meal in Compound Diets for Rohu, *Labeo rohita* (Hamilton) Fingerlings. J. Appl. Ichthyol. 23: 74-79.

Sayer WC, Mosenthin R, Ahrens F, Denttartog LA (1991). The Effect of Science of Fibre on Ileal and Faecal Amino Acid Digestibility and Bacterial Nitrogenous Excretion in Growing Pigs. J. Anim. Sci. 69: 4070-4077.

Sogbesan OA, Ugwumba AAA (2006). Bionomics Evaluation of Garden Snail (*Limicolaria aurora* Jay) Meal in the Diet of *Clarias gariepinus* (Burchell) Fingerlings. Niger. J. Fish. 2-3: 358-371.

Wing-Keong NG, Hong-Aik L, Siew-Lang L, Che-Omar I (2002). Nutritive Value of Palm Kernel Meal Pre-Treated with Enzyme or Fermented with *Trichoderma koningii* (Oudemans) As a Dietary Ingredients for Red Hybrid Tilapia (*Oreochromis sp.*). Aquac. Res. 15-33: 1199-1207.

Wudiri BB (1992). Cereals in Food Economy of Nigeria. In: Recent Development of Cereal Production in Nigeria. (Lawani SM, Babaleye T Eds.). Media Forum for Agric. (New for More Food), pp. 13-32.