Dietary Decorticated Bambara Groundnut (*Vigna Subterranea*) effect on the Growth Responses of Clariid Catfish (*Heterobranchus Bidorsalis*) Fingerlings

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Abstract: An experiment was designed and carried out to assess the growth responses of *Heterobranchus bidorsalis* fingerlings fed graded levels of toasted *Vigna subterranean* based diets with the aim of establishing the best inclusion level of Bambara groundnut seed meal. Ground decorticated toasted Bambara groundnut (BG) was incorporated as a non-conventional feedstuff at 0%(T_1); 10% (T_2); 20% (T_3); 30% (T_4) and 40% (T_5) level of replacement for Soyabean for treatment one to five respectively. One hundred (100) fingerlings with an initial mean weight of 2.5± 0.5g were stocked randomly to five treatments in triplicate groups and were fed to satiation twice daily for 70 days. At the end of the experimental period here was no significant difference ($P>0.05$) among all treatments in terms of specific growth rate and percentage weight gain while feed conversion ratio of T_2 (1.61) and T_3 (1.78) were significantly different ($P<0.05$) from that of Control (2.93), T_4 (2.86) and T_5 (2.55). The specific growth rate and the Percentage weight gain had highest values in T_1 (1.72 and 13.07 respectively) and lowest value in T_5(1.42 and 10.85 respectively). The protein efficiency ratio was highest in T_2 (2.00) which was not significantly different ($P>0.05$) from T_3 (1.89) but had the least value in T_1 (1.16). The Net Protein Utilization (NPU) had the highest value in T_2 (43.4) while the least NPU value was recorded in T_4 (14.65)

Keywords: Bambara groundnut, fingerlings feed, *Heterobranchus bidorsalis* and *Vigna subterranean*

Introduction

In Nigeria, fish is widely accepted by the populace, thereby making the demand for it to be on the increase. In recent time, a good amount of fish consumed by Nigerians is from aquaculture because the conventional fish catch from ocean and rivers are continually declining due to over fishing and environmental hazards (FAO, 2006). Jamiu and Ayinla (2003) reported that feed accounts for minimum of 60% of the total cost of fish production in Africa including Nigeria and a major factor that determines the viability and profitability of fish farming enterprise. As aquaculture production becomes more and more intensive in Nigeria, fish feed will be a significant factor towards increasing the productivity and profitability of aquaculture (Akinrotimi *et al.*, 2007). The need to intensify the culture of the fish, so as to meet the ever increasing demand for fish has made it essential to develop suitable diets either in supplementary forms for earthen ponds or as complete feed in tanks and other artificial enclosures (Olukunle, 2006).

Soyabean that serves as the most utilizable plant source of protein in feed formulation have become expensive and has to be imported to meet local demands in sub Saharan countries like Nigeria (Fagbenro and Adebayo, 2005; Shipton and Hecht, 2005). This underscores the need for alternative plant protein, the search for alternatives to soyabean is important for sustenance of the aquaculture industry and its profitability hence the study on Bambara groundnut. Bambara groundnut (*Vigna subterranean* (L.)*Verdc*) is a legume grown mainly in the Middle Belt region and Enugu State of Nigeria (Doku and Karikari, 1971). Bambara groundnut seed has been reported to contain 14-24% crude protein (Rachie and Roberts, 1974 and Olomu, 1995). The protein of the nut is of high biological value (Olomu, 1995), with a high amount of lysine (6.60%) and 1.30% methionine (Temple and Aliyu, 1994). According to Ezuoke (2003), bambara groundnut is not an oily seed since it contains only about 6% of ether extract. It contains moderate amounts of calcium and iron, though poor in phosphorus and with fairly high contents of thiamine, riboflavin, niacin and carotene, but very low in ascorbic acid (Oyenuga, 1968). The general objective of this study is to determine the growth, and nutrient utilization of bambara groundnut by *Heterobranchus bidorsalis.*

Materials and Methods

This study was conducted within the premises of the wet laboratory of the Department of Aquaculture and Fisheries Management, Faculty of Agriculture, University of Benin, Benin-city, Edo state for Seventy days.

Experimental Diets: Bambara groundnut *(Vigna subterranea)* whole seeds were decorticated and toasted on a well heated pot of for ten minutes to reduce the effect of toxins and protein inhibitors such as polyphenols and trypsin inhibitors, after which it was allowed to cool then milled into fine form. Fishmeal, soybeans cake, corn meal, palm oil, Vitamin E-gel and bone meal were purchased from a retail outlet at Murtala Mohammed Way in Benin City. The composition of the experimental diets is shown in Table 1.

Table 1: Composition of the Experimental Diets

	Treatments				
Ingredients	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
% Substitution of Bambara seed meal	**0%**	**10%**	**20%**	**30%**	**40%**
Fishmeal (65.5% CP)	**25.40**	**25.40**	**25.40**	**25.40**	**25.40**
Soya bean (38.8% CP)	**42.00**	**32.00**	**22.00**	**12.00**	**2.00**
Bambara ground nut (31.5% CP)	**0.00**	**10.00**	**20.00**	**30.00**	**40.00**
Maize (9.5% CP)	**20.00**	**20.00**	**20.00**	**20.00**	**20.00**
Bone meal	**4.00**	**4.00**	**4.00**	**4.00**	**4.00**
Palm oil	**8.00**	**8.00**	**8.00**	**8.00**	**8.00**
Vitamin E gel	**0.60**	**0.60**	**0.60**	**0.60**	**0.60**

The various ingredients were measured accurately to their required quantity, after which they were homogenously mixed, finely pelleted and dried at the departmental fish farm. The pelleted feed was stored in sealed containers throughout the duration of the experiment. *Heterobranchus bidorsalis* fingerlings (mean weight 2.5 ± 0.5g) were obtained from Hatchery section of the department of Aquaculture and Fisheries Management, University of Benin, Benin City.

Feeding Trial: The study was conducted in the wet laboratory of Department of Aquaculture and Fisheries Management, University of Benin, Benin City. Fifteen (15) rectangular plastic tanks, five (5) treatments in three (3) replicates measuring (30cm×36cm×52cm) were used. Each tank was filled up to 2/3 of its volume with bore-hole water attached to the laboratory. The fishes were weighed in batches of five into each of the experimental units replicated three for each treatment. They were fed twice daily to satiation to ensure maximum growth between 8:00 - 9:00hrs and 15:00 - 16:00hrs. Feeding was monitored for each unit to ensure that fishes were not underfed or overfed. The experimental units were cleaned by total changing of the water daily and sometimes once in two days. All fishes per replicate were weighed and counted weekly to determine growth and survival, also the weekly weighing of feed was also carried out. The data obtained from the feeding trials were tested for significant differences using one way Analysis of Variance (ANOVA) test and the means were separated using Duncan's Multiple Range Test, all at 5% level of significance.

Parameters Monitored: Data on feed consumed and weight gain were collected weekly for each unit from which the following performance parameters were evaluated.

1. Weight gain (WG) = $W_2 – W_{1\,(g)}$ Where; W_1 = initial weight
   W_2 = final weight
2. Feed intake = Initial weight of feed – Final weight of feed
3. Specific growth rate per day (SGR) % = $\frac{\text{Loge W2} - \text{loge W1}}{\text{T2} - \text{T1}}$ X 100
   Where: T_1 and T_2 are time of experiment in days.
   W_2 = final weight at T_2
   W_1 = initial weight at T_1
   Loge = natural logarithm.
4. Relative weight gain (PWG) % = $\frac{\text{Weight Gain}}{\text{Initial Weight}}$ X 100
5. Food conversion ratio (FCR) = $\frac{\text{Feed Intake(g)}}{\text{Wet Weight Gain(g)}}$ X 100
6. Protein efficiency ratio (PER) = $\frac{\text{Weight Gain (g)}}{\text{Protein Intake}}$ X 100
7. Survival rate % = $\frac{\text{Initial stocked} - \text{mortality}}{\text{Initial stocked}}$ X 100

Result

Temperature of water within the experimental period was averaged 28 °C and PH at 7.4

Table 2: Proximate Composition (%) Of Experimental Diets

	Treatments					
Proximate Composition	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**Bambara Groundnut**
Moisture content (%)	**6.24**	**6.54**	**6.19**	**6.52**	**6.43**	**7.75**
Protein content (%)	**41.42**	**36.75**	**39.00**	**42.58**	**28.00**	**31.50**
Ether extract (%)	**15.22**	**14.25**	**14.88**	**13.60**	**14.57**	**9.25**
Crude fibre (%)	**4.45**	**3.15**	**3.27**	**3.95**	**3.52**	**4.54**
Ash (%)	**9.67**	**10.42**	**9.15**	**9.65**	**10.24**	**10.34**
NFE (%)	**23.00**	**28.88**	**27.51**	**23.69**	**37.23**	**45.75**

The proximate composition of experimental diet (Table 2) shows that crude fat is highest at T_1 (15.22%) and lowest at T_4 (13.60%), crude fiber content was highest in T_1 (4.45%) and lowest in T_2 (3.15%), moisture content was highest in T_2 (6.54%) and lowest at T_3 (6.19%), Crude protein value was highest in T_4 (42.58%) and lowest in T_5 (28.00%), Ash content value was recorded to be highest in T_2 (10.42%) and the lowest in T_3 (9.15%).

Table 3: Carcass composition (%) of *Heterobranchus bidorsalis* fingerlings fed varying levels of *Vigna subterrenean.* seed meal based diets for 70 days

	Initial carcass	TSF 1	TSF 2	TSF 3	TSF 4	TSF 5
Moisture content	**5.06**	**5.13**	**4.73**	**4.35**	**4.23**	**5.13**
Fat	**15.21**	**14.29**	**14.82**	**15.85**	**15.46**	**15.01**
ash	**10.20**	**10.35**	**9.55**	**10.00**	**9.84**	**10.22**
Crude protein	**64.75**	**61.83**	**65.33**	**68.25**	**67.08**	**60.08**
NFE	**4.77**	**8.39**	**5.56**	**1.55**	**3.38**	**8.66**

TSF = *Test fish carcass composition*

Proximate composition of test fish (Table 3) shows that the fat content were irregular, T_5 had the highest value (15.91) while T_1 had the lowest value (14.29). Ash content of test fish was highest in T_1 (10.35) and lowest in T_2 (9.55). T_3 had the highest crude protein value (68.25% CP) while T_5 had the least value (60.08% CP).

Table 4: Growth response and nutrient utilization of *Heterobranchus bidorsalis* fingerling fed *Vigna subterrenean* seed meal based diets

	TREATMENT					
PARAMETERS	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**SEM**
	0%	**10%**	**20%**	**30%**	**40%**	
Weight gain(g)	**2.11^b**	**2.47^{ab}**	**3.23^a**	**2.30^{ab}**	**1.70^b**	**0.47**
Feed Intake	**4.84^a**	**3.45^b**	**3.56^b**	**4.46^a**	**3.32^b**	**0.34**
Percentage weight gain(g)	**13.07**	**12.79**	**11.48**	**10.97**	**10.85^{NS}**	**1.19**
Specific growth rate(g)	**1.72**	**1.70**	**1.54**	**1.48**	**1.42^{NS}**	**0.15**
Feed conversion ratio	**2.93^b**	**1.61^a**	**1.78^a**	**2.68^b**	**2.55^b**	**0.35**
Protein efficiency ratio	**1.16^b**	**2.00^a**	**1.89^a**	**1.44^b**	**1.50^b**	**0.17**
Survival rate %	**94.67^b**	**98.67^a**	**100^a**	**100^a**	**100^a**	**1.21**
NPU	**15.83^c**	**43.4^a**	**26.04^b**	**14.65^c**	**39.43^a**	**3.70**

Mean in each row with the same superscript are not significantly different (P > 0.05) SEM = standard error of mean NS= No Significant Difference

The growth response and nutrient utilization data evaluated (Table 4) displayed a regular trend with almost all substitution levels. At all levels of substitution, there was an increase in weight gain. The highest weight gain was recorded in T_3 (3.23) that was fed with diet containing 20% Bambara seed meal. This treatment was not significantly different (P < 0.05) from $T_2$and T_4 with inclusion levels of 10% and 30% respectively but was significantly different (P < 0.05) from T_1 and T_5 with inclusion levels of 0% (control) and 40% respectively.

Percentage weight gain showed no significant difference (P > 0.05) across all treatments. However, T_1 had the highest value (13.07) while T_5 had the least value (10.85) .

Feed intake in T_1 and T_4 were not significantly different (P > 0.05) from each other but were significantly different (P < 0.05) from $T_{2,}$ T_3 and T_5 which were also significantly not different (P > 0.05) from each other. T_5 recorded the lowest feed intake value (3.32g) while T_1 had the highest feed intake value (4.84g).

There was no significant difference (P>0.05) in the specific growth rate value across all treatments after the experimental period. However, T_1 (1.73) had the highest specific growth rate while T_5 (1.42) recorded the lowest value.

The feed conversion ratio (FCR) recorded was an indication that food was converted to flesh at different rate. The best FCR value was reported in T_2 (1.61) while the control diet had the highest value (2.93).

Protein efficiency ratio showed no significant difference (P > 0.05) between T_2 and T_3. There was also no significant difference (P>0.05) between $T_{1,}$ T_4 and T_5. The highest value was recorded in T_2 (2.00) while the least value was reported in the control diet (1.16).

Net Protein Utilization (NPU) value was irregular in all treatments with T_2 having the highest value of 43.4% and T_4 having the lowest value of 14.64%. T_1 and T_4 were significantly different (P < 0.05) from T_2 and $T_{5.}$

Discussion

The survival of the experimental fish could be as a result of good water quality management, good handling and the suitability of BSM as an ingredient in *H.bidorsalis* diet.

The crude protein content of the bambara nut of 31.5%CP was higher than the 21.92% CP reported by Enyidi and Mgbenka, (2014) and 15.75% CP reported by Ekenyem *et. al.* (2006). It indicates that there are factors which affect the crude protein content such as the processing methods (Ndidi *et al.*,2014) and variety (Enyidi, 2012). The fat content of 9.25% was higher than the 4.75% reported by Ekenyem *et al.*(2006).

The study showed no significant difference (P<0.05) between the growth performance (percentage weight gain and specific growth rate) of the fingerlings fed the compounded Bambara nut substituted diets and that fed the conventional soyabean meal diet (control diet). This can be attributed to proper utilization of the compounded BSM. It may also be due to the fact that bambara groundnut contains the major limiting amino acids in plant based diet; lysine and methionine in high proportion (Poulter, 1981) and as reported by Ozório *et al.*(2002), High lysine content has been noted to improve feed intake in African catfish. Brough and Azam-Ali, (1992) reported that Bambara nut seed makes a balance food as it contains sufficient quantities of carbohydrate, protein and fats with relatively high proportion of lysine and methionine as percentage of the protein. Amarteifio *et al.* (2006) reported that Bambara groundnut is a good source of minerals and can be helpful in formulating a balanced diet.

The result showed that the control diet (0%) had a better growth rate which was closely followed by T_2 (10%) and T_3 (20%). This means that among the diets in which BSM was included, T_2 had the highest growth rate of 1.72g than all other inclusion levels of BSM. This however does not correlate with the study carried out by Aliu and Ikoko (2016) of BSM fed to *Clarias gariepinus* fingerlings in which growth rate was found to be highest for diet containing 40% BSM and also the works of Aliu and Okolie (2005) and Santiago *et al.,* (1986) who also recorded that 40% inclusion level of bambara nut produced best result in terms of growth rate.

Opara (1996) and Iyayi (2001) observed that higher crude fiber levels in diets depressed weight gain. Therefore the improved weight gain of fish fed the BSM can be due to the fact that the crude fibre content of the BSM diets were lower than the control diet as shown in Table 2 and hence this contributed to the improved weight gain of the fish fed with the BSM diets. It is also probable that the common processing techniques for bambara nut such as toasting and milling employed in this study were able to modify the nutritive value of the bambara nut thus ensuring nutrient availability to the fish. This view is in harmony with the report of **Just (1982)** who reported that common processing techniques such as grinding, pelleting, and others could modify the nutritive value of diets which also agrees with Fagbenro (1999), Francis *et al.,* (2001) and Siddhuraja and Becker (2003) who reported that reduction in anti nutrient by different processing techniques resulted in better palatability and growth in fish.

Feed utilization expressed as FCR is known to be affected by body weight **(Pandian, 1967),** ration and size (Condrey, 1982). The higher FCR for T_1 (0%), T_4 (30%) and T_5 (40%) indicated that feed utilization became less efficient and apparently fish did not consume the amount of protein needed for optimum growth (Anguas-Vélez et al., 2000). According to Adikwu, (2003) the lower the FCR, the better the feed utilization by the fish. The result from this study shows that the feed was better utilized by the fish fed with 10% BSM inclusion diet and 20% BSM inclusion diet since the FCR of these two treatments were not significantly different. The low FCR of diets containing BSM is in line with the findings of Aliu and Okolie (2005) which stated that feeds that contain bambara nut have low FCR. Contrary to this study, Uchechukwu *et al.* (2014) reported that increasing level of soybean recorded decrease in FCR catfish larvae.

From the result of this feeding trial, it is obvious that that the growth and nutrient utilization of *H. bidorsalis* were influenced by the levels of Bambara nut seed meal inclusion in the diets. Bambara nut is estimated to contain about 30% neutral sugars identified as glucose and galactose (Minka and Bruneteau, 2000) hence a combination of oil and sugars plus fish meal content of feed may have contributed to the palatability and positive gustatory effect. All the experimental diets were accepted by the experimental fish indicating that the incorporation of BSM in fish diets did not have adverse effect on the palatability of the experimental diets. It has been noted that cultured fish in artificial enclosures such as cages depend solely on the nutrient from the feed for growth with little or no contribution from natural food. This implies that the general increase in weight of trial fish was an indication that all the diets met a part or the whole nutrient requirement for growth in *H. bidorsalis* fingerlings.

Conclusion

The result of this study showed that Bambara seed meal (BSM) can be used as an alternative source of soya bean meal in the diet of *H. bidorsalis* fingerlings without necessarily impairing the growth rate of the fish. The result obtained from this study showed that among the diets which contained BSM, T_3 with 20% inclusion level performed best, however this performance was not significantly different from T_2 with 10% inclusion level but since weight gain of fish is what would translate into income for the fish farmer at the end of the production cycle, 20% inclusion rate of BSM in *H.bidorsalis* diet would produce better and profitable result at present.

References

Adikwu, I. A. (2003). A review of aquaculture nutrition in aquaculture development in Nigeria. In: Proceeding of the Joint Fisheries Society of Nigeria, National Institute for Freshwater Fisheries Research, FAO-National Special Programme for Food Security and National Workshop on Fish Feed Development and Feeding Practices in Aquaculture held at National Institute for Freshwater Fisheries Research, New-Bussa. Pp 34-42.

Akinrotimi, O.A., Gabriel, U.U., Anyanwu, P.E. and Anyanwu, A.O. (2007). Influence Of Sex, Acclimation Method And Period On Haematology of *Sarotherondon melanotheron*. *Research Journal of Bioogical sciences.;* 2(3):348-352.

Aliu, B.S and Okolie, N.P. (2005). Growth response of Nile Tilapia (*Oreochromis niloticus*) fingerlings to dietary decorticated Bambara groundnut (*Voandzeia subterranea*). *Journal of Sustainable Agricultural Research*.15:24-26.

Aliu, B.S and Ikoko, E. (2016). Growth response of Clariid catfish (Clarias gariepinus) fingerlings to dietary decorticated Bambara groundnut (*Voandzeia subterranea*). *International Journal of Fisheries and Aquatic Studies.* 4(6): 267-270.

Amarteifio, J. O., Tibe, O. and Njogu, R. M. (2006). The mineral composition of Bambara groundnut (*Vigna subterranea (L) Verdc*) grown in Southern Africa. *African Journal of Biotechnology*. 5(23): 2408-2411.

Anguas-Vélez, B.H; Civera-Cerecedo, R.; Cadena-Roa, M.; Guillaume, J. and Martinez-Diaz, S.F. (2000). Studies on the Nutrition of Spotted Sand Bass *Paralabrax maculatofasciatus*: Effect of the Dietary Protein Level on Growth and Protein utilization in Juveniles Fed Semi purified Diets. *Journal of World Aquaculture Society.* 31: 580-591.

Brough, S. H. and Azam-Ali, S. N. (1992). The Effect Of Soil Moisture On Proximate Composition Of Bambara Groundnut (*Vigna subterranean L.*) Verdc. *Journal of the Science of Food and Agriculture*. 60: 197-203.

Condrey, R. E. (1982). Ingestion-limited growth of aquatic animals: the case for Blackman kinetics. *Canadian Journal of Fisheries and Aquatic Science.* 39: 1585-1595

Doku, E. V. and Karikari, S. K. (1971).Bambara groundnut. *Economic Botany.* 25: 255-262.

Ekenyem, B.U. and Onyenagoro, C.P. (2006). Replacement value of bambaranut *Voandzeia subterranea* sievate for soybean meal *Glycine max* on the performance of finisher broiler chicken. *International Journal of Poultry Science*, (5): 381-384.

Enyidi, U.D. (2012). Production of feeds for African catfish *Clarias gariepinus* using plant proteins. *Jyvaskyla Studies in Biological Sciences, 251*.University of Jyvaskyla, Finland.

Enyidi, U.D. and Mgbenka, B.O.M. (2014). Replacement of fish meal with bambaranut waste meal in the diets of first feeding Heteroclarias (*Clarias gariepinus X Heterobranchus bidorsalis*) . *International Journal of Fish Aquatic Studies.* 1: 118-122.

Ezeuoke, O. C., (2003). Biochemical, Hematological and Nutritional Evaluation of raw and taste bambara groundnut by-products using rabbit thesis. College of Animal Science and Animal Health; Michael Okpara Universityof Agriculture.Umudike. Pp 15-16.

Fagbenro O.A. and Adebayo O.T. (2005). A review of animal and aquafeed industries in Nigeria. In: Moel, J. and Halwart, M. (eds), *Asynthesis of the formaulated animal and aquafeed industry in Sub-saharan Africa.* CIFA Occassional paper No. 26. Rome. Italy: FAO.pp. 25-36

Fagbenro, O.A. (1999). Comparative evaluation of heat processed winged bean (Psophocarpus tetragonolobus) meals as partial replacement for fishmeal in diets for African catfish (*Clarias gariepinus*). *Aquaculture.* 170: 297-305.

Food and Agriculture Organization (2006). Regional Review on Aquaculture Development in Sub-Sahara Africa. FAO Fisheries Circular No 1017/4 Pp1-23.

Francis, G., Makkar, H. K., Becker, K. (2001). Antinutritional Factors Present In Plant-Derived Alternate Fish Feed Ingredients And Their Effects In Fish. *Aquaculture*. 199: 197-227.

Iyayi, E.A. (2001). Cassava Leaves As Supplements For Feeding Weaner Swine. *Tropical Animal Prod. Invest.* 4:141-150.

Jamiu, D.M. and Ayinla, O.A. (2003). Potential for the development of aquaculture in Africa *NAGA*. 26 (3): 6-13

Minka, S.R. and Bruneteau, M. (2000). Partial chemical composition of Bambara pea (*Vigna subterranea* (L) Verde). *Food Chemistry*.; 68:273-276.

Ndidi, U.S; Ndidi, C.U; Olagunju, A; Muhammad, A.; Billy, F.G. and Okpe, O. (2014). Proximate, antinutrients and mineral composition of raw and processed (boiled and roasted) *Sphenostylis stenocarpa* seeds from Southern Kaduna, North-West Nigeria. *ISRN Nutr.* 2014(2014):1–9.

Olomu, J. M. (1995). Monogastric Animal Nutrition: Principles and Practices. Jachem Publishers Benin. Pp 67-159.

Olukunle, O. (2006). Nutritive Potential of Sweet Potato Peel and Root Replacement Value for Maize Diet of African Catfish advanced fry. *Journal of Food Technology*. 4(4): 289-293.

Opara, C. C. (1996). Studies on the use of Alchornia cordifolia leaf meal as feed ingredient in poultry diets. MSc Thesis, Federal University of Technology, Owerri, Nigeria.

Oyenuga, V. A. (1968). Nigeria's Food and Feeding Stuff, Their Chemistry and Nutritive Values. Ibadan University Press, Ibadan. Pp 87-89.

Ozório, R.O.A., Booms, G.H. R., Huisman, E.A. and Verreth, J.A.J. (2002). Changes in amino acid composition in the tissues of African catfish (*Clarias gariepinus*) as a consequence of dietary L-carnitine supplements. *Journal of Applied Ichthyology*. 18: 140-147.

Poulter, N. H (1981). Properties of some protein fractions from bambara groundnut (V oandzeiasubterranea (L) Thouars). *Journal of the Science of Food and Agriculture.* 32: 44-50.

Rachi, K. O. And Roberts, L. M. (1974).Grain Legumes of the Low Lands Tropics. Ln Advance in Agronomy. Pp: 26-132. .

Santiago, C.B., Aldaba, M.B. and Reyes, O.S. (1986). Influence of feeding rate and diet form on growth and survival of Nile tilapia (*Oreochromis niloticus*) fry. *Aquaculture.* 64: 277-282.

Shipton, T. and Hecht, T. (2005).A synthesis of the formulated animal and aquafeed industry in sub-Saharan African. In: Moehl, J. and Halwart, M. (eds.), a synthesis of the formulated animal and aqua feed industry in sub–Saharan Africa, Committee for Inland Fisheries of Africa Occasional paper. 26: 1–13.

Siddhuraju, P. and Becker, K. (2003). Comparative nutritional evaluation of differentially processed mucuna seeds [*Mucuna pruriens* (L.) D C. var. Utilis (Wall ex Wight) Baker ex Burck] on growth performance, feed utilization and body composition in Nile tilapia *(Oreochromis niloticus* L). *Aquaculture Resources,* 34: 487-500.

Temple, V. J and Aliyu, R. (1994). Proximate composition of the cream coloured decorticated seeds of Bambara groundnut (*Voandzeia subterranea* (L.) Thouras). *Biological Science Research Communication.* 6: 51-54.

Uchechukwu E, Juhani P, Jouni V. (2014). Effects of Substituting Soybean (*Glycine max*) Meal with Bambara nut (*Voandzeia subterranea*) Meal on Growth Performance and Survival of African Catfish (*Clarias gariepinus*) Larvae. *International Journal of Fisheries and Aquatic Studies*. 1(3):152-157.