Online Journal of Animal and Feed Research

Volume 3, Issue 3: 143–148 (2013) *ISSN 2228-7701*

EFFECT OF FEEDING TIME ON THE PERFORMANCE OF JUVENILE AFRICAN CATFISH (*Clarias gariepinus,* Burchell 1822)

A.O. ANI *, B.A. OKPAKO and L.C. UGWUOWO

Department of Animal Science, University of Nigeria Nsukka, Nigeria

*Email: austinani2011@yahoo.com

ABSTRACT: *The experiment was conducted to investigate the effect of feeding time on the performance of juvenile African Catfish (Clarias gariepinus, Burchell 1822). The experimental fish were randomly assigned to four treatment groups (different feeding time intervals) of 60 fish each in a completely randomized design (CRD). Each treatment was replicated three times with 20 fish per replicate. The fish were fed with extruded fish feeds (Catco® fish concentrate) at 3% of the fish body weight. The four treatments (feeding time) were T1 - once a day feeding time of morning hours (07.30 to 08.30) only, T2- once a day feeding time of afternoon hours (12.30 to 13.30) only, T3- once a day feeding time of evening hours (17.00 to 18.00) only and T4- twice a day feeding time of morning hours (07.30 to 08.30am) and evening hours (17.00 to 18.00) only for twelve weeks. There were significant difference (P<0.05) among treatments in fish' final body weight (223.63g, 200.13g, 196.33g and 168.17g for T4, T1, T3 and T2, respectively), mean total body weight gain (208.97g, 184.83, 181.07g and 153.41g for T4, T1, T3 and T2, respectively), mean daily body weight gain (2.60g, 2.20g 2.16g and 1.83g for T4, T1, T3 and T2, respectively), specific growth rate (SGR) of 1.41,1.33, 1.32 and 1.26 for T4, T1, T3 and T2, respectively) and daily feed intake (3.27g, , 3.09, 2.95g and 2.54g for T4, T1, T3 and T2, respectively). There were also significant differences (P<0.05) among treatments in water temperature (26.13 °C, 25.50°C, 26.43 °C and 28.10 °C for T4, T1, T3 and T2, respectively). However, there were no significant differences (P>0.05) among treatments in dissolved oxygen (7.1 mg/l, 6.8mg/l, 7.3 mg/l and 7.5 mg/l for T1, T2, T3 and T4, respectively), water pH (7.1), feed cost per kg weight gain (N390.00, N380.00, N379.00 and N368.00, for T1, T2, T3 and T4, respectively) and mortality rate of fish (13.38%, 11.67%, 10.00% and13.3% for T1, T2, T3 and T4, respectively). It is evident from the result obtained in the present day study that the growth performance of African catfish (Clarias gariepinus, Burchell 1822) fed twice a day (in the morning and evening hours) was superior to the performance of those fed once a day especially those fed in the afternoon hours only.*

ORIGINAL ARTICLE

Key words: *Effect, Feeding Time, African Catfish, Growth Performance*

INTRODUCTION

Aquaculture, the farming of aquatic organisms including fish, molluscs, crustacean and aquatic plant is necessary to meet the protein need of Nigerians. Over time, there has been increase in fish production in Nigeria. Bello (2007) and FAO (2005) reported increase in fish production in 2005. According to him, the artisan fish production level grew by 5.4%, aquaculture fish production by 43% and industrial fishery through the use trawlers by 12% over the previous years. However, of this increase in fish production, the desired result has not been attained. Quantitatively, details of fish production as at 2005 stood at 490,600 tons from the artisan fishery, 56,300 tons from industrial fishery through the use of trawlers; while fish importation stood at 61,150 tons. In meeting up with the growing need for fish production, aquaculture practice has been identified as a possible alternative; the reasons being that the activities of artisans and industrial fishery in our natural waters have led to over exploitation and degradation due to human activities in our coastal water. To fully bring aquaculture to its desired level, four production challenges have been identified. These are the challenges of feeding the fish stock in the pond, management of pond water quality, fish seeds provision and pond construction/establishment. The first two challenges: fish feeding and water quality management affect each other. The level of feeding of the stocks affects the water quality and the level of water quality affect the feeding performance of fish in the pond (George, 2001).

Fish like other animals need food to be able to carry out their metabolic activities. In aquaculture, fish feeding is either supplemental or complete (total supply). Supplemental feeding is when feeds are given to the

To cite this paper: Ani, A.O., Okpako, B.A. and Ugwuowo, L.C. 2013. Effect of feeding time on the performance of juvenile African catfish (*Clarias gariepinus,* burchell 1822). *Online J. Anim. Feed Res.*, 3(3): 143-148.
Scienceline/Journal homepages: http://www.science-line.com/index/; http://www.ojafr.ir

animal at a minimal level to add to the natural food available for the fish in the pond water. These natural foods are in the form of phytoplanktons and zooplanktons. The complete feeding is when the source of food fed to the fish is solely supplied by the farmer. In whichever case, the type of feeding practiced depends on the nature of the pond and the type of production the farmer is involved with (Michael, 1987; Michael et al., 2005). The most popular cultured fish in Nigeria is the catfish. It is naturally carnivorous, a bottom pond dweller, nocturnally very active and belongs the family of *Claridae* (William, 1967; Idodo-Umeh, 2003). However, with the fish domestication, its modes of feeding and activities have been destabilized and modified. To this end, the feeding regime has become diverse but the thumb rule of feeding stock at optimum level should be very economical so as to have savings in feed cost and the overall economic justification. Webster et al. (1992) reported that catfish can be fed once or twice daily and rainbow trout at three times a day. In whichever case, the type of production, climatic condition and economic status of the farmer dictate the feeding requirement. According to Raven and Walker (1978), a major problem facing fish feed manufacturers and fish nutrition is the increasing competition for the same feeding stuff between man and the fish feed industry due to their conventional status. This has brought about the high price and scarcity of such feed stuffs. Various studies have been done in fish feeding (Collins and Delmendo, 1979; Sena and Brain, 1992) but much is still to be done in the area of the best time of the day to feed catfish so as to have good growth performance that will justify the high cost of feeds provided by the farmer. Determining the best time of the day to feed the catfish will therefore help to maximize performance, discourage waste and ensure the success of the enterprise. This will help to discourage the deterioration of water quality which may arise from the decomposition of feeds fed to the fish due to feeding at inappropriate time. This will help to minimize fish mortality due to pond water quality deterioration. The overall production of the stock will also be enhanced (Norm Meck, 2000).

This study was therefore conducted to determine the effect of feeding at different time intervals of the day on the growth performance of African catfish (*Clarias gariepinus,* Burchell 1822).

MATERIALS AND METHODS

The experiment was carried out in the Fisheries Unit of the Teaching and Research Farm, Department of Animal Science, University of Nigeria, Nsukka. Two hundred and forty post juvenile African catfish fingerlings (*Clarias gariepinus* Burchell 1822) were used for the study which lasted for ten weeks. The post juvenile African catfish fingerlings were purchased from the local hatchery in Makurdi, Benue state, Nigeria.

MANAGEMENT OF THE EXPERIMENTAL FISH

A total of two hundred post juvenile African Catfish fingerlings weighing 15.0 ± 0.26 g on the average were randomly divided into four treatment groups (T1, T2, T3 and T4) of 60 fish per group using a completely randomized design (CRD). The treatment groups were designated as follows: T1 (Fish in this group were fed once daily in the morning at 07.30 hour to 08.30 hour at 3% of their body weight), T2 (Fish in this treatment were fed once daily in the afternoon at 12.30 hour to 13.30 hour at 3% of their body weight), T3 (Fish in this group were fed once daily in the evenings at 17.00hour to 18.00hour at 3 % of their body weight) and T4 (Fish in this treatment were fed twice a day in the morning and evening at 07.30 hour to 08.30 hour and at 17.00 hour to 18.00 hour, respectively at 3% of their body weight). The feed used for treatment 4 was divided into two so that the fish receive half of the ration in the morning and the remaining half in the evening. Each group was replicated three times with 20 fish per replicate placed in plastic tanks measuring 0.6m x 0.6m x 0.9m. The fish were fed with extruded commercial feeds of Catco® Fish Concentrate. The composition of the diet is presented in Table 1.

Table 1 - Nutritional composition of the experimental diet

Crude Protein	42.0
Crude Fat	13.0
Crude Fibre	1.9
Ash	9.5
Phosphorus	1.1
Vitamin A (I.U./kg)	15000
Vitamin D3 (I.U./kg)	2000
Vitamin E (mg/kg)	200
Vitamin C (Stable) (mg/kg)	150
Copper (mg/kg)	5

To mitigate the environment as a result of the exposure of the plastic materials to atmospheric temperature, and the volume of the water used for the experiment, an open shed was constructed with rough thatch over the water holding vessels with its sides rounded up with wire mesh up to three feet high to prevent the entrance of rodents and human factors.

The fish were fed daily with 1.5mm to 4.5mm feed size of the extruded commercial feeds at 3% body weight throughout the twelve weeks experimental period. The initial body weight (gm) and length (cm) of the fish were taken using sensitive scale and meter rule, respectively before they were stocked and subsequently at two weeks interval. The temperatures of the water were also measured daily using the thermometer and the pH using the pH meter before feeding the animals. The dissolved oxygen was monitored and measured weekly using the dissolved

To cite this paper: Ani, A.O., Okpako, B.A. and Ugwuowo, L.C. 2013. Effect of feeding time on the performance of juvenile African catfish (*Clarias gariepinus,* burchell 1822). *Online J. Anim. Feed Res.*, 3(3): 143-148.
Scienceline/Journal homepages: http://www.science-line.com/index/; http://www.ojafr.ir

oxygen meter. The volume of the water was maintained at 0.18m^3. The top of the vessels was also covered with 5mm mesh size net to protect the stocks from jumping out while the water in the vessels was changed bi-weekly to avoid the buildup of nitrates and nitrites as effluent leaching was not possible due to the use of plastic materials.

PARAMETERS MEASURED

Live weight (g) of the fish was measured using sensitive top loading scale. The length (cm) of the fish was measured using the rule meter. Feed in-take of the fish was measured using sensitive top loading scale. Dissolved oxygen was measured using the dissolved oxygen meter; water temperature was measured using the thermometer and water pH using the pH meter according to the various replicates and treatments. Some of the data generated were used to calculate weight gain, protein efficiency ratio and feed cost per kg weight gain. The specific growth rate was calculated as follows: Specific Growth Rate = Final body weight of fish – initial body weight of fish/No of Days the fish were reared. Mortality was monitored and records kept on daily basis.

STATISTICAL ANALYSIS

Data collected were subjected to analysis of variance (ANOVA) as described by Steel and Torrie (1980) and Akindele (2004). Significantly different means were separated using Duncan's New Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Data on the growth performance and body length of African catfish fed at different time intervals are presented in Tables 2 and 3, respectively. Significant differences ($P<0.05$) were noticed in the feed intake and weight gain of the fish in the various treatments. Final mean body weight was 223.63g (T4), 200.13g (1), 196.33g (T3) and 168.17g (T2). The mean body weight gained was 208.97g (T4), 184.83g (T1), 181.07g (T3) and 153.41g (T2) and the mean daily weight gain for the period was 2.60g (T4), 2.20g (T1), 2.16g (T3) and 1.83g (T2). The specific growth rate (SGR) also showed significant difference at ($P<0.05$) with mean value as follows: T4 (1.41) T1 (1.33), T3 (1.32) and T2 (1.26). These results were due to the feed consumption rate of the fish that showed significant difference ($P<0.05$) in the same order. This shows that the feed fed to the fish impacted the fish positively at the various time intervals of feeding. This is in agreement with Davies et al. (2006) and Odeyemi (2007) of the high performance of the fish fed twice a day as there was efficient utilization of the feed. However, there were no significant differences ($P>0.05$) in the feed conversion ratio with a range of 1.23 - 1.30. This result agreed with the result of 0.98 -1.46 recorded by Hecht and Appelbaum (1988). The feed conversion ratio of 1.23 was observed in treatment T4; also support that of Mostafa et al. (2002). This high performance is attributed to the high quality of the extruded feed used for the experiment whose nutritional composition and form conformed to the prescription by ADCP (1980), Jan (1995) and Zulfiker (2001)

Table 2 - Growth performance of African catfish fed at different time intervals

Parameters/Treatments	T1	T2	T3	T4	SEM
Initial number stocked	60	60	60	60	-
Final stock density less mortality	52	53	54	52	0.41
Initial body weight (g)	15.1	14.5	15.2	14.5	0.26
Final body weight (g)	200.13^b	168.17^c	196.33^b	223.63 ^{a}	3.74
Total weight gain (g)	184.83^b	153.47^c	181.07^b	208.97^a	3.74
Average daily weight gain (g)	2.20^b	1.83^c	2.16^b	2.60^a	2.58
Specific growth rate (SGR)	1.33^b	1.26^c	1.32^b	1.41^a	0.02
Mortality	8.0	7.0	6.0	8.0	2.04
Mortality %	13.3	11.67	10.00	13.33	2.04
Total feed consumed (g)	13512.2^b	11297.5^c	13372.7^b	14268.3^a	0.57
Average daily feed intake (g)	3.09^b	2.54^c	2.95^b	3.27^a	0.03
Feed conversion ratio (FCR)	1.30	1.27	1.26	1.23	0.21
Protein efficiency ratio (PER)	1.96	1.94	1.93	2.09	0.04

^{abc} =Means with different superscripts on the same row are significantly($P<0.05$) different , SEM= Standard error of mean

Similarly, the time of feeding also supported the growth performance of the fish. Nutritionally, feed intake of fish is controlled by three factors which are the environmental factor, the fish physiological factor and the feed factors. So long the same feed was used in the various treatments, feed factors should not be considered to be the reason for the observed significant differences, Kasumya (1999) and NRC (2009) reported that environmental factors in relation to feeding time and water physico-chemical quality have a marked impact on the feed intake of the fish as they can affect the fish physiological endowment capable of creating all sort of stress and neuro-endocrinological imbalance (Wynne et al., 2003). Fish feeding is one of the enormous tasks the farmer is faced with if the fish must grow considering the aforementioned relationship between the feeding and the water quality as they affect each other during the cause of management. The practice of feeding is far from being an exact science. It is a highly subjective process. FAO (2005), Edwin and Meughe (2007) and Brown (2008) reported that though catfish has been cultured over the years and it ranks the most popular cultured fish in Nigeria, there is a

To cite this paper: Ani, A.O., Okpako, B.A. and Ugwuowo, L.C. 2013. Effect of feeding time on the performance of juvenile African catfish (*Clarias gariepinus,* burchell 1822). *Online J. Anim. Feed Res.*, 3(3): 143-148.
Scienceline/Journal homepages: http://www.science-line.com/index/; http://www.ojafr.ir

considerable alteration in the feeding behaviour of the fish . Recently, Edwin et al. (2009) argued that the best time of day to feed fish is still an object of debate. Nevertheless, they opined that the time of day to feed fish is largely dictated by the logistics of feeding practice. Thus the response of the fish to time of feeding and its acceptance is not static as it's nocturnal habit make up has been broken due to the practice of domestication.

As shown in Table 3, the length of the fish showed no significant difference (P>0.05) in all the various treatments.

Table 3 - Body length of African catfish fed at different time intervals

Parameters/Treatments	T1	T2	T3	T4	SEM
Initial body length(cm)	10.5	9.8	10.0	10.0	0.28
Final body length(cm)	31.2	29.7	31.0	32.0	0.48
Gain in body length(cm)	20.7	19.9	21.0	22.0	0.18

[abc] =Means with different superscripts on the same row are significantly(P<0.05) different , SEM= Standard error of mean

The final mean total body length (cm) of 31.2cm (T1), 29.7cm (T2), 31.0cm (T3), and 32.0cm (T4) and the total gain in length of 20.7cm (T1), 19.9cm (T2), 21.0cm (T3) and 22.0cm (T4) did not contradict the observed body weight gain of the fish within the said short period of the experiment. However, differences in total body length could have begun to appreciate with more time as observed by Marc and Jean (1991) and Hengsawat et al. (1997). There was no significant difference (P<0.05) in the mortality rate in all the treatments. The mortality rate was observed as follows: 13.38% (T1), 11.67% (T2), 10.00% (T3) and 13.3% (T4). The observed mortality values in all the experimental treatments were traceable to handling stress during weighing and change of water. This same scenario was also recorded by Davies et al. (2006). The recorded mortality was within the production range of 10-20% reported by Graaf et al. (1995) and was not due to any pathological disease conditions.

As shown in Table 4, there were significant differences (P<0.05) among treatments in water temperature. The difference may be due to environmental condition vis-à-vis the degree of exposure to sunlight and heat absorption. The water temperature was highest in treatment T2 followed by T3 and T4. The least value was recorded in treatment T1.

Table 4 - Physicochemical properties of pond water

Parameters/Treatments	T1	T2	T3	T4	SEM
Water temperature(°C)	25.50[c]	28.10[a]	26.43[b]	26.13[b]	0.14
Dissolved oxygen (mg/l)	7.1	6.8	7.3	7.5	0.10
Water pH	7.1	7.1	7.1	7.1	0.17

[abc] =Means with different superscripts on the same row are significantly (P<0.05) different, SEM= Standard error of mean

These observed water temperature value also were in line with the findings of Odeyemi (2007) and was attributed to the level of the water in the experimental tanks which might affected the assimilation of heat since the tanks were exposed to atmospheric sunlight and heat (Boyd, 1979; Boyd, 1995; Boyd, 2002). However, the recorded temperature range of 25.5°C to 28.10°C is within the tolerable range for catfish production in the tropics but with minimal metabolic effect fluctuation (Boyd, 1982; Boyd, 2002; Yeamni et al., 2007). Although the temperature range (25.5°C to 28.10°C) recorded in the present study is within the tolerable range for catfish production in the tropics, the differences in temperatures being quite significant (P<0.05) might have fluctuating effect on fish metabolism. Thus the high water temperature (28.10°C) of treatment 2 could have altered the metabolic activities within the fish due to heat-induced stress. This would have affected the growth of fish in that treatment, hence the inferior growth rate observed in those fish. Jan (1995) explained that there are differences between metabolic energy for production (MEp) and metabolic energy for body maintenance (MEm). The ratio between these levels of energy varies within body weight and water temperature due to the interactive effect of feeding level and temperature on the fish body weight. Similarly, Ali (2006) reported that temperature affects the growth rate of fish by affecting a variety of metabolic processes including respiration, feed intake and digestion. That, any divergence from the normal ranges of the metabolic processes could alter the optimal range for fish health and growth. Although, the feed consumption may be high but greater proportion could have been used for body maintenance.

There were no significant (P>0.0) differences among treatments in dissolved oxygen and pH values. While all the treatments had the same pH value (7.1) the dissolved oxygen values were 7.1, 6.8, 7.3 and 7.5 for T1, T2, T3 and T4, respectively. The physico-chemical properties obtained in the experiment were within the tolerable values for catfish production. Davies et al. (2006) Cruz et al. (2000), Boyd (1982), Michael (1999) and Michael et al. (2005) showed that the dissolved oxygen and pH in pond should not be below 2.5mg/l and pH of 5.0 - 8.0 for catfish production. It has been shown that the most dictating factor in fish production is the water quality of the pond as governed by water temperature, pH and dissolved oxygen. Considering the fact that the time of day has a good bearing on the water temperature, pH and dissolved oxygen in addition to feeding management, it does seem that feeding time has a great impact on performance of African cat fish, especially on feed intake and growth rate.

Table 5 shows the economic aspect of the various treatments used in the experiment. The cost implication of feeding the fish at the various treatments levels showed a significant difference (P<0.05) for the total cost of fish

To cite this paper: Ani, A.O., Okpako, B.A. and Ugwuowo, L.C. 2013. Effect of feeding time on the performance of juvenile African catfish (*Clarias gariepinus,* burchell 1822). *Online J. Anim. Feed Res.*, 3(3): 143-148.
Scienceline/Journal homepages: http://www.science-line.com/index/; http://www.ojafr.ir

at the prevailing market price with the highest value of ₦6,969.00 for T4, ₦6,360.84 for T3, ₦6,243.60 for T1 and ₦5,346.40 being the lowest for T2. There was also a significant difference (P < 0.05) among treatments in total cost of feed consumed by the fish in the course of the experiment. The value of ₦4, 280.79 was recorded for T4, ₦4, 053.66 for T1, ₦4, 011.81 for T3 and the lowest value of ₦3, 389.25 for T2. The observed significant differences (P<0.05) in the total cost of feed consumed were as a result of the different body weight gained of the fish in accordance to their different feed of the fish. However, the profit margin percentage recorded ranged from 54.10% to 62.90% showing no significant differences (P>0.05). This observed marginal profit percentages agreed with the 40-60% range of profitability recorded by Adebayo and Adesoji (2008) and Davies et al. (2006). This means that though there were significant differences (P<0.05) in the cost of the fish and feed used, the profit recorded were still high and that the feeding methods used were also economical. There were also no significant differences (P>0.05) in the feed cost per kilogram weight gain of the fish as their values ranged from N390.00, N380.00, N379.00 and N368.00 for T1, T2, T3 and T4 respectively. This was due to the profit margin recorded which lie also within economic level.

Table 5 - Cost implication of feeding the fish at different time interval

Parameters/Treatments	T1	T2	T3	T4	SEM
Total cost of fish at ₦600.00/Kg	6,243.60	5,346.54^{c}	6.360.84^{b}	6,969.00^{a}	0.01
Total cost of feed at ₦300.00/Kg	4,053.66^{a}	3,389.25^{c}	4,011.81^{b}	4,280.79^{a}	0.33
Profit margin (₦)	2,189.94	1,957.29	2,349.03	2,688.21	0.01
Profit margin %	54.10	58.06	58.73	62.9	1.98
Feed cost per Kg weight gain (₦)	390.00	380.00	379.00	368.00	0.72

^{abc} =Means with different superscripts on the same row are significantly(P<0.05) different , SEM= Standard error of mean

CONCLUSION

It is therefore evident from the results obtained in the present study that catfish should be fed twice daily; morning and evening time of the day. However, it is pertinent to consider when the prevailing physico-chemical characteristics (water temperature, pH, dissolved oxygen, and so on) that affect fish feeding behaviour are at optimal levels in the pond. Other factors such as stocking density, stocking integration and aggression, feed composition, feeds size, fish type and feed preparation should also be considered in determining best time of the day to feed catfish.

REFERENCES

ADCP (1980). Aquaculture Development and Coordination Programme (ADCP) (1980). Fish Feed Technology. In Lecture Presented by The FAO / ADCP Training Course in Fish Feed Technology College of Fisheries University of Washington U.S.A. Pp 10-60.

Akindele SO (2004). Basic Experimental Designs in Agricultural Research Royal Bird Ventures. Mushin-Lagos. Pp. 19-81.

Ali T (2006). Effects of Feeding Frequency on Growth, Feed Consumption, and Body Composition in Juvenile Turbot (*Psetta maxima Linnaeus*, 1758) at Low Temperature.

Bello A (2007). Trade and Investment Opportunities in Nigeria's Agriculture. The India-Africa Food Summit at New Delhi-India. Pp 1-7.

Boyd CE (1979). Water Quality in Warm Water Fish Pond Auburn University Agricultural Experience Station Auburn Alabama: Pp13-93, 117-156.

Boyd CE (1982): Water Quality Management of Pond for Fish Cultures. Elsevier Science Publication Company Amsterdam. Pp 318 - 341.

Boyd CE (1995). Bottom Soil Sediments and Pond Aquaculture Chapman and Hall, New York. Pp 45 - 56.

Boyd CE, Wood CW and Toworn T (2002). Aquaculture Pond Bottom soil Quality Management. In Pond Dynamics Support Program of USA: 2002: 21-38.

Brown S (2008). Feeding Habits of Catfish. *EzineArticles.com*. http://ezinearticles.com.

Collins RA and Delmendo MN (1979). Comparative Economics of Aquaculture in Cages, Raceway and Enclosures. In T.V.R. Pillay and W.A. Dill (Editors) Advances in Aquaculture. Fishing News Books Ltd Farmham, Surrey, England. Pp 472-477.

Cruz EM, Almatar S, Aludul EK and Al-Yaqout A (2000). Preliminary Studies on the Performance and Feeding Behaviour of Silver Pomfret (*Pampus argentens euphrasen*) Fingerlings fed with Commercial Feed and Reared in Fibreglass Tanks. *Asian Fisheries Society* Manila, Philippine 13: 191-199.

Davies OA, Inko-Tariah MB and Amachree D (2006). Growth Response and Survival of *Heterobranchus Longifilis* Fingerlings fed at Different Feeding Frequencies. Afric. J. Biotechnol. 5(9):778-780.

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

Edwin HR and Meughe, HL (2007). Catfish Protein Nutrition. Mississippi Agricultural and Forestry Experience Station Bulletin No 1159:1-18.

Edwin HR, Meughe, HL and Martin WB (2009). Feeding Catfish in Commercial Ponds. In SRAC 181 Technical Article on Aquacultural Nutrition. Oklahoma State University Cooperative Extension. 181:1-5.

Ella Michael, O. (1987). Simple Calculations in Fish Farming. Wusen Press Limited Calabar, Nigeria: Pp 1-34.

FAO (2005). Regional Review on Aquaculture Development in Sub-Sahara Africa. FAO Fisheries Circular No. 1017/4 pp 1-23.
George WL (2001). Oxygen Depletion in Ponds. Warnell School of Forest Resources, University of Georgia, pp 1-4.
Graaf GT, Galemoni F and Bangoussi B (1995). The Artificial Reproduction and Fingerling Reproduction of the African Catfish (*Clarias gariepinus* (Burchell 1820) in Protected and Unprotected Pond._Aquaculture Res. 26 (4). 233-242 Nefisco Foundation Amsterdam the Netherlands.
Hecht T and Appelbaum S (1988). Observations on Intra-specific Aggression and Coeval Siblings Cannibalism by Larval and Juvenile *Clarias gariepinus* (Clariidae: Pisces) under controlled condition. J. Zoo. London: 214:21-44.
Hengsawat K, Ward FJ and Jaruartjamorn P (1997). The Effect of Stocking Density on Yield, Growth and Mortality of African Catfish (*Clarias gariepinus* Burchell, 1822) cultured in cages. Aquaculture J. 152: 67-76.
Idodo-Umeh G (2003). Freshwater Fishes of Nigeria (Taxonomy, Ecological Notes, Diet and Utilization). Idodo-Umeh Publishers Limited, Benin City - Nigeria. pp 119 - 129.
Jan, H VW (1995). Nutrition and Growth in *Clarias* species - a review. Aquat. Living Resource. 8: 395-401.
Kasumya OA (1995). Olfactory and Gustatory Responsibility of Young Sturgeon and Paddle Fish to Natural and Artificial Diurnal Stimuli. Proceeding of International Symposium on Acipenserid. VNIRO Publishing Moscow. pp 22-33.
Marc L and Jean JA (1991). Maximum Observed Length as an Indicator of Growth Rate in Tropical Fishes. Aquaculture J. 94:327-34 Elsevier Science Publishers B.V., Amsterdam 327.
Michael BN (1987). Feeds and Feeding of Fish and Shrimps. United Nations' Development Programme. FAO, Rome. pp 120 - 220.
Michael P M, Don S and Billy H (1999). Catfish Pond for Recreation. In Texas Agricultural Extension Service No B. 1319. The Texas A. and M. University System: pp1 - 11.
Michael PM, Peter W and Grey C (2005). Texas catfish Production in Ponds. Cooperative Extension Manual of the Texas A. and M. University System. 342: 1-28.
Mostafa ARH, Graham SH and Malcolm CMB (2002). Effect of Feeding Time and Frequency on the Growth and Feed Utilization of African catfish. *Aquaculture Research Journal*. 2002: 999-1004
Norm M (2000). Pond Water Chemistry. Koi Club of San Diego Publication U.S.A. pp 1-30.
NRC (2009). National Research Council , Predicting Feed Intake of Food Production Animals. In the National Academics Home Board of Agriculture (BOA), National Academy of Science Washington DC 20001. pp 7-24.
Odeyemi DO (2007). Survival and Growth Rate of Hybrid (*Female; Clarias gariepinus)* and Male *Heterobranchus longifilis* Fingerlings: Effect of Broodstock Sizes. American-Eurasian J. Scientific Res. 2(1):19-23.
Raven A and Walker G. (1978). Ingredients for Fish Feed Manufacture in the United State. In, Lectures presented at the FAO/UNDP Training course in fish feed technology held at the College of Fisheries, University of Washington, Seattle Washington 9th October to 15th December 1978. pp 100-230.
Sena SDS and Brain FD (1992). Fish Nutrition Research for Semi-Intensive Culture System in Asia. Asian Fish. Sci. 5: 129-144.
Steel, RGD and Torrie JH (1980). *Principles & Procedures of Statistics. A Biometric Approach* (2nd ed.). McGraw-Hill Publishers, New York. 633pp.
Webster CD, Tidwell JH and Yancey BA (1992). Effect of Protein Level and Feeding Frequency on Growth and Body Composition of Cage Reared Channel Catfish. Prog. Fish culture. 54: 92-96.
William R (1967). Fish and Fisheries of Northern Nigeria. Ministry of Agriculture, Northern Nigeria. Gaskiya Corporation, Zaria, Nigeria. Pp 14-28,78-83.
Wynne K, Stanley S, McGowan B and Bloom S (2005). Appetite Control. J. Endocrinol. 2005; 291-318.

Yeamin H, Saleha J and Abu HMI (2007). A Preliminary Observation on Water Quality and Planktons of an Earthen Fish Pond in Bangladesh: Recommendation for Future Studies. *Pak. J. Biol. Sci.* 10(6):868-873.
Zulfikar A (2001). Dietary Protein and Energy Interactions in African Catfish (*Clarias gariepinus* Burchell, 1822). A Ph.D Thesis; submitted to the University of Stirling Scotland, United Kingdom. Pp 1-15.

To cite this paper: Ani, A.O., Okpako, B.A. and Ugwuowo, L.C. 2013. Effect of feeding time on the performance of juvenile African catfish (*Clarias gariepinus,* burchell 1822). *Online J. Anim. Feed Res.*, 3(3): 143-148.
Scienceline/Journal homepages: http://www.science-line.com/index/; http://www.ojafr.ir