

Effect of different feeding frequency on the growth, survival and feed utilization of African catfish (*Clarias gariepinus*) fingerlings

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ABSTRACT

The effect of different feeding frequency on the growth rate of African catfish (*Clarias gariepinus*) fed commercial feed (Coppens) was conducted with 180 fingerlings of 3.55 ± 0.01 g average weight and 4.09 ± 0.05 cm average length. The feeding trial included once (at 11:00 am), twice (9:00am and 4:00pm), thrice (9:00am, 1:00pm and 4:00pm), and four times (9:00am, 11:00am, 1:00pm and 4:00pm), daily to satiation for 14 weeks. Biweekly weight gain shows that those fed four times per day had the highest weight gain of 27.40g, the lowest of 19.11g was seen in those fed once per day, the biweekly mean length shows those fed four times per day had the highest length gain of 9.24cm, the least was in those fed once per day with 6.35cm length gain. Highest specific growth rate of 0.96 was observed in fish fed four times per day groups compared to fish fed only once per day with 0.82. The highest feed conversion ratio of 0.54 was observed in fish fed twice per day whereas those fed once per day had the lowest conversion rate of 0.44. The highest survival rate of 81.5% was recorded in fish fed four times per day while the lowest was recorded in those fed once per day with 40% survival rate. The study suggests that the body composition of African catfish fingerlings is affected by the frequency of feeding.

Keywords: Feeding frequency, growth, survival, feed utilization, African catfish.

INTRODUCTION

Fish farming provides much needed high quality animal protein and other essential micronutrients because of its affordability to the poorer segments of the community in addition to the provision of employment opportunities and cash income (Umaru *et al.*, 2016). Fish culture is receiving a lot of attention in Nigeria with the result that new cultivation techniques are being introduced and adopted (Olagunju *et al.*, 2007), because fish is a relatively cheap source of animal protein and other essential nutrient required in human diet (Sadiku and Oladimeji, 1991). Over the last decade, spectacular growth in aquaculture has taken place in Nigeria. Although Fish farming activity in Nigeria

started about 50 years ago (Olagunju *et al.*, 2007) aquaculture is in the developmental stage in the country, because it has not been able to meet the demand of the ever increasing population (Ojutiku, 2008).

Several attempts have been made to reduce the feed cost by increasing the growth performance through employing suitable feeding strategy in order to maximize utilization of supplied nutrients to cultured fish, by mixed feeding schedule of alternating the high and low dietary protein level diet (Haylor, 1991; Gabriel *et al.*, 2000), and optimizing the feeding rate (Dong-Fang *et al.*, 2003). Feed management in terms of optimization of feeding rate and frequency is becoming imperative in the culture of marine and

freshwater fishes and it has become one of the crucial areas of research in the field of aquaculture. Overfeeding and waste food disrupts the water quality (Ng *et al.*, 2000) while inadequate food supply has direct impact on production cost (Mihelakakis *et al.*, 2002).

Feed is one of the major inputs in aquaculture production and fish feed technology has become one of the least developed sectors of aquaculture particularly in Africa and other developing countries of the world (Gabriel *et al.*, 2007). A survey of the aquaculture sub-sector in Nigeria revealed that 87% of the fish farmers fed their fish, 36-48% feed once daily while 17-39% fed twice per day (Obi and Ahunanya, 2004). Feeding frequency is one important consideration as it can affect growth, survival and fillet composition as well as water quality. Feeding also at the optimum frequency can result in tremendous savings in feed cost (Davies, Inko-tariah and Amachree, 2006).

The aim of this research is to determine the optimum feeding frequency for the culture of *Clarias gariepinus*.

MATERIALS AND METHOD

A total of 180 *C. gariepinus* fingerlings 3.55 ± 0.01 g average weight and 4.09 ± 0.05 cm average length were obtained from a fish farm in Yola, Nigeria. Fish were kept in plastic tanks for acclimatization at experimental conditions for seven days before commencement of feeding trials and were fed a maintenance diet of 1.5mm size commercial feed (Coppens) containing 58% crude protein. The fingerlings were divided equally into twelve (12) 20L plastic tanks with 12 fish held in each tank. The tanks were fitted to a semi flow through system. Trial conditions included four feeding frequencies, with each feeding frequency being experimentally tested in triplicate.

The experiment was laid out in a completely randomized block design with 12 fishes stocked in each plastic tank of 20L capacity. The experiment was conducted over a period of 14 weeks. The treatment was designated A, B, C and D to represent once, twice, thrice and four times feeding frequencies respectively.

Feeding Trials

Fish were fed commercial feed (Coppens) of 58% crude protein level at 5% body weight. Feeding trial included once (at 11:00 am), twice (9:00am and 4:00pm), thrice (9:00am, 1:00pm and 4:00pm), and four times (9:00am, 11:00am, 1:00pm and 4:00pm), daily to satiation for 14 weeks.

Water Quality Parameters

Water parameter data were taken twice a week before feeding: Temperature values were recorded from a mercury-in glass thermometer graduated in units of $^{\circ}\text{C}$ by immersing the thermometer slightly under the surface of water (2cm) for 5 minutes until mercury stood at one place. Dissolved oxygen was determined using the Winkler's solution and pH of water was obtained with pH meter (E251) model, and ammonia was also monitored twice weekly. The bowls were cleaned daily by siphoning the residual feed and faecal waste.

Fish Length-Weight Measurement

The initial body weight of each set of fish was measured using sensitive weighing balance before stocking and subsequently bulk weighing of the fish in each tank was done at two weeks interval. The length measurement was carried out to the nearest centimeters using a measuring board graduated in centimeters. Total length was measured from the anterior most extremity of the fish to the end of the caudal fin. The total weight was measured in grams using Ohaus electric weighing balance of 500gm capacity.

Survival and Mortality

The survival and mortality of fish in each treatment were monitored by counting the mortalities on a daily basis

Data Analysis

Mean Weight Gain (MWG)

The fish mean weight gain (MWG) was calculated as the difference between the final mean weight of the fish and initial mean weight in grams (Castell and Tiewa, 1980).

Specific Growth Rate (SGR)

This is the mean percentage increase in body weight per day over a given time interval (Brown, 1957). In this study the time interval was 14 weeks.

$$SGR = \frac{\text{Ln weight at the time of observation} - \text{Ln initial weight}}{\text{Duration of experiment in days}} \times 100$$

Where Ln = natural log

Relative Growth Rate (RGR)

This is the percentage ratio of the weight gained to the initial body weight which was determined according to Fasakin *et al.*, (2001) as follows:

$$RGR (\%) = \frac{(W_f - W_i)}{W_i} \times 100$$

Feed Conversion Ratio (FCR)

The efficiency of a feed is normally measured by the amount necessary to produce a unit weight of fish. This is called the feed conversion ratio (Hepher, 1988)

$$FCR = \frac{\text{Total dry feed consumed (g)}}{\text{Total Wet weight gain (g)}}$$

Protein Intake (PI)

This is the numerical value of the quantity of protein present in the feed fed to the fish during the experimental periods and was determined following Sveier *et al.*, (2000) method as follows:

$$PI (\text{g of protein in 100 g diet/fish}) = \text{Total feed intake} \times \% \text{ crude protein in the diet.}$$

Protein Efficiency Ratio (PER)

This is the efficiency with which the fish utilizes dietary protein and is defined by the equation below (Osborne *et al.*, 1919):

$$PER = \frac{\text{wet weight gain by fish (g)}}{\text{Weight of crude protein fed}}$$

Net Protein Utilization (NPU)

NPU denotes the protein retention in the body of the fish. This was calculated as follows:

$$NPU = \frac{CP_f - CP_i}{PI}$$

Where: CP_i = Crude Protein in fish at the beginning of the experiment
 CP_f = Protein in fish at the end of the experiment
 PI = Protein intake (g of protein in 100g of diet/fish)

RESULTS

Biweekly Mean Weight Gain in Gram

The biweekly mean weight gain is presented in Table 1. Treatment D has the highest total weight gain of 27.40g, followed by treatment C with total weight gain of 25.36g, treatment B, 24.44g weight gain while treatment A has the lowest weight of 19.11g

Biweekly Mean Length Measurements of Fish Per Feeding Frequency

The biweekly mean length change is presented in Table 2. Treatment D has the highest total length gain of 9.24 cm, followed by treatment C with total length gain of 9.12cm, while treatment B gained 8.70cm. Treatment A recorded the lowest total length gain of 6.35cm.

Mean Feed Consumption for the Study Period

The mean feed consumption for the study period is shown in Table 3. From the results it could be seen that treatment D had the highest total feed consumption of 54.10g, while the lowest feed consumption value of 43.20g was recorded in treatment A which was the fish fed once per day ration. The mean feed consumption value for treatment B and C are 3.25g and 3.50g respectively

Growth Performance of *C. gariepinus*

Table 4 shows the growth performance indices for all the treatment diets. The highest specific growth rate (SGR) was

recorded in treatment D (0.96), followed by treatments B and C with (0.91) and (0.88) respectively, while the lowest SGR (0.82) was recorded in treatment A. The relative growth rate (RGR) for the treatment diet A, B, C, and D showed increment in ascending order with diet treatment D having the highest with 765.36% followed by C and B respectively while the least RGR was treatment A with 538.31%. In terms of feed utilization, treatment A had the lowest FCR of 0.44 followed by treatment D (0.51) and C (0.52) respectively, while the highest feed conversion ratio is 0.54 (treatment B).

The condition factor (k) for treatment A is the highest value (7.46), followed by treatment C (3.34) and B (3.71) while the lowest condition factor of 0.20 was recorded in treatment D. Protein intake (PI) increased from treatment A to treatment D which is an indication that treatment D had the highest value of PI (1.77), followed by C (1.37) B (1.14), the lowest of 0.95 in treatment A. The survival rate was high in all the treatments except in treatment A which had the lowest survival rate of 40% while the highest survival rate of 81.5% was recorded in treatment D, followed by treatment B (80%) and treatment C (60%).

Net protein utilization (NPU) of 487.57 was recorded as the highest in treatment D, followed by treatment C (298.54), treatment B (85.09) and lowest NPU of 60.00 was recorded in treatment A.

Table 1: Biweekly Mean Weight of Fish in Grams

Treatment(s)	Initial mean weight (g)	Wk 2	Wk 4	Wk 6	Wk 8	Wk 10	Wk 12	Wk 14	Total mean Weight gain (g)
A. Once daily	3.55	4.26	5.14	8.14	12.10	16.54	19.10	22.66	19.11
B. Twice daily	3.57	4.48	6.45	11.02	16.18	20.47	25.11	28.01	24.44
C. Thrice daily	4.00	5.68	6.84	11.84	17.05	21.84	25.56	29.36	25.36
D. Four times daily	3.58	5.87	7.86	15.38	19.09	23.71	28.20	30.98	27.40

Table 2: Biweekly Mean Length of Fish in Centimetres

S/No	Treatment (s)	Initial mean length (cm)	Wk 2	Wk 4	Wk 6	Wk 8	Wk 10	Wk 12	Wk 14	Total mean length gain (cm)
A.	Once daily	4.09	4.61	5.17	6.59	7.15	8.22	9.45	10.44	6.35
B.	Twice daily	4.11	4.49	6.13	7.70	8.50	9.42	11.72	12.81	8.70
C.	Thrice daily	4.20	4.51	5.31	6.66	8.93	10.05	11.82	13.32	9.12
D.	Four times daily	4.15	4.35	5.00	7.30	9.09	9.88	11.90	13.39	9.24

Table 3: Mean Total Feed Consumption per Fish at Each Feeding Frequency During The Study Period

Feeding Frequency	Week 0	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12	Week 14	Total Feed Intake (g)	Mean Feed Intake (g)
A (Once)	5.00	5.40	5.60	5.40	5.70	5.50	5.30	5.30	43.20	3.09
B (Twice)	5.60	5.63	5.66	5.80	5.73	5.70	5.73	5.69	45.54	3.25
C (Thrice)	6.00	6.13	6.16	6.28	6.03	6.10	6.10	6.15	48.95	3.50
D (Four times)	6.25	6.65	6.85	7.06	7.04	6.85	6.65	6.75	54.10	3.86

Table 4: Summary Table Showing Growth and Feed Utilization of Different Feeding Frequency of Coppens Diet by *Clarias gariepinus*

Parameters	A Once	B Twice	C Thrice	D Four times	SEM
Initial mean weight (g)	3.55	3.57	4.00	3.58	±0.07
Final mean weight (g)	22.66	28.01	29.36	30.98	±0.20
Mean weight gain (g)	19.11 ^a	24.44 ^b	25.36 ^c	27.40 ^d	±0.8
Initial mean length (mm)	4.09	4.11	4.20	4.15	±0.05
Final mean length (mm)	10.44	12.81	13.32	13.39	±0.04
Mean length gain (mm)	6.35	8.70	9.12	9.24	±0.03
Relative growth rate (RGR) (%)	538.31 ^a	684.59 ^b	634.00 ^c	765.36 ^d	±0.02
SGR (%)	0.82	0.91	0.88	0.96	±0.03
Mean feed intake (g)	3.09 ^a	3.25 ^a	3.50 ^b	3.86 ^c	±0.12
Feed conversion ratio (FCR)	0.44	0.54	0.52	0.51	±0.12
Condition factor (K)	7.46	3.71	3.34	0.20	±0.99
Protein intake	0.95 ^a	1.14 ^b	1.37 ^c	1.77 ^d	±0.04
Protein efficiency ratio (PER)	34.75	44.34	44.53	44.64	±0.01
Net Protein Utilization (NPU)	60.00	85.09	298.54	487.57	±0.30
Survival (%)	40	80	60	81.5	±0.01

Means with different superscript for each growth parameter are significantly different (p<0.05)

Water quality parameters

Table 5 shows the mean water quality parameters obtained. Treatment C and D recorded the highest temperature values (28.83±0.01), followed by treatment B (28.67±0.49); while A recorded the least temperature value of (27.7±0.50). pH were almost neutral in all the treatments with A recording the highest value of (7.60±0.50) followed by B (7.52±0.50), C

(7.43±0.07) and D having the least (7.36±0.08). Ammonia recorded its highest value of (0.26±0.09) in treatment D followed by treatment C (0.20±0.11), treatment B (0.19±0.13) and the least of (0.17±0.07) was recorded in treatment A. Dissolved oxygen recorded the highest value of (7.03±0.21) in treatment A followed by treatment B (5.33±0.15), treatment C having (5.33±0.13) and the least was (4.80±0.10) in treatment D.

Table 5: Mean Water Quality Parameters

Treatments	Temperature (°C)	pH	NH ₃	Dissolved Oxygen
A	27.7±0.50	7.60±0.05	0.17±0.07	7.03±0.21
B	28.67±0.49	7.52±0.05	0.19±0.13	5.33±0.15
C	28.83±0.01	7.43±0.07	0.20±0.11	5.33±0.13
D	28.83±0.01	7.36±0.08	0.26±0.09	4.80±0.10

DISCUSSION

Fish is restricted in movement when in captivity and the supply of food depends on its captors. Its growth is governed by the kind of food provided, frequency of feeding, ration size, the food intake of the fish and its ability to absorb the nutrient component (Mollah and Tan, 1982).

The mean water quality parameters obtained in the studies. Treatment C and D recorded the highest temperature values (28.83±0.01) while treatment A recorded the least (27.7±0.50), pH were almost neutral in all the treatment with A recording the highest value of (7.60±0.50). The highest value (7.03±0.21) of dissolved oxygen was recorded in treatment A and the least (4.80±0.10) in treatment D. These fall within the optimal requirements for fish production as reported by Ochang, *et al.*, (2007) and Anyanwu, *et al.*, (2012) who recorded mean values for the water condition of the experimental aquaria as 27.4± 0.55 for temperature, 4.49±1.23 for pH and 7.1± 0.20 for dissolved oxygen.

The relative growth rate (RGR) for the treatment diet A, B, C, and D showed increment in ascending order with diet treatment D having the highest, while the least RGR was treatment A. These agree with the report of Teshima, *et al.* (1984), who observed that in milkfish, *Chanos chanos*, best growth performance was recorded in fingerlings fed twice per day than fish fed once per day, while Chiu *et al.*, (1987) reported that in milkfish, better

growth was achieved in fish fed with eight times per day than when fed four times per day.

In terms of feed utilization, treatment A had the lowest FCR of 0.44, followed by treatment D (0.51) and the highest feed conversion ratio is 0.54 (treatment B). This result agrees with Marimuthu, *et al.*, (2010), who reported that low FCR values were recorded in African catfish fed with twice every other day followed by once a day and twice/day respectively; whereas, significantly no difference in FCR values were observed in fingerlings fed with all the feeding regimes except once every other day fed groups. This indicates that the efficiency of feed utilization and feed conversion was not influenced by the feed frequency. This might indicate that African catfish fed more frequently might utilize diet less efficiently than fish fed less frequently. Webster, *et al.*, (1998), also reported that in channel catfish fed once per day or twice per day had similar FCR values. Wang *et al.* (1993) found that there was no difference in FCR among hybrid sunfish fed one, two, three, or four times per day. Hepher, (1980) stated that feeding frequency had little effect on FCR. This may indicate that food consumption is the growth limiting factor as found for other fish species (Hashim, 1994).

Protein Efficiency Ratio (PER) was highest in treatment D and lowest in the treatment A, this agrees with the report of Noeske-Hallin, *et al.*, (1985) who stated increased lipid levels in channel catfish fed

twice daily compared to fish fed once daily. It has been demonstrated that, low body lipid content of fish resulted from declined feeding frequency.

The survival rate was high in all the treatment except in treatment A which had the lowest survival rate of 40%, while the highest survival rate of 81.5% was recorded in treatment D, followed by treatment B (80%) and treatment C (60%) respectively. This does not agree with the report of Marimuthu *et al.* (2010), who recorded that a poor survival rate (76.70%) was observed in fingerlings fed with once every other day groups. However, no survival difference was observed in the other feeding regimes. This could be due to the time interval between the next meal is longer than the other feeding regimes that could have given more appetite, aggressive behavior and cannibalistic behaviour in the once every other day fed groups. Survival in the present study was higher than the range reported by Webster *et al.* (2001) in juvenile sunshine bass, *Morone chrysops* X *M. saxatilis*, had survival rate between 62-75%. The survival rate range (68-90 %) was recorded in the catfish *H. longifilis*. In fishes, cannibalism is usually associated with heterogeneous size variation, limited food availability, high population densities, limited refuge areas, and light conditions (Qin and Fast, 1996). In the present study size variation and food availability are considered the primary causes of cannibalism.

CONCLUSION

This study shows that the length and weight of African catfish fingerlings is affected by the frequency of feeding. The results of this study based on the growth performance and feed utilization suggests that *C. gariepinus* fingerlings (3.55 ± 0.01 g average weight and 4.09 ± 0.05 cm average length) should be fed at four times per day for maximum growth and better survival.

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REFERENCES

- Adewolu, M. A., Adeniji, C. A. and Adejobi, B. 2008. Feed utilization, growth and survival of *Clarias gariepinus* (Burchell 1822) fingerlings cultured under different photoperiods. *Aquaculture*, 283, pp. 64–67.
- Anyanwu, D. C., Umeh, O. I., Maduka, B. C. and Mbchu, M. U. 2012. Nutrient utilization and growth of catfish (*Clarias gariepinus*) fed dietary levels of cassava leaf meal. *Pakistan Journal of Nutrition* 11(11), pp. 1037-1040.
- Bascinar, N., Okuma, I., Bascinar, N. S. and Saglam, E. H. 2001. The Influence of daily feeding frequency on the feed consumption of rainbow trout fingerlings, *Concorynchus mykiss* reared at 18.5-22.5°C. *The Israel Journal of Aquaculture Bamidgeh*, 53(2), pp. 80-83.
- Brown, M. E. 1957. Experimental Studies on growth. In: Physiology of Fishes. Vol.1 (M.E. Brown ed). Academy Press. New York.
- Castell, J. D. and Teiwa, K. 1980. Report of the EIFAC, IUNS and ICES working group on standardization of methodology in Fish Nutrition Research FIPAC/736, EIFAC/FAO. The State of World: Fishery and Agriculture. FAO Fisheries technical Paper No. 500. Rome.
- Chiu, Y. N., Sumagaysay, N. S. and Sashillo, M. A. S. 1987. Effect of feeding frequency and feeding rate on the growth of milkfish, *Chanos chanos*, juveniles. *Asian Fisheries Science*, 1, pp. 27-31.

- Davies, O. A., Inko-tariah, M. B. and Amachree, D. 2006. Growth response and survival of *Heterobranchus congigilis* fingerlings fed at different feeding frequencies. *African Journal of Biotechnology*, 2 (5), pp. 778-787.
- Dong-Fang, D., Koshio, S., Yokoyama, S., Bai, S.C., Shao, Q., Cui, Y. and Hung, S. S. O. 2003. Effects of feeding rate on growth performance of white sturgeon (*Acipenser transmontanus*) larvae. *Aquaculture*, 217, pp. 589-598.
- Eyo, A. A. 2003. Fundamentals of Fish Nutrition and Diet Development - An Overview. Paper presented at National Workshop on Feed Development and Feeding practices in aquaculture. At National Institute for Freshwater Fisheries Research (NIFFR) New Bussa, 12 pp.
- Fasakin, E. A., Balogun, A. M. and Fagbenro, O. A. (2001). Evaluation of sun dried water fern *Azolla africana* and duckweed, *Spirodella polyrrhiza*, in practical diets for Nile Tilapia, *Oreochromis niloticus* fingerlings. *Journal of Applied Aquaculture*, 11 (4), pp. 83-92.
- Gabriel, U. O., Akinrotimi, O. A., Ananwu, P. E., Bekibele, D. O. and Onunkwo, D. N. 2007. Locally produced fish feed potential for aquaculture development in sub-Saharan Africa. *Journal of Agriculture Research*, 2, pp. 287-295.
- Gabriel, U. U., Inko-Tariah, M. B., Allison, M. E. and Davies, O. A. 2000. Growth of *Heterobranchus bidorsalis* fingerlings fed varying dietary protein and energy rations. *Journal Agriculture, Biotechnology and Environmental*, 2 (1/2), pp. 35-41.
- Hashim, R. 1994. The Effect of mixed feeding schedules of varying dietary protein content on the growth performance of *Channa striata* fry. *Asian Fisheries science*, 7, pp. 149-155.
- Haylor, G. S. 1991. Controlled hatchery production of *Clarias gariepinus*, Burchell, 1822: growth and survival of larvae at high stocking density. *Aquaculture*, 22, pp. 405-422.
- Hepher, B. 1988. Nutrition of Pond fishes. Cambridge University press, U.K 388pp.
- Kestemont, P., Toko, I., Fiogbe, E. D. and Koukpode, B. 2007 Rearing African catfish (*Clarias gariepinus*) and vundu catfish (*Heterobranchus longifilis*) in traditional fish ponds (whedos): effects of stocking density on growth, production and body composition. *Aquaculture*, 262:65-72.
- Marimuthu, K., Ang Chi, C., Muralikrishnan, S. and Kumar, D. 2010. Effect of Different Feeding Frequency on the Growth and Survival of African Catfish (*Clarias Gariepinus*) Fingerlings. *Advances in Environmental Biology*, 4(2), pp. 187-193.
- Mihelakakis, A., Tsolkas, C. and Yoshimatsu, T. 2002. Optimization of feeding rate for hatcheryproduced juvenile gilthead sea bream *Sparus aurata*. *Journal of the World Aquaculture Society*, 33, pp. 169-175
- Mollah, M. F. A. and Tan, E. S. P. 1982. Effects of different feeding frequency on the growth and survival of catfish, (*Clarias macrocephalus*) larvae. *Indian Journal of Fisheries*, 29, pp. 1-7.

- Ng, W. K., Lu, K. S., Hashim, R. and Ali, A. 2000. Effects of feeding rate on growth, feed utilization and body composition of tropical bagrid catfish. *Aquaculture International*, 8, pp. 19–29.
- Noeske-Hallin, T. A., Spieler, R. E. Parker, N. C. and Suttle, M. A. 1985. Feeding time differentially affects fattening and growth of channel catfish. *Journal of Nutrition*, 115, pp. 1228-1232.
- Nwani, C. D., Ifo, C. T., Nwamba, H. O., Ejere, V. C., Onyishi, G., Ikwaagwu, E. O. and Odo, G. E. 2015. Oxidative stress and biochemical responses in the tissues of African catfish *Clarias gariepinus* juvenile following exposure to primextra herbicide. *Drug, Chemical and Toxicology*, 38 (3), pp. 278-285.
- Obi, A. and Ahunanya, A. 2004. Effect of feeding frequency on the survival and growth and yield of clarias catfish hybrid fingerlings in outdoor concrete tanks. *Nigerian Journal of applied science*, 22, pp. 14-18.
- Ochang, S. N., Fagbenro, O. A. and Adebayo, O. T. 2007. Growth performance, body composition haematology and product quality of the African catfish (*Clarias gariepinus*) fed diets with palm oil. *Pakistan Journal Nutrition*, 6, pp. 452-459.
- Ojutiku, R. O. 2008. Comparative survival and growth rate of *Clarias gariepinus* and *Heteroclaris* hatchlings fed live and frozen *Daphnia*. *Pakistan Journal of Nutrition*, 7(4), pp. 527-529.
- Olagunju, F. I., Adesiyun, I. O. and Ezekiel, A. A. 2007. Economic Viability of Catfish production in Oyo state, Nigeria. *Journal of Humanity and Ecology*, 21(2), pp. 121-124.
- Osborne, T. B., Wendel, L. B. and Ferry, E. L. 1919. A method for expressing numerically the growth-promoting value of proteins. *Journal of Biochemistry*, 39, pp. 223-224.
- Qin, J. and Fast, A.W. 1996. Effects of feed application rates on growth, survival, and feed conversion of juvenile snakehead (*Channa striatus*). *Journal of World Aquaculture Society*, 27, pp. 52–56.
- Sadiku, S. and Oladimeji, A. 1991. Relationship of Proximate composition of *Synodontis schall* *Research community*, 3 (1), pp. 29 – 40.
- Sogbesan, A. O. and Ugwumba, A. A. A. 2008. Nutritive evaluation of termite (*Macrotenes subhyalinus*) as animal protein supplement in the diet of *Heterobranchus longifilis* (Valenciennes 1840) fingerlings. *Turkish Journal of Fisheries and Aquatic Sciences* 8, pp.149-157.
- Teshima, S. I., Kanazawa, A. and Kawamura, G. 1984. Effects of several factors on growth of milkfish (*Chanos chanos*) fingerlings reared with artificial diets in aquaria. *Aquaculture*, 37, pp. 39-50.
- Umaru, J., Auta, J., Oniye, S. J. and Bolorunduro, P. I. 2016. Growth and economic performance of African catfish, *Clarias gariepinus* (Burchell, 1822) Juveniles to imported and local feeds in floating bamboo cages. *International Journal of Fisheries and Aquatic Studies*; 4(2), pp. 221-226.
- Wang, N., Hayward, R. S. and Noltie, D. B. 1998. Effect of Feeding Frequency on Food Consumption, Growth, Size Variation, and Feeding Pattern of Age-0 Hybrid Sunfish. *Aquaculture*, 165, pp. 261-267.

- Webster, C. D., Tidwell, J. H. and Yancey, D. H. 1992. Effect of protein level and feeding frequency on growth and body composition of cage-reared channel catfish. *Progressive Fish Culturist*, 54, pp. 92-96.
- Webster, C. D., Thompson, K. R., Morgan, A. M., Grisby, E. J. and Dasgupta, S. 2001. Frequency feeding affects growth, not fillet composition, of juvenile Sunshine bass *Morone chrysops* X *M. saxatilis* grown in cages. *Journal of Aquaculture Society*, 32, pp. 79–88.