p-ISSN. 2406-9825
e-ISSN. 2614-3178
Acta Aquatica: Aquatic Sciences Journal, 11:2 (August, 2024.): 116-120

Acta Aquatica
Aquatic Sciences Journal

Penilaian pertumbuhan dan kelangsungan hidup ikan lele Afrika (*Clarias gariepinus*) dan hibridanya dengan dua spesies heterobranchus

Growth and survival assessment from African lungfish (*Clarias gariepinus*) and its hybrid with two species of heterobranchus

Received: 01 January 2023, Revised: 01 July 2023, Accepted: 04 May 2024
DOI: 10.29103/aa.v11i2.10059

Abdulraheem Ikililu[a*], and Abubakar Musa Idi-Ogede[b]

[a]*Department of Aquaculture and Fisheries, Federal University of Agriculture Abeokuta, PMB 2240, Abeokuta, Nigeria*
[b]*Department of Aquaculture and Fisheries Management, University of Ilorin, Ilorin, Nigeria. abubakar.mi@unilorin.edu.ng; +2348036458262*

Abstracts

Obtaining good quality and quantity of fish seeds for increasing fish production is a major quest by fish farmers. *This study examined the growth responses and survival of Clarias gariepinus and two species of heterobranchus. One thousand five hundred (1500) fry (28-day after hatched) were randomly selected from each of the three crosses of Clarias gariepinus (T1), C. gariepinus x Heterobranchus longifilis (T2) and C. gariepinus x Heterobranchus bidorsalis (T3) broodstocks. They were stocked separately in triplicate at a stocking rate of 500 fish per replicate and reared for 90 days. The data were analysed for significant differences (P<0.05) by Analysis of Variance (ANOVA). There was no significant difference in the growth parameters but fish in T3 had the highest value of mean weight gain while T1 had the least. No significant difference (p>0.05) was observed in the body weight gains from day 40 to day 90 except at day 70 where T3 had the highest weight gain (18.97 g) which was significantly different (p<0.05) to the value recorded in T1 (18.20 g) but not significantly different (p>0.05) to the value recorded in T3 (18.97 g). The results of length increment showed that the growth pattern from day 0 to day 80 were similar. A little difference was observed at day 90 with T3 >T2>T1. The fish in T1 (Clarias gariepinus) had the highest significant percentage survival (89.60%). The results of water quality parameters showed that the mean temperature was 28°C, pH 6.8, dissolved oxygen 5.6 mg/l and turbidity 5.45 NYU.* The culture of *C. gariepinus* by farmers will improve their output and consequentially increase in profit.

Keywords: aquaculture; fish breeding; hybrids; weight gain

1. Introduction

The African catfish *Clarias gariepinus* (Burchell, 1822) have some advantages like as grows fast, can consumed large variety feed from agriculture by-products and can be cuture in high densities. It is therefore considered as a good aquaculture commodity (Naorbe, 2021). Some species of catfish have been cultured (cultivated) in Nigeria are *Clarias gariepinus*, *Heterobranchus bidorsalis*, *Clarias* × *Heterobranchus* hybrid ('Heteroclarias') and *Clarias nigrodigitatus*. *C. gariepinus* and Heterobranchus (Adewumi and Olaleye, 2017). Catfish species have fast growth rate, acceptable taste, low feed requirements, high fecundity, good market price, easy production in captivity, tolerate relatively harsh environmental conditions and resistance to diseases (Ljubobratovic *et al*., 2015; Rency and Agung, 2020; Shourbela *et al*., 2020; Maranga *et al*., 2023).

Some of the challenges facing aquaculture activity in Nigeria was identified by Adewumi and Olaleye (2017), among the obstacles were poor management skills, lack of capital, high cost of feed, faulty data collection, lack of environmental impact consideration and marketing of products as well as inadequate supply of good quality seed which remains the fundamental problem of fish farming. Many farms ran into problems during production which led to little or no profit because of poor quality fish seed used. Obtaining good quality and quantity of fish seeds for increasing fish production is a major quest by fish farmers which was hindered by the scarcity of natural spawning in captivity, diseases and numerous other factors (Mylonas *et al.,* 2010; Duncan *et al.,* 2013; Mylonas *et al.,* 2016). However, to produce good quality seed (fry, fingerlings, juveniles, etc) for aquaculture, needs to explore the potential of genetic engineering (Adewumi and Olaleye, 2017).

Therefore, crosses between the rapid growth of *Heterobranchus* sp. and the early maturation of *C. gariepinus* became essential (Piria *et al*., 2022). Hybridization of catfish species especially *C. gariepinus* and *H. bidorsalis* have been studied by several authors (Haniffa and Sridhar, 2002; Nwokoye *et al.,* 2007; Akinwande *et al.*, 2009; Ataguba *et al.*, 2009; Owodeinde and Ndimele, 2011; Aliu *et al*., 2018). But, there was a few or no research done to evaluate the growth

***** *Korespondensi: Department of Aquaculture and Fisheries, Federal University of Agriculture Abeokuta, PMB 2240, Abeokuta, Nigeria.*
Tel: +234(0)8035643663
e-mail: abdulraheemi@funaab.edu.ng

response of crosses between *C. gariepinus* and its crosses with both *H. bidorsalis* and *H. longifilis*. Hence, the aimed of this study was to determine the growth responses of *C. gariepinus* and Heteroclarias of both *H. bidorsalis* and *H. longifilis.*

2. Materials and Methods

2.1. Experimental site

The experiment was carried out at the Hatchery Unit of Motherhood Freshwater Fish Farms, off Abeokuta-Ibadan Expressway, Obantoko, Odeda Local Government Area, Abeokuta, Ogun State, Nigeria. The farm lies between Latitudes 7°10'34.4"Nand 7°10'35.4"N and Longitudes 3°23'48.4"E and 3°23'49.3"E.

2.2. Experimental procedure

The broodstocks of *Clarias gariepinus*, *Heterobranchus bidorsalis* and *Heterobranchus longifilis* of known breeding records were obtained from a reputable fish farm. The broodstocks were selected based on their external morphological features as described by Viveen *et al.* (1985). Pure and mixed crosses of these species were carried out in the hatchery. The breeding process was carried out as described by Ataguba *et al*. (2009).

Seeds for treatments were reared for 28 days. They were fed ad libitum (four time daily) with dried decapsulated cysts of Artemia sp. for the first 14 days, and the second 14 days, introduced gradually to commercial feed (0.2 – 1 mm). One thousand five hundred (1500) seeds (28-day after hatched) were randomly selected for each treatment. The treatment namely:

- T1 = female *C. gariepinus* × male *C. gariepinus*,
- T2 = female *C. gariepinus* x male *Heterobranchus longifilis*,
- T3 = female *C. gariepinus* x male *Heterobranchus bidorsalis*

Fish reared in plastic experimental tanks (1.2 x 0.6 x 0.5m^3) at stocking rate of 500 fish per replicate. The 36-litre experimental tanks were filled with 35 litres of water.

Fish were fed at satiation two times a day with commercial feed (57% Crude protein, 15% crude fat, 0.1% crude fibre, 11% ash, 3% calcium, 1% sodium and 1.8% phosphorus). The feed size was adjusted according to the size of the fish and fed to the fish for 90 days. Fish were batch weighed every 10 days using a weighing balance nearest to 0.001g (Model: EHA 501, specification: 0.001 to 100g). The fish were not fed on the sampling days to minimize the stress impose on them.

2.3. Growth performance

2.3.1. Mean weight gain

The fish were sampled every 10 days. The average weight in gram was used to calculate the Mean Weight Gain as follows:

$$\text{Weight gain (w)} = \text{Final weight (W2)} - \text{Initial weight of fish (W1)}$$

2.3.2. Specific growth rate

Specific growth rate which is the increase in cell mass of the fry per unit time is expressed as the per cent daily fish body weight gain throughout the culture period. The average specific growth rate for each treatment was then calculated as follows according to Ricker, (1975)

$$\text{Specific growth rate (SGR, \% per day)} = \frac{(\text{Loge Wi} - \text{Loge Wt}) \times 100}{D}$$

Where Wi and Wt are the initial and final mean weight respectively and 'd' represents the number of feeding days.

2.3.3. Daily growth rate

$$\text{Daily Growth Rate (DGR)} = \frac{\text{Final weight (g)} - \textit{Initial weight (g)}}{\text{Duration}}$$

2.3.4. Survival

$$\textit{Survival \%} = \frac{\textit{Initial number of fish stocked} - \textit{mortality} \times 100\%}{\textit{Initial number of fish stocked}}$$

2.3.5. Growth pattern

The growth pattern was obtained from the weekly growth data of the experimental fish using Microsoft Excel 2016 version.

2.3.6. Length measurement

Total length (cm) measured from the maxilla to the end of the caudal fin, and standard length (cm) measured from the maxilla to the end of the caudal peduncle were taken every sampling days (10 days interval). Linear body measurement was carried out using a transparent ruler and digital Vernier caliper.

2.4. Water parameters

Water quality parameters including temperature, Dissolved Oxygen (DO), pH and conductivity were monitored. Temperature, pH, dissolved oxygen (DO) and conductivity were measured daily at 6.30 am with mercury in-glass thermometer, pH meter model WTW pH 330 and DO meter (Model MW600), respectively. Other water quality parameters such as Ammonia, Nitrate and Nitrite were tested with Merck test kits 2/3 days per week.

2.5. Statistical Analysis

The data were analyzed for significant differences ($P<0.05$) by Analysis of Variance (ANOVA) using computer Statistical Package for Social Sciences (IBM SPSS version 20). The differences among the means were separated using Duncan Multiple Range Test (DMRT).

3. Results and Discussion

3.1. Results

The growth performance of Clarias *gariepinus* and its hybrids are presented in Table 1. The results showed no significant difference ($p>0.05$) in the initial weight, final weight, mean weight gain, daily growth rate and specific growth rate. There was a significant difference ($p<0.05$) in the percentage survival. The fish in T1 (*C. gariepinus*) had the highest significant percentage survival (89.60%) and were significantly different ($p<0.05$) with T2 (87.20%) and T3 (86.53%).

The body weight gain of *Clarias gariepinus* and two hybrids reared for 90 days is presented in Table 2. The results revealed that there was no significant difference ($p>0.05$) on day 10. At day 20 and day 30, T2 was significantly different ($p<0.05$) from T1 but not significantly different from T3. No significant difference ($p>0.05$) was observed in the body weight gains from day 40 to day 90 except at day 70 where T3 had the highest weight gain (18.97 g) which was significantly different ($p<0.05$) to the value recorded in T1 (18.20 g) but not significantly different ($p>0.05$) to the value recorded in T3 (18.97 g).

The growth pattern and length growth of *C. gariepinus* and two hybrids reared for 90 days is presented in Figure 1 and Figure 2 respectively. The results of length growth showed that the growth patterns from day 0 to day 80 were similar. A little difference was observed at day 90 with T3 >T2>T1. The length increment of *Clarias gariepinus* and two hybrids reared for 90 days did not show any substantial difference as shown in Figure 2.

The Survival of *Clarias gariepinus* and two hybrids reared for 90 days is shown in Table 3. There were significant differences ($p<0.05$) in the survival of *Clarias gariepinus* and two hybrids except at day 10, 20, 40 and 50. T1 had the highest significant mean survival at days 30, 60, 70, 80 and 90. At day 90, T3 had the lowest survival value (432.67 fish)

The water quality parameter of the experimental fish during the ninety days is shown in Table 4. The results showed that the mean temperature was 28°C, pH 6.8, dissolved oxygen 5.6 mg/l and turbidity 5.45 NYU.

Table 1
Growth performance of Clarias and two hybrids.

Parameters	T1	T2	T3
initial	0.33±0.03	0.36±0.03	0.32±0.02
Final	25.26±0.08	26.10±0.46	26.57±0.56
MWG	24.93±0.08	25.75±0.44	26.25±0.54
DGR	0.28±0.00	0.29±0.01	0.29±0.01
SGR	4.82±0.12	4.77±0.08	4.90±0.06
Survival	89.60±0.42 [a]	87.20±0.64 [b]	86.53±0.47 [b]

Means with different superscripts along same row are significantly different (p<0.05), T1= control (pure clarias), T2= Clarias X Heterobranchus longifilis male, T3= Clarias X *Heterobranchus bidosalis* male.

Table 2
Body Weight Gain of pure *Clarias gariepinus* and two hybrids reared for 90 days.

Days	T1	T2	T3
10	0.89±0.05	0.95±0.02	0.95±0.02
20	2.21±0.10 [b]	2.47±0.03 [a]	2.42±0.05 [ab]
30	5.25±0.04 [b]	5.42±0.01 [a]	5.45±0.03 [a]
40	7.22±0.41	7.87±0.01	7.80±0.06
50	10.41±0.13	10.70±0.01	10.69±0.09
60	14.42±0.30	14.53±0.16	14.73±0.34
70	18.20±0.11 [b]	18.95±0.18 [a]	18.97±0.12 [a]
80	22.03±0.64	22.37±0.76	22.00±0.52
90	25.26±0.08	26.10±0.46	26.57±0.56

Means with different superscripts along same row are significantly different (p<0.05), T1= control (pure clarias), T2= Clarias X Heterobranchus longifilis male, T3= Clarias X *Heterobranchus bidosalis* male

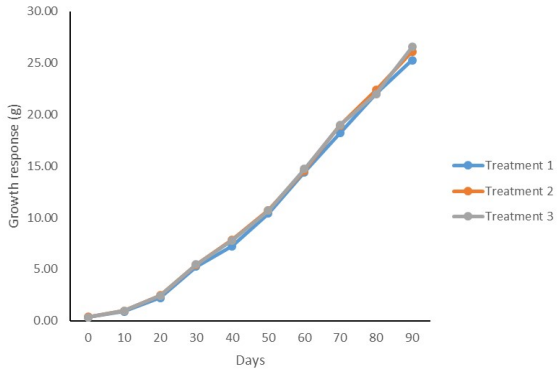

Figure 1. Growth pattern of pure *Clarias gariepinus* and two hybrids reared for 90 days.

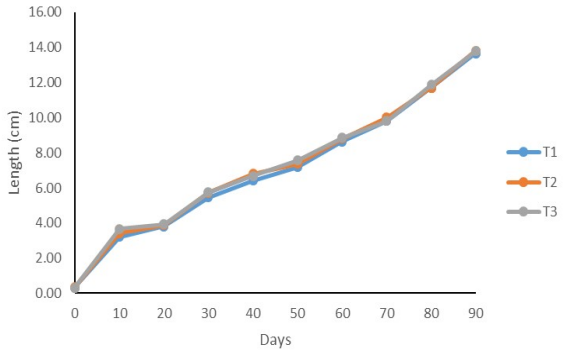

Figure 2. Length Increment of pure *Clarias gariepinus* and two hybrids reared for 90 days

Table 3.
Survival (mean and percenage) of pure *Clarias gariepinus* and two hybrids reared for 90 days.

Days	T1		T2		T3	
	Mean	%	Mean	%	Mean	%
0	500	100	500	100	500	100
10	490.00±1.15	98.00	485.33±1.76	97.07	487.33±2.73	97.47
20	486.00±1.53	97.20	477.67±1.86	95.53	480.33±3.48	96.07
30	481.33±2.4 [a]	96.27	471.67±1.45 [b]	94.33	473.33±2.40 [b]	94.67
40	475.67±3.18	95.13	466.33±2.73	93.27	465.67±3.48	93.13
50	470.00±2.00	94.00	461.00±4.04	92.20	459.33±2.60	91.87
60	465.00±1.73 [a]	93.00	456.67±3.53 [ab]	91.33	450.33±1.45 [b]	90.07
70	456.33±3.18 [a]	91.27	451.00±4.04 [ab]	90.20	443.33±2.40 [b]	88.67
80	451.00±2.65 [a]	90.20	442.67±4.37 [ab]	88.53	439.00±1.00 [b]	87.80
90	448.00±2.08 [a]	89.60	436.00±3.21 [b]	87.20	432.67±2.33 [b]	86.53

Means with different superscripts along same row are significantly different (p<0.05), T1= control (pure clarias), T2= Clarias X Heterobranchus longifilis male, T3= Clarias X *Heterobranchus bidosalis* male

Table 4
The mean water quality parameter in the experimental tanks.

Parameters	Mean value
Temperature (°C)	28±1.2
pH value	6.8±0.5
Dissolved Oxygen(mg/l)	5.6±0.78
Ammonia NH_4(mg/l)	0.4±0.06
Nitrate, NO_2(mg/l)	0.02±0.00
Turbidity (NYU)	5.45±0.21
Total solids (mg/l)	290±15.4
Nitrite, NO_3	0.01±0.00
Ammonium, NH_3	0.02±0.00

3.2. Discussion

The daily growth rate (0.29 g/day) observed in this study for the hybrid clarias is higher compared to -0.5 g/day after 24 weeks but lower than 4.14 g/day for 30 days reported by Owodehinde *et al*. (2012) for *Clarias gariepinus x Heterobranchus bidosalis* reared in earthen ponds for 24 weeks. The hybrid of *C. gariepinus* and *H. longifilis* had a higher mean weight gain compared to that of *C. gariepinus* in this study. This is in contrast with the report of Yisa (2011) who reported a better mean weight gain for crosses of *C. gariepinus* when the growth performance of catfish fingerlings of the various mating combinations was determined at the end of 8 weeks of outdoor rearing. Ndimele and Owodeinde (2012) also reported highest mean percentage weight gain in *C. gariepinus* (C.g ♀ x C.g ♂) induced with ovaprim and the lowest in hybrid (C.g ♀ x H.b ♂) induced with male pituitary. But the growth response reported in this study is similar to the trend observed by Solomon and Maiyaki (2022) who observed that the hybrid had the highest growth and feed utilization in two different culturing systems than the pure breed. Hybrids in most cases were known to be superior to their parental line in terms of growth, food conversion and disease resistance (Solomon and Maiyaki, 2022). The SGR obtained in this study for all the fish species was higher than the values (1.67 – 2.1 %day^{-1}) obtained by Solomon *et al*. (2013) for *C. gariepinus*, Heteroclarias and *H. bidorsalis*. And also, higher than the range of 2.12 – 3.96 %day^{-1} reported by Nguenga *et al*. (2000) for various strains of *H. longifilis*. Wilfred (2018) also reported lower specific growth rates of 3.54 and 3.52% for *H. longifilis* reared with two organic fertilizers in earthen ponds. Also, the SGR obtained in the heteroclarias from *H. bidorsalis* was higher than the values obtained in the clarias and heteroclarias of *H. longifilis*. Abdulraheem (2022) also reported a better SGR in heteroclarias of both *H. longifilis* and *H. bidorsalis* compared to pure crosses of *C. gariepinus*.

The final weight of the three fish species used in this study were not significantly different with the highest value recorded in *H. bidorsalis.* This disagreed with the report of Ekelemu (2010) who observed significant differences in the body weight from day 7 to day 49 among *C. gariepinus, Heteroclarias* and *H. bidorsalis* fed commercial diets. The differences may be as a result of the differences in the initial weights of fish used.

In this study, *C. gariepinus* had a highest value of percentage survival from day 10 till the end of experiment compared to the hybrids while the hybrid of *C. gariepinus* and *H. bidorsalis* had the least value. Ndimele and Owodeinde (2012) also reported higher percentages of survival (14 Days Post-Hatch) of *C. gariepinus* and Hybrids (*C. gariepinus* and *H. bidorsalis*) Induced with either synthetic hormone (Ovaprim) or pituitary. The author reported the lowest value of percentage survival in *heteroclarias* (C.g ♀ x H.b ♂) induced with ovaprim. Solomon *et al*. (2013) also reported higher survival in *C. gariepinus* when compared with *H. bidorsalis* and Heteroclarias fed commercial diet.

The values for the water quality observed in this study were within the range recommended for aquaculture practice (Anifowose *et al*., 2021; Ukwe *et al*., 2019). The water temperature, dissolved oxygen and nitrite observed in this study is similar to the report of Anifowose *et al* (2022) who recorded a temperature range of 27.5 ^{o}C to 27.63 ^{o}C, dissolved oxygen range of 6.5 to 7.0 mg/l and nitrite value of 0.01mg/l for *Clarias gariepinus* fed on live and artificial diets. Meanwhile, the values of pH and ammonia recorded in this study was lower than the values observed in Anifowose *et al*. (2022). Nlewadim *et al.,* (2011) also suggested pH values of 6.5 to 7.1 in their study on growth and survival of *Heterobranchus longifilis* in concrete tanks.

4. Conclusion

Clarias gariepinus compete favourably with the hybrids (C.g ♀ x H.l ♂ and C.g ♀ x H.b ♂) in term of growth parameters. *C. gariepinus* also had the highest significant ($p<0.05$) value for percentage survival. Therefore, the culture of *C. gariepinus* by farmers will improve their output and consequentially increase in profit.

Bibliography

Abdulraheem, I. 2022. Growth assessment of pure bred *Clarias gariepinus* (Burchell, 1822), Heterobranchus longiflis (Valenciennes, 1840), Heterobranchus bidorsalis (Geoffrey Saint Hillarie, 1809) and their Hybrids. International Journal of Fisheries and Aquatic Studies, 10(6): 07-12.

Adewumi, A.A., and Olaleye, V.F. 2017. Catfish culture in Nigeria: Progress, prospects and problems. Advanced Journal of Environmental Science and Technology ISSN 7675-1686. 8 (2): 001-005.

Akinwande, A.A., Moody, F.O., and Umar, S.O. 2009. Growth performance and survival of Heterobranchus longifilis, Heterobranchus bidorsalis and their reciprocal hybrids, African Scientist, 10(1): 15-18.

Aliu, B.S., Osayamen, S., Esume, A.C. 2018. Growth Responses of Hybrid Catfish (*Clarias gariepinus* ♀ X Heterobranchus bidosarlis ♂) Fingerlings Fed Diets Lablab Bean Meal (Lablab purpureus). Asian Journal of Fisheries and Aquatic Research, 1(3): 1-6.

Anifowose, O.R., Oladosu, G.A., and Oladele, O.O. 2021. Causal factors of mass mortality of hatchery reared *Clarias gariepinus* fry during exogenous feeding. Int. J. of Fish. Aquat. Stud, 9(1): 235-239.

Anifowose, O.R., Oladosu, G.A., and Oladele, O.O. 2022. Comparative growth performance and survival of hatchery-reared African catfish fry (*Clarias gariepinus* Burchell 1822) fed on live and artificial diets. International Journal of Fisheries and Aquatic Studies, 10(2): 106-112.

Ataguba, G.A., Annune, P.A., and Ogbe, F.G. 2009. Induced breeding and Early Growth of Progeny from crosses between two African Clariid fishes, *Clarias gariepinus* (Burchell) and *Heterobranchus longifilis* under hatchery conditions. Journal of Applied Biosceiences, 14:755-600. http://www.biosciences.elewa.org/JABS/2009/14/1.pdf.

Duncan, N., Sonesson, A., and Chavanne, H. 2013. Principles of finfish broodstock management in aquaculture: Control of reproduction and genetic improvement. In: Allan, G., Burnell, G. (Eds.), Advances in Aquaculture Hatchery Technology. Woodhead Publishing Limited, Cambridge, UK. pp. 23-75.

Ekelemu, J.K. 2010. Differential growth patterns of *Clarias gariepinus*, *Heterobranchus bidorsalis* and Hybrid Heteroclarias fed commercially prepared diets. Agriculture and Biology Journal of North America 1(4): 658-661.

Haniffa, M.A.K., and Sridhar, S. 2002. Induced spawning of spotted murrel (*Channa punctatus*) and catfish (*Heterebranchus fossils*) using human chorionic gonadotropin and synthetic hormone (ovaprim). Veterinary Archive, 72(1): 51-56.

Ljubobratovic, U., Kucska, B., Feledi, T., Poleksic, V., Markovic, Z., Lenhardt, M., Peteri, A., Kumar, S., and Ronyai, A., 2015. Effect of weaning strategies on growth and survival of pike perch, *Sander lucioperca*, larvae. Turkish Journal of Fisheries and Aquatic Sciences, 15: 327-333.

Maranga, B., Kagali, R., Omolo, K., Orina, P., Munguti, J., Ogello, E. 2023. Growth Performance of African Catfish (*Clarias gariepinus*) Fed on Diets Containing Black Soldier Fly (*Hermetia Illucens*) Larvae Under Aquaponic System *Aquaculture Studies*, *23(5), AQUAST910*. http://doi.org/10.4194/AQUAST910.

Mylonas, C.C., Duncan, N.J., and Asturiano, J.F. 2016. Hormonal manipulations for the enhancement of sperm production in cultured fish and evaluation of sperm quality. Aquaculture. In press.

Mylonas, C.C., Fostier, A., and Zanuy, S. 2010. Broodstock management and hormonal manipulations of fish reproduction. General and Comparative Endocrinology, 165(3): 516-534.

Naorbe, M.C. 2021. Biological performance of African catfish *Clarias gariepinus* (Burchell, 1822) fingerlings fed with raw chicken entrails. The Palawan Scientist, 13(2): 13-24.

Ndimele, P.E., and Owodeinde, F.G. 2012. Comparative Reproductive and Growth Performance of *Clarias gariepinus* (Burchell, 1822) and Its Hybrid Induced with Synthetic Hormone and Pituitary Gland of *Clarias gariepinus*. Turkish Journal of Fisheries and Aquatic Sciences, 12: 619-626.

Nguenga, D., Teugels, G.G., and Ollevier, F. 2000. Fertilization, hatching, survival and growth rates in reciprocal crosses of two strains of an African catfish *Heterobranchus longifilis* Valenciennes 1840 under controlled hatchery conditions. *Aquaculture Research*. 2000. 31. pp. 565–573.

Nlewadim, A.A., Udoh, J.P., and Otoh, A.J. 2011. Growth response and survival of *Heterobranchus longifilis* cultured at different water levels in outdoor concrete tanks. *Aquaculture, Aquarium, Conservation and Legislation-International Journal of the Bioflux Society (AACL Bioflux)*, 2011, 4(3).

Nwokoye, C.O., Nwuba, L.A., and Eyo, J.E. 2007. Induced propagation of African clariid catfish, *Heterobranchus bidorsalis* (Geoffrey Saint Hillarie, 1809) using synthetic and homoplastic hormones. African Journal of Biotechnology, 6(23): 2687-2693.

Owodeinde, F.G., and Ndimele, P.E. 2011. Survival, growth and feed utilization of two clariid catfish (*Clarias gariepinus,* Burchell 1822 and *Heterobranchus bidorsalis*, Geoffroy, 1809) and their reciprocal hybrids. Journal of Applied Ichthyology 27: 1249-1253.

Owodeinde, F.G., Fakoya, K.A., and Anetekhai, M.A. 2012. Growth performance of Hybrid Catfish (*Clarias gariepinus x Heterobranchus bidosalis*) in Earthen ponds. Asian Journal of Biological Sciences, 5(4): 192-200.

Piria, M., Jelkić, D., Gavrilović, A., Horváth, Á., Kovács, B., Balogh, R.E., Špelić, I., Radočaj, T., Vilizzi, L., Ozimec, S., and Opačak, A. 2022. Finding of hybrid African catfish "Clariobranchus" in the River Danube. J. Vertebr. Biol., 71: 1-9.

Rency, S.E., and Agung, N.R. 2020. Growth performance and carcass composition of African catfish, *Clarias gariepinus* fed different protein and energy levels. Iranian Journal of Fisheries Sciences 19(4): 1828-1839.

Shourbela R.M., Tohamy, H.G., and El-Hawarry, W.N. 2020. Induced spawning of African catfish (*Clarias gariepinus* Burchell, 1822) after pre-spawning prophylactic disinfection; the breeding performance and tissue histopathological alterations are under scope. Iranian Journal of Fisheries Sciences, 19(1): 309-324.

Solomon, S.G., Okomoda, V.T., and Ochai, L. 2013. Growth responses of pure bred *Heterobranchus bidorsalis*, *Clarias gariepinus* and their intergeneric crosses fed commercial diet. Banat's Journal of Biotechnology, 2013, 4(8): 71 – 76. http://www.bjbabe.ro.

Solomon, J.R., and Maiyaki, M.A. 2022. Comparative analysis of the growth performance and feed utilization of catfishes (*Clarias gariepinus*) Burchell and *Heterobranchus longifilis*-Geofroy- ST- Hilaire and their Hybrid (Heteroclarias) under Mono and Polyculture systems. Direct Research Journal of Veterinary Medicine and Animal Science, 7(1): 1-23.

Ukwe, I.O.K., Amachree, D., and Jamabo, N.A. 2019. Growth Assessment and Microbial Flora Presence in African Catfish (*Clarias gariepinus*) Larvae Fed Live and Commercial Feeds. Int. J. Sci. 8:7.

Yisa, N.S. 2011. Artificial hybridization of *Clarias gariepinus* and *Heterobranchus longifilis*. A thesis submitted to the school of Postgraduate studies, Ahmadu Bello University, zaria for the award of masters of Fisheries (M. SC. Fisheries) Department of Biological Sciences, Faculty of Science, Ahmadu Bello University, Zaria, Nigeria. 65 pages.