Journal of Experimental Agriculture International

43(7): 67-75, 2021; Article no.JEAI.72949
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Effect of Local Food on the Growth Performance of *Clarias gariepinus* (Burchell, 1822) Fry Reared at the Peyrie Fish Farm Station in Gabon

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2021/v43i730714
Editor(s):
(1) Lanzhuang Chen, Minami Kyushu University, Japan.
Reviewers:
(1) Malik Mohamed El-Sayed Khalafalla, Kafrelsheikh University ,Egypt.
(2) M.Ganeshwari, Bharathiar University, India.
Complete Peer review History: https://www.sdiarticle4.com/review-history/72949

Original Research Article

Received 16 June 2021
Accepted 23 August 2021
Published 02 September 2021

ABSTRACT

To assess the effects of two rations on growth performance of *Clarias gariepinus* fry, a study was carried out at the Peyrie fish farm station in Libreville, Gabon. To this effect, 3000 fry aged 14 days with 80 mg live weight were used. The animals were randomly distributed into six plastic tanks of 0.62 m^3 each with three replications per treatment. They were fed the ration T, a ration formulated with fishmeal and broiler chick feed, and the commonly used ration (CR), within 4 weeks. Weight growth, mean weight gain (MWG), daily individual growth (DIG), specific growth rate (SGR), survival rate (SR), nutrient quotient (NQ), protein efficiency ratio (PER), quantity of feed distributed and

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manufacturing cost per kg of feed were evaluated. It appears that there is no significant difference (p> 0.05) between the growth parameters of the fry regardless of the ration (T and CR). Thus, at the end of the study, for the CR and the ration T, a final mean weight of 3.481 ± 1.02 g vs 3.409 ± 0.97 g respectively was obtained; a MWG of 3.401 ± 0.31 g vs 3.330 ± 0.23 g; a DIG of 20.24 ± 7.44 mg/day vs 19.82 ± 5.58 mg/day, a SGR of 1.54 ± 0.22% mg/day vs 1.49 ± 0.27% mg/day and a SR of 26.13 ± 4.44% vs 20.60 ± 1.47%. In addition, a NQ of 1.52 ± 1.08 vs 1.21 ± 0.65 and a PER of 1.41 ± 0.81 vs 1.84 ± 0.39 and the quantity of feed of 1.96 kg vs 1.77 kg were also determined. In view of all these results, the ration T can be recommended for feeding *Clarias gariepinus* fry at the age of 14 days.

Keywords: Clarias gariepinus fry; growth; survival rate; feed efficiency.

1. INTRODUCTION

Aquaculture is a large and varied activity that increasingly acts in food security sector [1]. It is considered as a large sector which produces food with high animal protein content [2]. Aquaculture, which takes into account the farming of marine fishes, freshwater fishes, crustaceans, mollusks and algae, has grown considerably with important changes and is an integral part of the means used to ensure food security and economic development [3]. In Africa, fish is the main source of animal proteins [4]. Fish for consumption plays an essential role by providing more than 30% of total animal protein intake in countries like Ghana (58.6%), Congo (45.3%), Malawi (44.2%), Senegal (37.8%)) and Ivory Coast (30.0%) [5]. However, the decline in fish stocks caused by overfishing [6] is increasingly observed. Particular attention must therefore be paid to fish farming in order to contribute to meeting the populations demand for animal proteins. Among all fish species, *Clarias gariepinus* is an excellent intensively bred species due to its tolerance to poor water quality, ability to maintain strong growth at high density, resistance to disease and their ability to accept cheap feeds [7]. In addition, it is one of the fish species with significant economic potential [8]. Also, the technique of its artificial reproduction which is relatively simple coupled with the high protein content (60%) of its flesh make it one of the solutions for the sustainable development of fish farming [9]. However, the lack of appropriate feeding methods during the larval and post-larval stages constitutes one of the major constraints for the development of its breeding [10]. The general objective of this study is to contribute in improving knowledge on the diet of the species *Clarias gariepinus*.

2. MATERIALS AND METHODS

2.1 Experimental Site

This trial took place at the Peyrie fish farm station in Libreville, Gabon. This station is located in the Estuary Province at a latitude of 0 ° 2430.8 North, and a longitude of 9 ° 2740.2 East [11]. The tropical monsoon climate is characterized by abundant rainfall, a short dry season and not very arid, the rainfall in the driest month drops below 60 mm. The average rainfall is 2883 mm/year and the average annual temperature is 26.2 ° C [11]. There is a vegetation of the equatorial umbrophilic type.

2.2 Larvae Production

For this study, 3000 *Clarias gariepinus* fry aged 14 days (Figure 1), from the hatchery of the Peyrie fish farm station were used. These larvae were produced by the method of artificial reproduction by hormone induction. This is a method described by [12, 13]. It promotes the development and rapid maturation of oocytes in females. To carry out this reproduction, four males weighing between 0.5 and 2 kg were sacrificed to obtain milt (spermatozoa) and twelve females weighing between 0.5 and 1.5 kg were used for the production of oocytes.

2.3 Technical Material

The fry were distributed at a density of 1.6 individuals/L in fish breeding pond having a length of 1.12 m, a width of 0.91 m and a height of 0.61 m. The 6 ponds (Fig. 2) were covered with black plastic film to limit the penetration of sunlight and a net to control predation by birds. By an overflow control system with PVC pipes of 3 cm of diameter, water was kept in the pond at a constant level of 30 cm.

Fig. 1. Larvae of *Clarias gariepinus* at the age of 14 days

Fig. 2. Fish breeding ponds

The water from the dam pond located about 30 m from the basins, supplied them continuously through a system of pipes, manholes and taps. This water is conveyed to the level of the basins by the effect of gravity. The average flow rate of the water in the basins was 15 mL/s, which allowed a continuous renewal of the water, and therefore its good oxygenation.

2.4 Experimental Design and Data Collection

For this test, the control ration (CR) and the manufactured ration (T) were used. However, between the hatching phase of the larvae and the transitional feeding period, the larvae were fed on brine shrimp. The CR is imported by the fish farm station to feed *Clarias gariepinus* fry as from the age of 14 days. Regarding the ration T, its formulation was proposed by the fish farm station in order to compare it with the CR which is expensive. The chemical composition of the 2 rations is presented in Table 1. All the ingredients used in manufacturing the ration T were purchased from resellers of agricultural by-products in the city of Libreville. The quantity of each ingredient was weighed with an electronic scale of the OHAUS type, with a maximum mass

Table 1. Formulation and chemical composition of the experimental rations

Ingredients	Experimental rations			
	Ration T	**Control ration (RC)**		
Fish meal	50	-		
SMAG broilers feed	39	-		
Peanut chips	4.9	-		
Wheat flour	5.9	-		
Vitamins (Amin total)	0.1	-		
Salt	0.1	-		
Total	100	-		
Chemical composition			**Fish meal**	**SMAG feed**
Dry matter	80	70	-	-
Organic matter	90	91	-	-
Crude proteins	40.39	42	69	20.5
Crude fats	3.6	12	9.1	2.39
Crude fibers	3	3.5	0	3.98
Total ash	10	9	14	5.73

***CR:** Imported diet; **T:** Feed produced and sold in the city market*

of 3 kg and precision to the nearest thousandth. The mixing of all the ingredients was done manually and the water was added gradually. In order to solidify all the ingredients among themselves, the mixture thus obtained was transformed into a granular form, and then dried. After drying, the granules were crushed in order to reduce them into fine particles. The ration was thus distributed to the 14-day-old fry in powder form.

The fry were acclimatized for three days. With the plastic tanks already set up, the 3000 fry were first divided into six batches of 500 animals. Each batch was weighed using an OHAUS-type electronic balance with a maximum mass of 3 kg and precision to the nearest thousandth, and placed in separate tanks. The fry from tanks B1, B3 and B5 were fed the ration T, and those from tanks B2, B4 and B6 received the control ration (CR). The three CR tanks and three other T tanks, meaning three repetitions per diet, were arranged according to a completely randomized block design. They were fed *ad libitum* at 50% initial ichthyobiomass and the feed was distributed 5 times a day every 3 hours (7 a.m., 10 a.m., 1 p.m., 4 p.m. and 7 p.m.) for a period of 4 weeks. During feeding, the taps were closed for better observation of the fry. The physicochemical parameters of the water such as temperature and pH were measured twice a day until the end of the study. In the morning at 7 a.m. before the first feeding and between 2 p.m. and 5 p.m. An electronic-type pH meter of the pH 10A brand was used not only for measuring the pH but also for measuring the temperature. The siphoning operation was carried out every day before the first meal using a 1 cm diameter siphon, this permitted to reduce plant debris, feed residues and fry droppings from the bottom of the pond. Every week, a control fishery was carried out in the six ponds in order to count and weigh the fry according to the experimental rations. On the day of the control fishery, the fry were only fed once (6 p.m.). Then, each batch of fry is placed back in its respective basin. Then the feeding resumes for the following week until the end of the trial.

2.5 Proximate Analyses

The chemical composition of the 2 rations distributed to the fry was determined at the Biochemistry laboratories of the Faculty of Science and Food Sciences (INSAB) of the USTM. The parameters analyzed were the content (%) of dry matter (DM), crude proteins (CP), crude fibers (CF), fats and ash. Three repetitions per sample were necessary to determine the mean value of each of these components. The DM and ash contents were determined according to the [14] method, the CP content according to the Bradford/Sedmak method, the fat content by the extraction method under reflux using the device of Soxhlet. The determination of the CB content was carried out by Sheerers method.

2.6 Statistical Analyses

Data on growth parameters, survival and feed conversion were subjected to 2-way analysis of variance (ration and week). When significant differences existed between the treatments, the separation of the means was made by Students test at the 5% significance level. The software used was R commander version 3.4.3.

3. RESULTS

3.1 Temperature and pH of the Water According to Weeks

The Table 2 presents the evolution of temperature and pH of the breeding environment according to the evolution of weeks.

From this table, it appears that the temperature recorded in the second week was higher (31.00 ± 0.20 ° C) than those obtained in the first, third and fourth weeks, respectively 27.68 ± 0.06°C; 28.60 ± 0.20°C and 29.37 ± 0.16°C. There was no significant difference ($p>0.05$) between the pH values regardless of the weeks.

3.2 Growth Parameters of the Fry during the Trial

The growth parameters of the fry according to rations and weeks are summarized in the Table 3. From this table, it can be seen that the rations did not influence the mean live weight (MLW), nutrient quotient (NQ), protein efficiency ratio (PER) and survival rate (SR) of the fry. In fact, statistical analysis revealed that no significant difference ($p>0.05$) was observed between the two rations concerning the MLW, NQ, PER and SR of fry for any week. Furthermore, fry weights steadily increased from the first to the fourth week. The average weight gain (AWG) and the specific growth rate (SGR) of the fry were influenced by the rations. With the exception of the AWG and SGR of the fry fed the ration T and CR in the second and fourth weeks, those of the fry in the first and third weeks showed a significant difference ($p<0.05$). The rations also influenced the daily individual growth (DIG) of the fry. With the exception of the DIG of fry fed ration T and CR at week 4, those of fry fed at weeks 1, 2 and 3 showed a significant difference ($p<0.05$).

3.3 Manufacturing Costs per kg of Feed Distributed

The Table 4 shows the quantities and prices of the different ingredients used in the formulation of a kilogram of feed, the quantities of feed distributed during the trial, the cost price per kilogram of feed and their total costs.

The analysis of Table 3 shows that the fry fed the ration CR received a higher amount of feed than the fry fed with the ration T. Furthermore, given the price per kilogram of both types of feed, the T treatment had the lowest cost (2749 FCFA /kg).

4. DISCUSSION

The lowest temperatures recorded during the trial were obtained at the first, third and fourth weeks, respectively 27.68 ± 0.06 ° C; 28.60 ± 0.20°C and 29.37 ± 0.16 ° C. Except the temperature obtained in the second week (31.00 ± 0.20°C), these values are within the standards recommended for the species *Clarias gariepinus* which situate the optimum temperature favorable for a good growth between 20 and 30°C [15]. The pH values recorded during the trial vary between 6.76 and 7.94. These values are in line with those recommended for the good growth (6.5 to 9) of this species [16].

The average weight of the fry subjected to the T treatment at the fourth week was 3.409 ± 0.97 g and that of the CR treatment at the same week was 3.481 ± 1.02 g. These values are lower than those reported by [17] (4.55 g and 4.44 g). This difference could be explained by the quality of the feed used. In fact, [18] reported that an average weight of about 10 g can be obtained after three weeks of rearing with a density of 10,000 to 20,000 individuals per hectare, in larvae of *Clarias gariepinus* fed a ration made from live feeds (*Hermetia illucens*). In addition, [19] report that, optimal growth rates of *Clarias gariepinus* and *Heterobranchus longifilis* are achieved with a combination of artificial and live feeds. In addition, obtaining these average

Table 2. Evolution of temperature and pH of the rearing medium according to weeks

Physicochemical parameters	Weeks of the trial			
	1	2	3	4
Temperature (° C)	27.68 ± 0.06^a	31.00 ± 0.20^b	28.60 ± 0.20^a	29.37 ± 0.16^a
pH	7.28 ± 0.01^a	7.94 ± 0.07^a	7.08 ± 0.07^a	6.76 ± 0.01^a

The means with the same letters on the same line are not significantly different at the 5% level

Table 3. Growth parameters of the fry during the trial

Growth parameters	Treatments	Start of the test	Week 1	Week 2	Week 3	Week 4	Week 1 – 4
MLW	**T**	0.079 ± 0.00[a]	1.007 ± 0.01[a]	1.370 ± 0.02[a]	2.262 ± 0.09[a]	3.409 ± 0.97[a]	-
	CR	0.080 ± 0.00[a]	1.058 ±0.01[a]	1.282 ± 0.06[a]	2.391 ± 0.04[a]	3.481 ± 1.02[a]	-
AWG	**T**	-	0.928 ± 0.01[a]	0.363 ± 0.02[a]	0.892 ± 0.07[a]	1.147 ± 0.03[a]	3.330 ± 0.23[a]
	CR	-	0.978 ± 0.01[b]	0.225 ± 0.06[a]	1.109 ± 0.02[b]	1.089 ± 0.00[a]	3.401 ± 0.31[a]
DIG	**T**	-	22.09 ± 0.29[a]	8.64 ± 0.44[b]	21.23 ± 1.64[a]	27.31 ± 0.72[a]	19.82 ± 5.58[a]
	CR	-	23.28 ± 0.32[b]	5.34 ± 1.49[a]	26.39 ± 0.02[b]	25.94 ± 0.10[a]	20.24 ±7.44[a]
SGR	**T**	-	1.53 ± 0 .35[a]	1.19 ± 0.32[a]	1.78 ± 0.16[a]	1.47 ± 0.24[a]	1.49 ± 0.27[a]
	CR	-	1.62 ± 0.17[b]	1.21 ± 0.19[a]	1.81 ± 0.39[b]	1.52 ± 0.12[a]	1.54 ± 0.22[a]
NQ	**T**	-	0.06 ± 0.01[a]	1.88 ± 0.13[a]	1.06 ± 0.22[a]	1.84 ± 0.17[a]	1.21 ± 0.65[a]
	CR	-	0.05 ± 0.00[a]	3.48 ± 0.91[a]	0.82 ± 0.03[a]	1.73 ± 0.26[a]	1.52 ± 1.08[a]
PER	**T**	-	40.32 ± 4.06[a]	1.32 ± 0.08[a]	2.45 ± 0.44[a]	1.84 ± 0.39 [a]	-
	CR	-	44.62 ± 2.73[a]	0.77 ± 0.24[a]	2.91 ± 0.10[a]	1,41 ± 0.81 [a]	-
SR	**T**	-	69.46 ± 4.98[a]	51.87 ± 6.62[a]	38.27 ± 1.24[a]	20.60 ± 1.47[a]	-
	CR	-	76.47 ± 4.89[a]	57.93 ± 10.04[a]	40.73 ± 6.48[a]	26.13 ± 4.44[a]	-

Means with the same letters in the same column are not significantly different at the 5% threshold. MLW: Mean live weight, NQ: Nutrient quotient, DIG: Daily individual growth, PER: Protein efficiency ratio SR: Survival rate, AWG: Average weight gain, SGR: Specific growth rate

Table 4. Quantities and prices of ingredients used in the formulation of a kg of feed

Ingredients	Quantities of feed (g/kg of feed)	Prices of quantities purchased (FCFA/kg)	Prices of quantities used (FCFA)
Fish meal	500	5000	2500
SMAG broilers	400	440	176
Peanut chips	48	120	5,76
Wheat flour	50	500	25
Vitamins (Amin total)	1	41000	41
Salt	1	400	0.4
Total	**1000**	**-**	**2748.16 ~ 2749**
Total costs of feeds distributed			
Treatments	**Quantities distributed during the trial (kg)**	**Prices per kg of feeds (FCFA/kg)**	**Total costs of feeds distributed (FCFA)**
T	1.77	2749	**4866**
CR	1.96	6000	**11760**

weights could also be explained by the size of the eggs during reproduction. Some authors have reported the existence of variations in the weight of fingerlings produced from the same stock of Clariidae parent stocks at the same time [20].

T and CR treatments of *Clarias gariepinus* fry provided mean weight gains of 3.330 ± 0.23 g and 3.401 ± 0.31 g, respectively, at the end of the study. However, during the 2nd week of rearing, the weight gains of the fry declined sharply. This state could be caused by the high temperature (31.00 ± 0.20 ° C) recorded this week. On the other hand, when fish are fed high protein diet and the temperature rises sharply, the amount of total ammoniacal nitrogen in the toxic non-ionized form, increases and causes growth retardation in the fish [21].

The daily individual growths (DIG) of the fry fed the ration T and CR recorded at the end of this study were 19.82 ± 5.58 mg/day and 20.24 ± 7.44 mg/day respectively. These values are lower than that reported by [22] (3.2 g/day) for a production of un-hybridized *Clarias gariepinus* from the sub-adult phase. Moreover, these values were equally lower than those recorded by [23] (1.52 g) in hybrids of *Clarias gariepinus* reared in monoculture in a concrete tank and fed zooplankton (Rotifers, Cladocerans and Copepods). Research works of [17, 24] revealed higher values, respectively 110 mg/day - 140 mg/day and 66 mg/day. This difference could be justified by the genetic variability, the stage of growth of the fish, the mode of feeding and the duration of rearing. In addition, this difference could be justified by the storage density; in fact, the optimal growth of *Clarias gariepinus* was obtained at densities of 5, 10 and 15 fry/liter of water. It appears that, at low stocking density, fry feed well and convert the feed as much as possible into biomass [25, 22].

The specific growth rates (SGR) of fry recorded at the end of this study were 15.66 ± 3.34%/day and 15.73 ± 3.67%/day respectively for T and CR. These rates are lower than the standard which is 12% [26] and to those obtained by [17] which are 17.06%/day and 16.24%/day with fry reared in polyester tanks for a period of 38 days. These rates were also lowerr than those reported by [24] which varied between 2.78 ± 0.07%/j and 3.99 ± 0.04%/j. This difference could be justified by the stocking density of the fry.

The survival rate of the fry subjected to the two treatments showed no significant difference ($p > 0.05$) at the end of the trial. However, the lowest survival rate (20.60 ± 1.47%) was recorded at the fourth week in fry fed the ration T. This rate is lower than that reported by [27] (80%). This difference could be attributed to the stocking density thus leading to the phenomenon of cannibalism and social hierarchy, a phenomenon often encountered in growing *Clarias gariepinus* farms [22]. In addition, this low survival rate could also be explained by improper handling of the fry.

The nutrient quotient (NQ) of the fry subjected to the two treatments showed no significant difference ($p > 0.05$) during this study. However, at the end of the trial, the highest NQ (1.52 ± 1.08) was recorded in fry fed CR. This value is lower than those obtained by [24] which oscillated between 3.50 ± 0.00 and 5.81 ± 0.01. This difference could be justified by the amount of feed wasted by the fry.

As far as the protein utilization ratio (PER) is concerned, the statistical analysis has revealed that, regardless of the weeks, no significant difference (p>0.05) was observed between the two treatments. Therefore, the highest value (44.62 ± 2.73) was recorded at the first week in fry fed CR. This coefficient was higher than that obtained by [24] which varied between 0.09 ± 0.00 and 0.61 ± 0.02. This difference could be explained by the valorization by the fry of proteins contained in rations. In fact, the higher the PER, the more the protein in the feed is better processed by the fry.

Regarding the price per kg of feed, the CR treatment has a higher cost (6000 FCFA/kg) than the T treatment (2749 FCFA/Kg). Like their similar performance obtained, the ration T is cheaper; thus it should be recommended for fry feed.

5. CONCLUSION

At the end of this study on the effect of two rations on the growth performance of *Clarias gariepinus* fry, it emerges that the growth performance recorded in the fry at the level of T and CR treatments was similar. On the other hand, treatment T was the one with the cheaper price per kg of feed. In view of these results, the use of the ration T may be recommended for rearing *Clarias gariepinus* fry at the age of 14 days.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Little DC, Newton RW, Beveridge MCM. Conference on The future of animal products in the human diet: Health and environmental concerns. Symposium alternatives to meat. Proceedings of the Nutrition Society. 2016;75:274-286.
2. Pradeepkiran JA. Aquaculture role in global food security with nutritional value: a review. Aquaculture role in global food security and sustainability; 2019.
3. FAO. The state of world fisheries and aquaculture. Meetings the sustainable development goals. Rome. Licence: CC BY-NC-SA 3.IGO. ISBN 978-92-5-130562-1; 2018.
4. Jim F, Garamumhango P, Musara C. Comparative analysis of nutritional value of Oreochromis niloticus (Linnaeus), Nile Tilapia, meat from three different ecosystems. Hidawi, Journal of Food Quality. 2017;Article ID 6714347 DOI:https://doi.org/10.1155/2017/6714347
5. CIRAD-GRET. Mémento de lagronome. Ministère des affaires étrangères. France. 2002 ;1571-1615.
6. FAO. La situation mondiale des pêches et de laquaculture. Contribuer à la sécurité alimentaire et à la nutrition de tous. Rome. 2016 ;224. ISBN 978-92-5-209185-1.
7. Abraham TJ, Mallick PK, Paul P. African catfish Clarias gariepinus farming practices in North and South 24 Parganas districts of West Bengal, India. Journal of Fisheries. 2018;6 (1):579-586.
8. Strauch SM, Wenzel LC, Bischoff A, Dellwig O, Klein J, Schüch, Wasenitz B, Palm HW. Commercial African catfish (*Clarias gariepinus*). Recirculating Aquaculture systems: Assessment of Element and Energy Pathways with special Focus on the Phosphorus cycle. Sustainability. 2018;10 (1805).
9. Kayuma M, Ngoy K, Ipungu L, Binemo K, Lubula K, Ompey I, Kidinda M, Bulembu N, Mubili M, Kalenga L. Mise au point dun aliment sec pour lélevage larvaire du poisson-chat africain (Burchell 1822) souche de Lubumbashi. Journal of Animal & Plant Sciences. 2018;38:6152-6158.
10. FDNS. 2004. Information for MSKU as of August 2004. Available:www.fdns.org.
11. AOAC (Association of Official Analytical Chemist). Official method of analysis 15th edition. AOAC. Washington D.C. 1990;10.
12. Amisah S, Oteng MA, Ofori JK. Growth performance of the African catfish (*Clarias gariepinus*) fed varying inclusion levels of Leucaena leucocephala leaf meal. J. Appl. Sci. Environ. Manage. 2009;13(1):21-26.
13. Uzoka CN, Anyanwu JC, Uche CC, Ibe CC, Uzoma A. Effect of pH on the growth performance and survival rate of Clarias gariepinus fry. International Journal of Research in Biosciences. 2015;4(3) :14-20.
14. Rukera Tabaro S, Micha JC, Ducarme C. Essais dadaptation de production massive de juvéniles de *Clarias gariepinus* en conditions rurales. Tropicultura. 200; 23(4):231-244.

15. Talamuk R. Comparison of growth performance of African catfish (*Clarias gariepinus*, Burchell, 1822) fingerlings fed different inclusion levels of black soldier fly (*Hermetia illucens*) larvae meal diets. Thesis presented in partial fulfilment of the requirements for the degree of Master of Science in Agriculture (Aquaculture) at Stellenbosch University. 2016;69. Stellenbosch University.
Available :https://scholar.sun.ac.za
16. Agadjihouèdé H, Chikou A, Bonou CA, Lalèyè PA. Survival and growth of Clarias gariepinus and Heterobranchus longifilis larvae fed freshwater zooplankton. Journal of Agricultural Science and Technology. 2012;192-197 B2. ISSN 1939-1250.
17. Umanah SI. Maternal age influence on fry survival, growth and size variation in Clarias gariepinus. Asian Journal of Animal Sciences. 2020;14(4):145-152.
18. Chatvijitkul S, Boyd CE, Davis DA. Nitrogen, phosphorus, and carbon concentrations in some common aquaculture feeds. Journal of the World Aquaculture Society; 2017.
DOI: 10.1111/jwas.12443.
19. Dasuki A, Auta J, Oniye SJ. Effect of stocking density on production of *Clarias gariepinus* (Tuegels) in floating bamboo cages at Kubanni reservoir, Zaria, Nigeria. Bayero Journal of Pure and Applied Sciences. 2013;6(1):112 – 117.
20. Mfwana ID, Kasongo TG, Ntende MB, Katemo MB, Chocha MA. Etude comparative des performances de croissance et de taux de survie des larves de deux espèces du genre Clarias (*C. gariepinus* et *C. ngamensis*) au jardin zoologique de Lubumbashi, RD Congo. International Journal of Innovation and Applied Studies. 2016;17(3):738-744. ISSN: 2028-9324.
21. Jamabo NA, Keremah RI. Effects of stocking density on the growth and survival of the fingerlings of *Clarias gariepinus* (Burchell, 1822). Journal of Fisheries International. 2009;4(4) : 55-57.
22. Ducarme C, Micha JC. Technique de production intensive du poisson-chat africain (*Clarias gariepinus*). Tropicultura. 2003 ;21(4):189-198.
23. Mfwana ID, Kasongo TG, Ntende MB, Katemo MB, et Chocha MA. Etude comparative des performances de croissance et de taux de survie des larves de deux espèces du genre *Clarias* (*C. gariepinus* et *C. ngamensis*) au jardin zoologique de Lubumbashi, RD Congo. *International Journal of Innovation and Applied Studies*. 2016;17(3):738-744. ISSN: 2028-9324.
24. Kouadio NJS. Influence de la source de protéines alimentaires et de la mise en charge sur les performances zootechniques des post-larves de mâchoiron, *Chrysichthys nigrodigitatus* (Lacepede, 1803). Mémoire de master. Biologie et Production animale. Université Nangui Abrogoua. Côte-d'Ivoire. 2014;75.
25. Jamabo NA, Keremah RI. Effects of stocking density on the growth and survival of the fingerlings of *Clarias gariepinus* (Burchell, 1822). Journal of Fisheries International. 2009;4 (4):55-57.
26. Richir J. Valorisation des produits agro-industriels dans l'alimentation du poisson-chat africain, *Clarias gariepinus* (Burchell, 1822), au Rwanda. Mémoire présenté pour l'obtention du grade de licencié en Sciences biologiques. Facultés Universitaires Notre-Dame de la Paix, Namur. 2004;87.
27. Ducarme C, et Micha, JC. Technique de production intensive du poisson-chat africain (*Clarias gariepinus)*. Tropicultura. 2003;21(4):189-198.

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