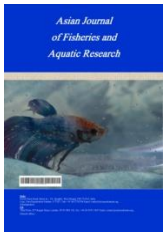

Asian Journal of Fisheries and Aquatic Research

14(4): 22-28, 2021; Article no.AJFAR.73378
ISSN: 2582-3760

Culture Pond Influences the Growth and Survival of *Clarias gariepinus* Fingerlings reared in Poly and Monoculture

L. U. Onyia[1], I. J. Ochokwu[2*] and I. J. Bargudu[1]

[1]Department of Fisheries, School of Agriculture and Agricultural Technology, Modibbo Adama University of Technology, PMB 2076, Yola, Nigeria.
[2]Department of Fisheries and Aquaculture, Federal University Dutsinma, PMB 5001, Katsina State, Nigeria.

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/AJFAR/2021/v14i430302
Editor(s):
(1) Dr. Matheus Ramalho de Lima, Federal University of South of Bahia, Brazil.
Reviewers:
(1) Najamuddin, Hasanuddin University, Indonesia.
(2) Zakirah Mohamad Taufek, Malaysia.
Complete Peer review History: https://www.sdiarticle4.com/review-history/73378

Original Research Article

Received 21 June 2021
Accepted 01 September 2021
Published 09 September 2021

ABSTRACT

Monoculture is the rearing of single species of fish in a pond while polyculture is the farming of two or more species in the same physical space. This study aims to compare the growth parameters of *Clarias gariepinus* fingerlings in monoculture and polyculture, using concrete and earthen ponds in a randomized complete block design. The polyculture, comprised of *Clarias gariepinus* and *Oreochromis niloticus.* 480 fingerlings were used; the stocking density was 40fish in a 3x2x1.5m depth with initial weight (4.84±0.11547) for *C. gariepinus* in monoculture and 40 each in polyculture with an initial pooled weight of *O. niloticus* (50g) replicated thrice, it was fed for eight weeks with commercial feed (40% crude protein). Weekly, random sampling was done to measure the growth and adjust the feeding rate. The results revealed that polyculture has the best mean final weight (160.07±0.18559g) and weight gain of 155.29, while the highest total length (45.666±3.179) was recorded in monoculture for *Clarias gariepinus* reared in an earthen pond. The polyculture had the highest specific growth rate (2.46), Relative growth rate (246.49), and condition factor (0.184). There was a significant difference (P<0.05) in monoculture of both concrete and earthen ponds.

**Corresponding author: Email: ijochokwu@fudutsinma.edu.ng;*

Keywords: Growth; polyculture; monoculture; culture facilities; Clarias gariepinus.

1. INTRODUCTION

Monoculture is the rearing of single species of fish in a pond or tank, the culture of *Clarias gariepinus* only or *Oreochromis niloticus* [1]. The culture endows the farmer to formulate feed that will meet the nutrients requirements of a specific fish, particularly in the intensive and semi-intensive culture system [2]. Fish of diverse ages can be stocked such as omnivores and herbivores species, this can enhance selective harvesting [3]. Polyculture is the production of two or more cultured species either two different fish species or fish with animals or crops in the same physical space within the same period. The major objective of polyculture is to produce multiple products that have economic value [4]. In a polyculture system, fish farming is fundamentally distinguished according to their level of intensification; however, this is significantly defined according to their feeding practices. However, Aquaculture is the raising of animals and plants in a controlled and semi-controlled environment, in an Aquaculture system, feed typifies more than 50% of the total operating cost [5]. Similarly, other production cost includes water, land, capital, labor and the fish seed. Polyculture can be carried out intensively, semi-intensive and, in extensive methods [6].

In Nigeria, African catfish; *C. gariepinus*, *C. anguillaris*, *Heterobranchus bidorsalis*, *H. longifilis* and, their hybrids are the most cultured and consumed because of their hardiness, rapid growth, stress resistance, adaptation ability in captivity and can utilize both natural and artificial feed for growth and body maintenance [7]. In Nigeria, overfishing has led to the extinction of most wild species, due to high demand by a local market. In addition, the growing population has motivated the fishers to fish more; hence this has necessitated farmers into engaging in aquaculture systems with little or no knowledge; since that is the only way they can survive and feed their family in a population of over 200 million people.

Aquaculture is in a stage of development [8], most of the farmers engaging in aquaculture have little or no knowledge of the aquaculture management practices and feeding methods. The majority of the fish farmers' in Nigeria utilize concrete ponds, plastic tanks, fiber tanks and, tarpaulin ponds, which are not economical, and are not used for long-term farming because of the impact of the sun. Researchers have worked on survival rates in polyculture of catfish and Tilapia, [8-9] examined the impact of stocking density on *C. gariepinus* and *O. niloticus*; while [10] ascertained the performance of *C. gariepinus*, *O. niloticus* under integrated farming with Broiler. However, [11] reported the effect of prey density, predator size, and feed supplementation on the polyculture of *C. gariepinus* and *O. niloticus*. But in this research, the growth parameters of *C. gariepinus* reared in an earthen pond and concrete pond have not gained attention. In this research, the influence of concrete pond and earthen pond on the growth performance of *C. gariepinus* reared in a monoculture and polyculture system were evaluated. The aim was to expose its significance to fish farmers, to encourage them to practice polyculture and utilizing earthen ponds to maximize production and economically increase yield.

2. MATERIALS AND METHODS

The Experiment took place from 25th March 2019 to 20th July 2019 at the Department of Fisheries Teaching and research farm, Modibbo Adama University of Technology, Yola, Adamawa State. The state is located on latitude 9.20-9.33ºN, longitude 12.30-12.50ºE and, an altitude of 185.9m. Yola has an average annual rainfall of about 759mm, with a maximum temperature of 39.7ºC. The rainy season commences in May and ends in October. The dry season commences in November and ends in April [12].

2.1 Experimental Fish

A total of 480 fingerlings; 360 *C. gariepinus* and 120 *Oreochromis niloticus* were utilized. The fingerlings were collected from the nursery pond in the research farm. Polyculture consisting of 40 *Oreochromis niloticus* of 50g pooled weight was stocked before the commencement of the research. One month later, 40 *C. gariepinus* (4.8g initial body weight) was introduced in the earthen pond consisting of *O. niloticus* while in the monoculture, 40 *C. gariepinus* were stocked in an earthen pond and another 40 *C. gariepinus* in a concrete tank all in an outdoor facility and replicated thrice. All the ponds (concrete and

earthen pond) were replicated thrice was 3x2x1.5m depth. None of the ponds were fertilized with any organic/inorganic manure before the commencement of the feeding trials. All the fishes were fed with prime crown twice a day at 5% body weight. Fish were weighed weekly to ascertain the weight and length increase and subsequently adjust the feeding rate. Also, the water quality parameters (pH, dissolved Oxygen, Temperature) were monitored throughout the experimental period.

2.1.2 Experimental design

The research consists of three treatments with three replications each using a randomized complete block design (RCBD) as shown below:

Treatment 1 (monoculture) concrete tank stocked with forty (40) *C. gariepinus* only

Treatment 2 (monoculture) earthen pond stocked with forty (40) *C. gariepinus* only and

Treatment 3 (polyculture) earthen pond stocked with forty (40) *C. gariepinus* and forty (40) *Oreochromis niloticus*, all the treatments were replicated three times for accuracy.

The ponds are 3x2x1.5m in depth

2.1.3 Ponds preparation

The earthen ponds were drained, allowed to dry for one week to lay off every aquatic organism in the pond, and cored to avoid leakage. While the concrete tanks were washed and sanitized with saline solution before the commencement of the experiment. The water was pumped into the ponds two days before the experiment commenced. The same volume of water was maintained throughout the experimental period.

2.1.4 Nutrient utilization parameters [13]

Specific growth rate.

2.1.5 Statistical analysis

Data collected were subjected to one-way analysis of variance (ANOVA) using SPSS 20, differences between the means were analyzed using Duncan multiple range tests (DMRT).

3. RESULTS

3.1 Weekly Growth in Weight of Monoculture and Polyculture of *C. gariepinus* Fingerlings

The result of the growth in weight of monoculture and polyculture of *C. gariepinus* fingerlings reared in concrete and the earthen pond are presented in Table 1. *C. gariepinus* in polyculture had the highest final weight after the feeding trial 160.07±0.18559g followed by monoculture in earthen pond 148.04±0.11547g and the least was in monoculture in concrete pond 92.04±0.11547g.

3.1.1 Weekly growth in the length of monoculture and polyculture of *C. gariepinus* fingerlings

The result of the weekly growth in length of monoculture and polyculture of *C. gariepinus* juvenile reared in concrete and the earthen pond are presented in Table 2. The result showed that *C. gariepinus* reared in the monoculture (earthen pond) had the highest growth in length (45.666±3.179cm), trailed by polyculture in an earthen pond (44.333±2.185cm) and monoculture in a concrete tank (38.666±0.882).

3.1.2 Mean Growth parameters of polyculture and monoculture of *Clarias gariepinus* in concrete and earthen ponds

Table 3 displayed the result of the Growth parameters in polyculture and monoculture of *Clarias gariepinus* in concrete and earthen ponds. The *C. gariepinus* reared in polyculture in an earthen pond for 56days had the highest weight gain 155.29g, it was followed by *C. gariepinus* reared in monoculture (earthen pond) 143.22g and the least was in *C. gariepinus* reared in a concrete pond 87.0g. However, the *C. gariepinus* reared in a monoculture in an earthen pond had the highest length gain 40.33cm, followed by *C. gariepinus* reared in polyculture in an earthen pond 39.00cm and the least was in *C. gariepinus* reared in a concrete pond 33.33cm. The specific growth rate ranged from 1.38 in *C. gariepinus* reared in a concrete pond to 2.27 in an earthen pond (monoculture) and 2.46 in polyculture. The relative growth rate was 138.4 in a concrete pond, 227.33 in monoculture (earthen pond), and 246.49 in polyculture. The percentage survival in all the treatments was 100%, and there was no significant difference ($P<0.05$) in the condition factor across the treatments.

Table 1. Weekly growth in weight (g) of polyculture and monoculture *Clarias gariepinus* in concrete and earthen ponds

Weeks	Concrete Tank	Monoculture(Earthen pond)	Polyculture(Earthen pond)
1	4.84±0.12	4.82±0.01	4.78±0.06
2	6.04±0.12^{c}	12.02±0.06^{b}	36.04±0.12^{a}
3	12.03±0.09^{c}	36.02±0.06^{b}	60.06±0.15^{a}
4	28.04±0.12^{c}	64.04±0.12^{b}	84.05±0.12^{a}
5	36.03±0.09^{c}	80.03±0.09^{b}	104.05±0.12^{a}
6	48.03±0.09^{c}	96.03±0.09^{b}	116.06±0.15^{a}
7	60.03±0.09^{c}	116.04±0.12^{b}	132.07±0.19^{a}
8	76.03±0.07^{c}	132.03±0.09^{b}	148.06±0.15^{a}
9	92.04±0.12^{c}	148.04±0.12^{b}	160.07±0.19^{a}

Means with different superscripts are significantly different (p<0.05)

Table 2. Weekly Growth in the length (cm) of polyculture and monoculture *Clarias gariepinus* in concrete and earthen ponds

Week	Concrete Tank	Monoculture (Earthen pond)	Polyculture (Earthen pond)
1	5.333±0.58	5.333±0.33	5.333±0.33
2	7.333±0.33^{b}	8.667±0.88^{ab}	9.667±0.88^{a}
3	9.000±0.58^{b}	11.667±0.88^{ab}	12.667±1.86^{a}
4	12.333±1.45^{c}	15.000±1.16^{b}	19.667±1.45^{a}
5	12.666±1.20^{c}	23.666±0.88^{b}	30.333±0.88^{a}
6	25.333±2.91^{c}	34.000±2.08^{b}	39.000±2.08^{a}
7	29.000±2.08^{c}	37.000±3.61^{b}	41.333±1.86^{a}
8	34.667±1.45^{b}	41.666±2.19^{ab}	42.000±1.73^{a}
9	38.666±0.88^{b}	45.666±3.18^{ab}	44.333±2.19^{a}

Means with different superscripts are significantly different (p<0.05)

Table 3. Mean Growth parameters of polyculture and monoculture of *Clarias gariepinus* in concrete and earthen ponds

Parameters	Monoculture (Concrete pond)	Monoculture (earthen pond)	Polyculture (earthen pond)
Initial weight(g)	4.84	4.82	4.78
Final weight(g)	92.04^{c}	148.04^{b}	160.07^{a}
Mean weight gain(g)	87.0^{c}	143.22^{b}	155.29^{a}
Initial length(cm)	5.33	5.33	5.33
Final length(cm)	38.66^{c}	45.66^{a}	44.33^{b}
Mean length gain(cm)	33.33^{c}	40.33^{a}	39.00^{b}
Specific growth rate	1.38^{c}	2.27^{b}	2.46^{a}
Relative growth rate	138.4^{c}	227.33^{b}	246.49^{a}
Percentage survival	100^{a}	100^{a}	100^{a}
Condition factor	0.16^{a}	0.16^{a}	0.18^{a}

Means with different superscripts are significantly different (p<0.05)

Table 4. Mean water quality parameters throughout the experiment

Parameters	Monoculture concrete pond	Monoculture earthen pond	Polyculture earthen pond
pH	6.5^{b}	7.2^{a}	7.8^{a}
Dissolved O_2 mg/l	1.62^{b}	2.21^{a}	2.28^{a}
Temperature ^{o}C	32^{a}	33^{a}	33^{a}
Alkalinity mg/l $CaCO_3$	182.7^{c}	236.20^{b}	244.76^{a}
Ammonia	0.15^{b}	0.34^{a}	0.39^{a}
Water Turbidity cm	62^{a}	48^{c}	52^{b}

Means with different superscripts are significantly different (p<0.05)

3.1.3 Water quality parameters

The water quality parameters are presented in table 4. The temperature ranged from 32^0C in the concrete pond to 33^0C in monoculture and polyculture reared in an earthen pond. Dissolve Oxygen ranged from 1.62mg/l in a concrete pond, 2.21mg/l in monoculture in an earthen pond, and 2.28 in the earthen pond (polyculture), the pH (6.5) in a concrete pond, 7.2 in an earthen pond (monoculture), and 7.8 in polyculture. Ammonia was 0.15 in a concrete pond, 0.34 in monoculture in an earthen pond, and 0.39 in the polyculture respectively.

4. DISCUSSION

The weight increase of *C. gariepinus* in this research has proved that irrespective of the essentiality in the quality of feed consumed; other parameters are relevant in weight and length increase in farm animals; the culture medium, stocking density, size of the pond, physicochemical parameters of the water, general cleanliness and hygiene and level of exposure to toxic substances is weighty. The rearing process involved concrete ponds and earthen ponds; the *C. gariepinus* reared in the same pond with *O. niloticus* (polyculture, without fertilization) inherently increased in the body weight. The rate of the growth was incredible when compared with other treatments; this accord with previous research [14] who reported higher weight gain in *C. gariepinus* reared with common carp and Tilapia; subsequently, previously [15] reported a higher growth rate in pangasius catfish reared with silver carp, while [16] had a higher growth rate in polyculture of *Clarias gariepinus* and *Oreochromis*. Similarly, [9] recorded an increase in weight gain when *C. gariepinus* and *O. niloticus* were stocked in ratio 1:3 than in ratio 1:1 and 1:2; also the same trend was observed in previous research [17] respectively. There was a significant difference ($P<0.05$) across the treatments in the mean weight gain. In Nigeria, majority of the fish farmers utilize concrete pond and plastic tanks, with an increase in growth [18, 19], while some reported low growth with high mortality at the early stage of rearing [20], meanwhile, the mortality rate can be attributed to low pH of the water [12]. However, this research has proved that the rearing of catfish (*C. gariepinus*) in an earthen pond is more economical, effective and gives a better growth rate and yield when compared with *C. gariepinus* reared in a concrete pond. The weight gain recorded in monoculture of *C. gariepinus* reared in a concrete pond was 87.02g; however, the monoculture of *C. gariepinus* reared in an earthen pond was 143.22g while polyculture had 155.29g.

Concerning the growth in length, *C. gariepinus* reared in monoculture (earthen pond) had the highest growth in length, this is in comport with Khan et al. [15]; similarly, Algrient et al. [21] reported the highest length gain in monoculture *C. gariepinus*.

There was a significant difference ($P<0.05$) in the result of the specific growth rate, relative growth rate and, condition factor across the treatments. *C. gariepinus* reared in the polyculture system had the highest in the above-mentioned parameters; it agreed with researchers [9, 14-15]. There was no mortality at the end of the research across the treatments.

The water quality parameters carried out during the research revealed that the ponds were in good condition. However, the earthen ponds showed an increase in pH of the water; this disagreed with [22] who reported a decrease in pH of the pond water with the addition of catfish. The temperature was high. Subsequently, the dissolved Oxygen, turbidity observed in the research concord with [23]. Hence across the treatments used in this research, Polyculture has proved to be effective and productive. Rearing of *C. gariepinus* and *O. niloticus* maximized the growth of *C. gariepinus* which will result in higher productivity, the income level of the farmer, net profit per unit area of a pond used, and maximize feed intake.

5. CONCLUSION

The research revealed that the use of an earthen pond as a rearing medium in *C. gariepinus* in a polyculture system is advantageous, productive and, economical. It is a means of increasing the weight of the fish. This has established the reasons for Nigerian farmers to effectively utilize the vast land in the country for the polyculture system to meet the high demand for fish for the growing population.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Hecht T. A review of on-farm feed management practices for North African catfish (*Clarias gariepinus*) in sub-Saharan Africa. In M.R. Hasan and M.B. New, eds. On-farm feeding and feed management in aquaculture. FAO Fisheries and Aquaculture Technical Paper No. 583. Rome, FAO. 2013 463–479.
Available:http://www.fao.org/tempref/FI/CDrom/T583/root/17.pdf
2. Ozigbo Emmanuel, Anyadike Chinenye, Adegbite Oluwatobi, Kolawole Peter. Review of aquaculture production and management in Nigeria. American Journal of Experimental Agriculture. 2014;4(10):1137-1151.
Available:
http://eprints.covenantuniversity.edu.ng/3561/1/AJEA%20final%20publication.pdf
3. Hutubessy BG, Mosse JW, van Zwieten PAM, Hayward P. Towards an ecosystem approach to small island fisheries: A preliminary study of a balanced fishery in Kotania Bay (Seram Island, Indonesia). Journal of Marine and Island Cultures. 2014;3(2):98-105.
DOI: 10.1016/j.imic.2014.09.001
Available:https://www.sciencedirect.com/science/article/pii/S2212682114000171
4. Pereira R, Yarish C, Critchley AT. Seaweed aquaculture for human foods in land-based and IMTA systems. In: Christou P., Savin R., Costa-Pierce B.A., Misztal I., Whitelaw C.B.A. (eds) Sustainable Food Production. Springer, New York, NY; 2013.
DOI:https://doi.org/10.1007/978-1-4614-5797-8_189
5. Milstein A. Poly culture in aquaculture. Animal Breeding Abstracts. 2005;73(12):15-41.
Available:https://www.deepdyve.com/lp/centre-for-agricultural-bioscience-international/polyculture-in-aquaculture-pLFLoidzCl
6. Lazard J, Dabbadie L. Fresh water aquaculture and polyculture. Fisheries and Aquaculture, 2005;4:1-9.
Available:http://www.eolss.net/Sample-Chapters/C10/E5-05-04-02.pdf
7. Ochokwu IJ, Nwabunike MO, Udeh GN. Evaluation of milt quality of Cla*rias anguillaris* (Linnaeus, 1758) broodstock fed varying inclusion levels of wild hibiscus Azanza Garckeana Pulp Meal. Journal of Aquatic Sciences. 2019;34 (1):23-31.
DOI: 10.4314/jas.v34i1.4;
Available:https://www.ajol.info/index.php/jas/article/view/198799
8. Solomon, J.R., and Boro, S.G. Survival Rate in Poly Culture of Catfish Heteroclarias /Tilapia (Oreochromis Niloticus), Fed 2% Body Weight. New York Science Journal, 2010,3(9):68-78;
Available:http://www.sciencepub.net/newyork/ny0309/12_3192ny0309_68_78.pdf
9. Olele NF, Tighiri OH. Impact of stocking density on the polyculture of *Clarias gariepinus* and *Oreochromis niloticus*. Journal of Agricultural Science and Technology. 2012;A(2):1018-1023.
Available:https://www.academia.edu/4544920/Impact_of_Stocking_Density_on_the_Polyculture_of_Clarias_gariepinus_and_Oreochromis_niloticus_Olele_Nkeonyeasua_Florence_and_Tighiri_Onome_Harrison
10. Gabriel UU, Akinrotimi OA, Bekibele DO, Anyanwu PE, Onunkwo DN. Economic benefit and ecological efficiency of integrated fish farming in Nigeria. Scientific Research and Essay. 2007; 2(8):302-308.
Available:http://www.academicjournals.org/app/webroot/article/article1380271056_Gabriel%20et%20al.pdf
11. Abdel-Tawwab M. Predation efficiency of nile catfish, *Clarias gariepinus* (Burchell, 1822) on Fry Nile Tilapia, *Oreochromis niloticus* (Linnaeus, 1758): Effect of prey density, predator size, feed supplementation and submerged vegetation. Turkish Journal of Fisheries and Aquatic Sciences. 2005;5:69-74.
Available:http://www.trjfas.org/uploads/pdf_282.pdf
12. Ochokwu IJ, Apollos TG, Oshoke JO. Effect of egg and sperm quality in successful fish breeding. Journal of Agriculture and Veterinary Science. 2015;8(8):48-57.
Available:https://www.iosrjournals.org/iosr-javs/papers/vol8-issue8/Version-2/H08824857.pdf
13. Sanda MK, Onyia LU, Ochokwu IJ, Michael KG. Growth and survival of *Clarias anguillaris, Heterobranchus bidorsalis* fry and their reciprocal hybrids reared in two different culture units. Journal of Agriculture and Veterinary Science. 2015;8(4):54-57.

Avaiable:http://www.iosrjournals.org/iosr-javs/papers/vol8-issue4/Version-2/L08425457.pdf

14. Abuo-sief RA, Radwan MEI, Mahmoud AA. Effect of crop stocking ratios of nile tilapia, common carp, silver carp and catfish in polyculture in concrete ponds with 10 cm clayey loam on growth performance and total yield. Journal of the Arabian Aquaculture Society. 2012;7(1):1-18.
Avaiable:http://arabaqs.org/journal/vol_7/1/Text%2012%20-%2001.pdf
15. Khan S, Hossain MS, Haque MM. Effects of feeding schedule on growth, production and economics of pangasiid catfish (*Pangasius hypophthalmus*) and silver carp (*Hypophthalmichthys molitrix*) polyculture. Journal of Bangladesh Agricultural University. 2009;7(1):175–181.
Avaiable:https://www.banglajol.info/index.php/JBAU/article/view/4982
16. Okonji VA, Akolisa O. Growth performance of *Oreochromis niloticus* in combination with clariid catfishes in monoculture and polyculture. Fresh Water Biology. 2006;14:117-132.
DOI: 10.4314/tfb.v14i1.20889
Avaiable:https://www.ajol.info/index.php/tfb/article/view/20889
17. Nabil I, El Naggar G. Water quality, fish production and economics of nile tilapia, *Oreochromis niloticus*, and African Catfish, *Clarias gariepinus*, monoculture and polycultures. Journal of the World Aquaculture Society. 2010;41(4):574-582.
Avaiable:https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1749-7345.2010.00397.x
18. Ochokwu IJ, Onyia LU, Ajijola KO. Effect of *Azanza garckeana* (Goron Tula) pulp meal inclusion on growth performance of *Clarias gariepinus* Broodstock (Burchell, 1822). Nigeria Journal of Tropical Agriculture. 2014;14:134-146.
Avaiable:https://www.researchgate.net/publication/291945681
19. Abdulkarim B, Suleiman M, Taofik AB and Abdulkadir B. Growth performance of juveniles *Oreochromis niloticus* (Nile Tilapia) reared in concrete tanks with two different diets. International Journal of Fisheries and Aquatic Studies. 2019;7(5):490-496
Avaiable:https://www.fisheriesjournal.com/archives/2019/vol7issue5/PartF/7-5-27-794.pdf
20. Olanrewaju AN, Kareem OK, Ajani EK. Comparative study of growth performance and survival of African catfish (*Clarias gariepinus*, Burchell 1822) fry in indoor and outdoor concrete and hapa culture system. Journal of Fisheries Sciences .com, 2016, 10(1)27-30;
Avaiable:https://www.fisheriessciences.com/fisheries-aqua/comparative-study-of-growth-performance-and-survival-of-african-catfish-clarias-gariepinus-burchell-1822-fry-in-indoor-and-outdoor.php?aid=8213
21. Algrient NT, Romeo NR, Peguy T, Thomas EE, Salifou J. Comparative effect of monoculture and polyculture in two species of Clariidae: *Heterobranchus longifilis* and *Clarias gariepinus* in post fingerlings growth. International Journal of Fisheries Science Research, 2019;3(1):1010.
Available:file:///C:/Users/USER/Downloads/fulltext_ijfsr-v3-1010%20(1).pdf
22. El Naggar G. Efficiency of African Catfish *Clarias gariepinus* in controlling unwanted reproduction of Nile Tilapia *Oreochromis niloticus* in low input production system. Egyptian Journal of Aquatic Biology and Fisheries. 2007;11(3):105-113.
DOI: 10.21608/EJABF.2007.1953;
Avaiable:https://ejabf.journals.ekb.eg/article_1953.html
23. Limbu SM. The effects of on-farm produced feeds on growth, survival, yield, and feed cost of juvenile African Sharptooth catfish (*Clarias gariepinus*). Aquaculture and Fisheries. 2020; 5(1):58-64.
DOI:https://doi.org/10.1016/j.aaf.2019.07.002

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/73378