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Influence of partial and total static culture water withdrawal on water quality, growth and feed utilisation of African catfish (*Clarias gariepinus* Burchell, 1822), Juveniles

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Abstract
A sixty day experiment was conducted to investigate the effect of partial and total removal of rearing water on growth performance and feed utilisation of *Clarias gariepinus* juveniles. *C. gariepinus* of average weight 10g were stocked at 5kg/m^3 and hand fed with 45% Crude Protein (CP) diet twice daily at 5% body weight. The experiment had two treatments, one with partial culture water withdrawal (PWW) and the other, involving total withdrawal of static culture water (TWW). Apart from Alkalinity and Hardness which were both lower in the partial water withdrawal system, there was no significant difference in water quality parameters between the two treatments. All selected water quality parameters were within acceptable range for fish culture. The mean weight gain by fish was relatively higher in PWW compared to TWW with values 36.03±7.12 g and 27.43±0.63 g respectively. The specific growth rate was also higher in PWW (3.73±0.30%/day) compared to TWW (3.37±0.43%/day). Total feed consumed also followed the same trend with 553.57±27.77 g and 459±32.91 g in PWW and TWW respectively. A lower food conversion ratio of 1.54±0.24 was however recorded in PWW compared to 1.67±0.08 in TWW system. These results demonstrated that fish cultured in partial water withdrawal performed relatively better both in terms of growth and feed utilisation.

Keywords: African catfish, aquaculture systems, fish growth, feed utilisation, water exchange

1. Introduction

A right step towards arresting the deficit in fish demand-supply is aquaculture, which involves culturing of fish under a controlled environment where their feeding, growth, reproduction and well-being can be effectively monitored [1, 2]. The production of fish from aquaculture continue increasing globally and in Nigeria, production has increased from 25,720 metric tonnes in the year 2000 to 278,706 metric tonnes in 2013 [3]. However, the development of aquaculture in Nigeria is faced with a lot of constraints amongst which are: high cost of feed, water quality, water quantity, inadequate capital, disease infestation etc. [4]. The problem of water resources especially as it relates to inadequate quantity is not limited to Nigeria alone but an international challenge. Hence, the need to devise ways to ensure efficient management of the available water resources. According to FSD [5], an efficient way of managing water is by recycling water through its use for integration. Water that is originally meant for crop production can be used temporarily in fish culture and later withdrawn partially or wholly for crop production and with additional nutrients which may be useful for the crop [6]. Reuse of water is an important tool for aquaculture considering water conservation and its impacts on a variety of farm management options. Wastewater from fish contains a lot of dissolved nutrients especially nitrogenous waste, which is harmful to the culture organisms and the environment, most importantly when it released untreated [7]. Integrated farming system consists of a range of resource-saving practices that aim to achieve profits and sustained high production levels while minimising the negative effects of intensive farming and preserving the environment [8]. The culture of *C. gariepinus* involves the use of high-quality protein feed, resulting in, high level of nutrients in its wastewater, which may have a deleterious effect on the receiving environment. Hence, the need for culture systems where the wastewater can be gainfully re-used. Partial water withdrawal system is such a system where water from culture tank can be withdrawn to irrigate farmland or crops planted close to the culture tank. It is, therefore, necessary to examine the effect of the partial water withdrawal on the growth performance of fish cultured. Our previous experiment [6], was on table sized fish, and it revealed that partial water withdrawal system have a positive effect on yield of the cultured fish. However, it has not been established if the system will be applicable to all sizes of cultured fish. Fish response and sensitivity to environmental changes, growth pattern, and waste production are varied with species and size. This study was carried out to investigate the growth performance and feed utilisation of *Clarias gariepinus* juveniles cultured in partial rearing water withdrawal system.

2. Materials and methods

The experiment was carried out in the teaching and research farm of the Department of Aquaculture and Fisheries Management, University of Ibadan. Ibadan, Nigeria.

Six circular plastic tanks were used for this experiment, three for the treatment 1, fish cultured with partial water withdrawal (PWW) and three for the treatment 2, fish cultured with the total water withdrawal of the culture water (TWW) The dimensions of the tanks were 22.5 cm in diameter, 29 cm in depth and water level of 15 cm was maintained in order to have 20 litres of water in each of the culture tanks.

Clarias gariepinus juveniles with an average weight of 10 g were stocked at a density of 5 kg/m^3, and were hand fed at 5% body weight twice a day with a 45% crude protein 2 mm commercial pellet feed. The experimental design used was complete randomised design. An equal volume of water was withdrawn from each of the culture tanks for the partial water withdrawal system and the same volume of freshwater was replaced back to the culture tanks. The static culture water in the TWW treatment was only withdrawn and replaced every seven days that was designed for complete replacement of culture water for the two treatments. Two litres of water was removed from each tank of PWW treatment in the first two weeks. The amount was increased to four litres in the third week, six litres in the fourth and fifth weeks and eight litres in the sixth and seventh weeks. The culture water withdrawn from the tanks in PWW treatment was used to irrigate cucumber plant plots .The amount of water withdrawn from the tanks varied weekly as previously highlighted due to varying amount of water needed by the cucumber plants. The details and influence of this fertigation are as reported by Akinwole *et al.* [9]. The performance of the fish cultured in the two treatments (PWW and TWW) was assessed by monitoring the water quality parameters, growth and feed utilisation parameters. The selected water quality parameters measured and monitored weekly were; pH, temperature, dissolved oxygen, alkalinity, hardness and ammonia-nitrogen. They were all measured in line with the procedures described by Dauda and Akinwole [10]. The fish were sampled weekly and the feed supply adjusted to match the increase in weight of the fish. The fish growth and feed utilisation parameters were estimated as described by Akinwole and Faturoti [11]. The estimated growth and feed utilisation parameters were; mean weight gain (MWG), daily weight gain (DWG), specific growth rate (SGR), food conversion ratio (FCR) and survival rate. The data obtained were analysed using descriptive statistics while independent sample t-test was used to establish the significance of the differences in growth and feed utilisation parameters between the treatments. All the analysis were done using IBM SPSS software version 21.

3. Results

The results of water quality parameters in the two treatments are as shown in Table 1. pH, ammonia-nitrogen, dissolved oxygen, and temperature were very similar in the two treatments. However, alkalinity and hardness concentrations in culture water were both lower in the system with PWW (106.88±9.66 mg/l and 146.50±7.96 mg/l respectively) compared to TWW with mean values 109.13±11.23mg/l and 149.50±9.06mg/l respectively. Independent sample t-test did not show a significant difference between the two treatments for all the selected water quality parameters.

Table 1: Mean values of water quality parameters recorded in the two treatments

Parameters (unit)	Treatments	
	Partial Water Withdrawal (PWW)	**Total water withdrawal (TWW)**
pH	7.01±0.25	7.00±0.16
Hardness (mg/l)	106.88±9.66	109.13±11.23
Alkalinity (mg/l)	146.50±7.96	149.50±9.06
Ammonia-nitrogen (mg/l)	0.50±0.16	0.50±0.35
Dissolved Oxygen (mg/l)	1.81±0.36	1.81±0.14
Temperature (°C)	28.00±0.36	28.00±1.24

Mean values of the selected growth and feed utilisation parameters obtained in the experiment are as shown in Table 2. Relatively higher mean final weight of 46.03±7.14 g was recorded in PWW compared to 37.68±0.89 g recorded in TWW, but the difference was not significant between the two (P>0.05). Weight gain, mean weight gain, mean daily weight gain, and specific growth rate were all higher in PWW with values; 360.34±71.43 g, 36.03±7.12 g, 0.64±0.13 g/day and 3.73±0.30%/day respectively, compared to 274.27±6.25 g, 27.43±0.63 g, 0.49±0.02 g/day and 3.37±0.43%/day recorded in fish cultured in the TWW treatment. The difference between the two treatments was not significant (P>0.05) for any of the growth parameter. Fish cultured in PWW also had a total biomass of 460.33±71.44 g while those reared with TWW had a total biomass of 376.83±8.89 g. In terms of feed utilisation, a higher amount of feed (553.57±27.77 g) was consumed in PWW while a total of 459±32.91 g was consumed in TWW and the difference between the two was found to be significant (P<0.05). Relatively higher but not significant (P<0.05) FCR of 1.67±0.08 was obtained in TWW compared to 1.54±0.24 in PWW. No mortality was recorded in the two systems and the volume of water used was more in PWW than TWW with 446.00±0.00 litres and 260.00±0.00 litres of water used respectively for the fish culture.

Table 2: Mean values of growth and feed utilisation parameters of *Clarias gariepinus* juveniles raised in different culture water withdrawal systems.

Parameters	Treatments	
	Partial water withdrawal (PWW)	Total water withdrawal (TWW)
Final biomass (g)	460.33±71.44	376.83±8.89
Weight gain (g)	360.34±71.23	274.27±6.25
Mean final weight (g)	46.03±7.14	37.68±0.89
Mean weight gain (g)	36.03±7.12	27.43±0.63
Mean daily weight gain (g/day)	0.64±0.13	0.49±0.02
Specific growth rate (%/day)	3.73±0.30	3.37±0.43
Survival (%)	100.00±0.00	100.00±0.00
Total feed consumed (g)	553.57±27.77^{a}	459±32.91^{b}
Feed conversion ratio (FCR)	1.54±0.24	1.67±0.08
Volume of water used (litres)	446.00±0.00	260.00±0.00

Mean values with different alphabet superscripts on the same row are significantly different ($P<0.05$)

4. Discussion

pH, temperature, DO and ammonia-nitrogen were equal in the two treatments and they were all within the recommended range for fish culture in the tropics by Ajani *et al.* [12], except for DO which was far below the optimum range of 5 mg/l recommended. This still fell within a range where fish can survive, only that the growth rate may be slowed down. However, Akinwole and Faturoti [11], noted that the African catfish, can survive in culture water with DO level below 5 mg/l due to the presence of air-breathing organ which enable them to utilise atmospheric oxygen when the dissolved oxygen is below the optimum level. This is also supported by the report of Oyewole *et al* [13], who stated that African catfish can grow very well in a culture water where DO, goes down frequently below the optimum level. The low DO observed in the study may be attributed to the source of the water used for the fish culture which was a deep well. Sub-surface water sources generally have low DO [14]. The low DO in culture water may also possibly be due to metabolic activities of the fish and use of oxygen in the decomposition of organic wastes from uneaten feeds and faecal droppings. Nitrite-nitrogen and nitrate-nitrogen are products of decomposition of ammonia and they were found to be below detection level in this study. This may be due to the generally low amount of ammonia-nitrogen in the water body probably, which may be associated with low stocking density and frequency of change of the culture water [15]. Hardness and Alkalinity were both higher in TWW, however, they were within the recommended range for fish culture [12] in the two treatments. The high values observed may be due to the source of the water and nature of the soil around the well.

Fish growth parameters were all relatively better in the PWW, despite that the water quality parameters were relatively the same in the two treatments. Frequent removal and replacement of the culture water in the partial water replacement system (PWW) may be responsible for the observed better fish growth performance. This is because as the water is replenished frequently with fresh water, the cultured fish tends to feel more comfortable and make better use of feed supplied. Frequent withdrawal also implies that wastewater is taken out of the culture medium. Thereby, reducing the attendant deleterious effects it would have imposed on the cultured fish. The better utilisation of feed in terms of higher total feed consumed and lower FCR further emphasised the previous statement and is in line with the findings of Akinwole *et al* [6] on sub-adult *C. gariepinus* cultured in integration with Okra. Though the performance of fish cultured in PWW was better than that of TWW, generally the fish cultured in the two systems can still be classified as one that experienced good growth. The survival rate obtained in this study was higher than that reported by Odulate *et al* [16]. and Jambo and Keremah [17]. The FCR also fell within the same range with that reported by Odulate *et al*. [16] and Marimuthu *et al*. [18], but it was higher than that of Jambo and Keremah, (2009). The specific growth rate of *Clarias gariepinus* observed in this study was similar to the observation of Ajiboye *et al*. [19]. The results of the experiment further confirmed the assertion of FSD [5], who stated that recirculation is the most efficient way of managing water. The same water used in fish culture can be used for plant production and with additional nutrient. While the system will save the environment from possible pollution that may be associated with fish culture wastewater, it also has the potential of reducing the use of fertiliser in crop production, hence ensuring water conservation, healthy environment and also reduce the cost of agricultural production.

5. Conclusion

It can be established from our findings that partial withdrawal and replacement of culture water had a positive influence on growth performance and nutrient utilisation of *Clarias gariepinus* juveniles. Though more water may be consumed when using this system of culture, however, the water will not end up being a waste as it can be used positively in crop production. It is therefore recommended to fish farmers to develop an integrated culture system where the wastewater from fish culture system can be another source of wealth rather than constituting a nuisance to the receiving environment.

6. References

1. Dauda AB, Folorunso LA, Dasuki A. Use of probiotics for sustainable aquaculture production in Nigeria. Journal of Agriculture and Social Research 2013; 13(2):35-45
2. Ejiola MT, Yinka OF. Comparative cost structure and yield performance analysis of upland and mangrove fish farms in Southwest, Nigeria. International Journal of Agricultural Management & Development 2012; 2(3):187-198
3. Food and Agriculture Organization (FAO). The State of world fisheries and aquaculture-opportunities and challenges. Food and Agriculture Organization of the United Nations, Rome, 2014.
4. Dauda AB, Dasuki A, Bichi AH. Analysis of constraints to aquaculture development in the Sudano-Sahelian region of Nigeria. Tropical and Subtropical Agroecosystems, 2015; 18(2):189-193.
5. Farming Systems Design (FSD). Methodologies for

integrated analysis of farm Production Systems. Proceedings of an International symposium held August - *Monterey, CA,* 2009, 23-26.

6. Akinwole AO, Dauda AB, Nwolisa EC. Influence of Culture water draw-off on the growth of the African catfish (*Clarias gariepinus, Burchell 1822*) cultured under integrated system. International Journal of Applied Agricultural and Apicultural Research (IJAAAR). 2014; 10:139-144
7. Timmons MB, Ebeling JM. Wheaton FW, Summer felt ST, Vinci BJ. *Recirculating aquaculture systems*, 2nd Edition. Northeast Regional Aquaculture Center Publication No. 2002, 01-002:769.
8. Gupta V, Rai PK, Risam KS. Integrated crop-livestock farming systems: A strategy for resource conservation and environmental sustainability. Indian Research Journal of Extension Education, 2012; 2:49-54.
9. Akinwole AO, Dauda AB, Oyewole EB. Evaluation of growth and fruit quality of cucumber (*Cucumis sativus*) irrigated with African Catfish Culture wastewater**.** Paper presented at the First International Conference on Agricultural Sciences of the Ivorian Association of Agronomy (AISA). Yamoussoukro, Côte d'Ivoire, 2016, 16-20.
10. Dauda AB, Akinwole AO. Interrelationships among water quality parameters in recirculating aquaculture system. Nigerian Journal of Rural Extension and Development, 2014; 8(4):20-25
11. Akinwole AO, Faturoti EO. Biological performance of African catfish (*Clarias gariepinus)* cultured in recirculating system in Ibadan. Aquacultural Engineering 2007; 37:18-23.
12. Ajani EK, Akinwole AO, Ayodele IA. Fundamentals of fish farming in Nigeria. Walecrown Publishers Ibadan, Nigeria, 2011.
13. Oyewole IO, Momoh OO, Anyasor GN, Ogunnowo AA, Ibidapo CA, Oduola OA *et al*. Physico-chemical characteristics of Anopheles breeding site: impact on fecundity and progeny development, African Journal of Environmental Science and Technology. 2008; 3(12):447-452.
14. Akinwole AO, Dauda AB, Oredein TA. Performance of three simple aeration columns in freshwater aquaculture system. International Journal of Fisheries and Aquatic studies (IJFAS). 2015; 2(3):149-152.
15. Bjornsson B, Olafsdottir SR. Effects of water quality and stocking density on growth performance of juvenile cod (*Gadus morhua* L.). ICES Journal of Marine Science. 2006; 63:326-334.
16. Odulate DO, Idowu AA, Fabusoro AA, Odebiyi CO. Growth performance of juveniles *Clarias gariepinus* (Burchell, 1822), fed *Ipomoea aqatica* based diet. Journal of Fisheries and Aquatic Science. 2014; 9 (6): 468-472. DOI: 10.3923/jfas. 2014: 468-472.
17. Jambo NA, Keremah RI. Effects of stocking density on the growth and survival of the fingerlings *Clarias gariepinus* (Burchell, 1822). Journal of Fisheries International. 2009; 4(4):55-57.
18. Marimuthu K, Umah R, Muralikrishnan S, Xavier R, Kathiresan S. Effect of different feed application rate on growth, survival, and cannibalism of African catfish, *Clarias* gariepinus fingerlings. Emirate Journal of Food and Agriculture. 2011; 23(4):330-337.
19. Ajiboye AO, Awogbade AA, Babalola OA. Effects of water exchange on water quality parameters, nutrient utilization, and growth of African catfish (Clarias gariepinus). International Journal of Livestock. 2015; 6(5):57-60.