PRELIMINARY EVALUATION OF THE EFFECTS OF DIFFERENT WATER VOLUMES ON FERTILIZATION AND HATCHING RATES OF *Clarias gariepinus* IN GLASS AQUARIUM TANKS

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ABSTRACT

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The effects of different water volumes on fertilization and hatching rates of Clarias gariepinus in Aquarium tanks were conducted. Different borehole water volumes of (10.00, 20.00 and 30.00 litres) were used as treatments T1, T2 and T3 respectively for the incubation in indoor glass aquarium tanks. Two thousand five hundred (2,500) eggs were incubated and hatched in each glass aquarium tanks that contained 10.00, 20.00 and 30.00 litres in replicates. The result showed that eggs incubated with 30.00 litres of water gave highest (68.0%) fertility and (61.3%) hatching and fry survival (88.8%) rates, while eggs incubated with 10.00 litres of water had lower (57.2%) fertility and (50.7%) hatching rate. Similarly, highest fry weight gain of 3.64±0.46 and specific growth rates of 2.25±0.15 were recorded in fish hatched using 30.00 litres of water. Based on this, batch of 2,500 Clarias gariepinus eggs that were incubated with 30.00 litres of water had improved hatchability, survival and growth of fry as compared to eggs incubated with 10.00 and 20.00 litres of water.

Keywords*: Spawning, water volume, hatching rate, Clarias gariepinus, aquarium*

INTRODUCTION

Aquaculture is one of the fastest growing industries in recent times particularly in developing countries like Nigeria. With decrease in yield from capture fisheries and increase in demand for fish and fishery products, there is need to expand aquaculture practice using modern techniques in order to make meaningful contribution to the world's aquatic food production. This will in no small measure help to fight hunger, alleviate poverty and provide food security particularly to African nations. African catfish is a highly priced food fish in Nigeria and most parts of the world. The fish is widely cultured in Nigeria owing to their high market value, fast growing rate and ability to withstand adverse pond conditions especially low oxygen content (Diyaware, 2010). They have wide geographical distribution from the Middle East in the North Orange River in South and Northern Africa (Teugels, 1984). Due to their hardness and adaptability, they thrive well in variety of climatic conditions including Europe, Netherlands, Germany and Belgium (Verreth, 1993). *Clariids* are potamodromous, which means they migrate within streams and rivers (Teugels, 1984).

Artificial propagation of *Clarias gariepinus* is the stimulation of some conditions necessary for the production of fingerlings (fish seed) and this involves several methods such as: natural spawning without hormonal treatment, natural spawning with hormonal treatment and artificial spawning with or without hormonal treatment (Oyelese, 2006). Water quality and quantity is important in fish culture particularly to fish breeders and hatchery managers. This is so because the quality and quantity of water determines to a large extent the success of fertilization and hatching in fish breeding. Also of importance is the water volume and level. According to Bukat *et al*. (2012) water volume and level has effects on hatching, survival, growth and behaviour of different fish species. Hogendoorn and Vismans (1980) stated general principle of egg incubation and hatching to include that water must be adequate enough to flow over eggs continuously and renewed in order to provide dissolved oxygen. Fish perform all their bodily functions in water. It has been reported that a minimum rate of 13 gallons per minute (gpm) of water is required for each surface acre of ponds for successful production. Several findings had been reported on the effects of water volume and level on survival, growth and behaviour of different fish species (Einarsdottir and Nilssen, 1996); Thomas *et al*. (1999); Flodmark *et al.* (2002); Flodmark *et al*. (2004) and Bukat *et al*. (2012). The impact of water level fluctuations on the species communities has been widely studied in rivers, lakes and reservoirs (Kahi *et al*. (2004). Apart from problem of inadequate supply of good quality fish seed, one major constraint to aquaculture development in developing countries is water in term of quality and quantity which are necessary for fish bodily functions, hatching, survival and growth (Bukat *et al*. (2012). There is paucity of information on effects of different water volumes on fertilization, hatching rate, survival and growth performance of *Clarias gariepinus*. The aim of this study therefore is to determine the effects of different water volumes on fertilization, hatching rate, survival and growth performance of bred *Clarias gariepinus* fry. The study also seeks to ascertain the volume of water proportionate to quantum of eggs required to be fertilized and incubated for hatching to obtain optimal results.

MATERIALS AND METHODS

The experiment was conducted at indoor hatchery of the Department of Water Resources, Aquaculture and Fisheries Technology fish farm, Bosso Campus, Federal University of Technology, Minna for eight (8) weeks. Six ripe gravid brooders (three each of males and females) of *Clarias gariepinus* 500-800 g weight and 45.20 cm length were purchased from a private fish farm in Minna. They were transported in 50 L open plastic cans to the hatchery. On arrival they were disinfected with 5% salt bath for 5 minutes as described by Haruna (2003) and then acclimatized for 7 days. Thereafter they were fed with 40% crude protein commercial feed. After acclimatization, one male and one female of sizes 750-800g were selected, the female was induced with Ovaprim hormone at 0.5ml/kg of fish via intramuscular injection. After 9 hours of latency the eggs were stripped into a dry clean plastic bowl. Fecundity was determined by the formular:

$$Fecundity = \frac{TWES * TNES}{WES}$$

Where, TWES= Total weight of eggs stripped, TNES = Total Number of eggs in Sub-sample, WES= Weight of eggs in sub-sample and * = multiplication.

The male was sacrificed to collect testis for the milt. The milt was mixed with the saline solution in a clean petri dish and added onto the eggs and stirred gently with a plastic spoon for about 2-3 minutes to fertilize the eggs. After fertilization, the eggs were divided into 3 batches, each with about 2,500 eggs and used for the incubation in nine (9) indoor glass aquarium tanks (0.6m x 0.4m x 0.3m (length, breadth and depth respectively). Two thousand five hundred (2,500) eggs in number were estimated to be about 17.3g in weight. Incubation was monitored for about 48 h with flow through in addition to aeration with air pump. Water quality parameters particularly dissolved oxygen (DO), temperature, conductivity and pH were recorded during incubation, hatching and rearing. DO was determined by Winkler – azide method as described by Goolterman *et al*. (1978). Temperature was measured using a common mercury – in- bulb thermometer (-10-110^{0}C range). Conductivity was measured using conductivity meter model JENWAY 4010 as described by Lind (1979) and adopted by Yisa and Izuoegu (2015) while pH was measured using pH meter KENT EH, model 7045/46. Percentage fertilization and hatchability were calculated using the formulae:

$$Fertilization(\%) = \frac{NFE * 100}{NEI}$$

Where NFE= Number of Fertilized Eggs, NEI= Number of Eggs Incubated.

$$Hatchability(\%) = \frac{NHL * 100}{NFE}$$

Where NHL= Number of Hatched Larvae, NFE= Number of Fertilized Eggs

This was used to determine cumulative mean percentage fertility and hatching for each treatment.

The 7 days old fry were reared in the incubation tanks for 4 weeks after which 250 fry were further stocked in a rearing tank (0.6m x 0.4m x 0.3m deep) and in three replicates. They were then reared for another 8 weeks maintained in the same container with the same volume of borehole clean water for each treatment. Final weight (mg) and length (mm) and mortality were recorded. The following growth parameters were estimated using the following formulae:

Weight gain (mg), specific growth rate (%/day), mortality and survival (%)

$$SGR = \frac{WF - WI * 100}{T}$$

Where WF = final body weight of fish; WI = initial body weight of fish and T= time in days

$$Survival(\%) = \frac{FNF * 100}{INF}$$

Where FNF= Final Number of Fish, INF= Initial Number of Fish

The experiment was laid out in completely randomized design (CRD) was used for the experiment. Data obtained were subjected to one way analysis of variance (ANOVA) using (statistical package for social sciences (SPSS) version 15.0 Differences between the means were determined using LSD with the aid of statistical package SPSS version 15.0.

RESULTS AND DISCUSSION

The female brood stock used weighed 800g with egg weight of 298.48g and fecundity of 56,231 eggs. The hatching rate of *Clarias gariepinus* eggs incubated on different water volumes in glass aquaria is presented in Table 1. The highest percentage fertility, number of hatchling and hatching of 68.0%, 936.37±4.49 and 61.3% respectively were obtained in eggs incubated with 30.00 litres of water. The survival of the fry obtained during the experiment is presented in Table 2. Highest mortality (168) was obtained in glass aquaria tanks that contain 10.00 litres of water (T1). The egg incubated with 30.00 litres of water had highest survival of 88.8%. The growth performance of *Clarias gariepinus* fry reared in glass aquaria for 8 weeks at different water volumes is shown in

Table 3. The result reveals that highest standard length gain (2.95 mm) and total length gain (3.10 mm) was obtained in fry reared on aquaria tanks with 10.00 litres water volume, while body weight gain of (3.64 mg) was obtained in fry reared on aquaria tanks with 30.00 litres of water. Similarly, the result also shows that fry reared on aquaria tanks with 30.00 litres of water had the highest SGR of 2.25±0.15. Results of water quality parameters measured in all the treatments are presented in Table 4. The water quality parameters recorded were within the tolerance range of warm water fishes. The fry that were reared survived within the temperature range of 27.8-28.40 °C, DO range of 6.30 - 7.30 mg^{-l}, pH range of 7.80 - 7.81 and conductivity range 293 – 294 µs cm^{-1}.

Table 1: Hatchability of *Clarias gariepinus* eggs incubated using different water volumes levels in glass aquaria tanks

Water volume (m^3)	Number of eggs fertilized	Percentage fertility (%)	Number of hatching	Percentage hatching (%)
10.00	1430.45±10.02	57.2	725.25±3.01	50.7
20.00	1527.67±11.02	61.1	829.34±3.21	54.3
30.00	1701.23±12.44	68.0	936.37±4.49	61.3

(±SED)

Table 2: Percentage mortality and survival of *Clarias gariepinus* fry reared in glass aquaria for 8 weeks Using different water levels.

Water volume (m^3)	Total initial stock	Total mortality	Percentage mortality	Total survival	Percentage survival
10.00	250.00	168.00	67.2	82.00	32.8
20.00	250.00	80.00	32.0	170.00	68.0
30.00	250.00	28.00	11.2	222.00	88.8

Table 3: Standard length, total length and weight of *Clarias gariepinus* fry reared in glass aquaria for 8 weeks at different water levels.

	Treatments (Water volume (m^3)		
Parameters	T1(10.00)	T2 (20.00)	T3 (30.00)
Initial standard length (mm)	1.35±0.10a	1.30±0.10a	1.33±0.10a
Final standard length (mm)	4.30±0.61a	3.65±0.50b	3.82±0.55b
Standard length gain (mm)	2.95±0.15a	2.35±0.13b	2.49±0.14b
Initial total length (mm)	1.40±0.10a	1.40±0.10a	1.42±0.10a
Final total length (mm)	4.50±0.71a	3.70±0.51b	3.87±0.52b
Total length gain (mm)	3.10±0.05a	2.30±0.03b	2.45±0.04a
Initial weight (mg)	0.12±0.01b	0.12±0.01b	0.12±0.01b
Final weight (mg)	3.52±0.45b	3.60±0.50b	3.76±0.54a
Weight gain (mg)	3.40±0.41b	3.48±0.42b	3.64±0.46a
Specific growth rate	1.99±0.13b	2.01±0.14b	2.25±0.15a

Mean values on the same row carrying different superscript differs significantly (0.05) from each other.

Table 4: Mean water quality of *Clarias gariepinus* fry reared in different water levels of glass aquaria for 8 weeks.

	Mean water quality parameters			
Water volume (m^3)	Temperature (°C)	Dissolved Oxygen (mg^{-l}	pH	Conductivity (µs cm^{-1})
10.00	27.80±2.11	6.30±0.24	7.80±1.02	293±35.04
20.00	28.30±2.41	6.70±1.05	7.81±1.03	294±35.05
30.00	28.40±2.43	7.30±1.20	7.80±1.02	293±35.04

Although the total number of eggs incubated in each treatment was the same (2,500) in number, egg incubated with 30.00 litres of water had the highest percentage fertility (68.0%) and hatching (61.3%). This agrees with the findings of Hogendoorn and Vismans (1980), they stated that water must be adequate and enough to flow over eggs continuously and renewed in order to provide dissolved oxygen for egg incubation and hatching. According to them this is a general principle of egg incubation and hatching. It could be asserted that 30.00 litres was enough volume of water that flow over eggs continuously to ensure dissolved oxygen for egg incubation and hatching hence improved (highest) percentage hatching as compared to other treatments. In addition the highest percentage hatching could be attributed to egg quality and viability, dark brown and light green in colour of eggs and milt quality as similarly observed by Yisa *et al*. (2016) they recorded higher percentage hatching. Similarly, De graaf and Jansen (1996) developed a technology where eggs are allowed to stick to the roots of floating water hyacinth (*Eichhornia crassipes*) placed within a hapa made from mosquito netting (mesh size 0.5mm) located within a concrete basin with running water in a pond.. They opined that floating water through the roots of hyacinth are adequate and continuous over eggs to ensure good hatchability of eggs. The highest percentage survival (88.8%) of fry obtained from egg incubated with 30.00 litres of water agrees with work of Flodmark *et al*. (2004). They reported that water volume and level had to large extent affects fertilization, hatching, survival, growth and behaviour of fish species. Also, Kahi *et al*. (2004) reported impact of water volume and level fluctuations on fish egg fertilization, hatching and survival. They stated that water level fluctuations on fish species hindered egg fertilization and hatching. Values of water quality parameters measured were at optimum levels to culture warm water fishes. According to Huisman and Richter (1987), *Clarias gariepinus* maintained at 25.00-28.00 °C showed uninterrupted gonad development. Also, Oyelese (2006) recorded temperature of 27.66 °C that gave highest percentage fertilization rate of 66.7%, highest percentage hatchability rate of 77.8% and highest productivity of 51.9%. Fish are able to survive in waters with pH range of 3.50 - 10.00 but desirable ranges for good growth is from 6.50-9.00 and DO of 5.5-57.8 mg^{-l} (Ofojekwu, 1990). Hatching and growth performance of *Clarias gariepinus* obtained from egg incubated with 30.00 litres of water had positive effect on the fry, this is because highest weight gain of (3.64 mg) was obtained. Similarly, highest SGR of 2.25 was recorded from the same egg incubated with 30.00 litres of water. This corresponded with the observation made by Oyelese (2006), noted that water quantity and quality with optimum temperature is critical and influences artificial fish breeding in terms of fertilization, hatching, survival and growth.

CONCLUSION

Based on this result, it was concluded that eggs of *Clarias gariepinus* incubated with 30.00 litres of water on glass aquarium tank had the highest percentage fertility and hatching; survival and growth of fry. It is therefore recommended that at least 30.00 litres of water should be used to incubate 2,500 eggs of *Clarias gariepinus* for successful hatching.

REFERENCES

Bukat, T., Saraolu, E., Levi, E. E., Nihan Tavanoglu, U., Idilcakiroglu, A., Jeppesen, E. and Beklioglu, M. 2012. The influence of water level on macrophyte growth and trophic interactions in eutrophic Mediterranean shallow lakes; a mesocosm experiment with and without fish. *Journal of Freshwater Biology* 57 (8), 1631-1642.

Degraaf, G and Janssen, H. 1996. Artificial Reproduction and Pond Rearing of the African catfish, *Clarias gariepinus* in Sub Saharan Africa, FAO Fisheries Technical Paper No. 362 Rome, FAO 4- 73 pp.

Diyaware, M. Y., Haruna, A. B. and Abubakar, K. A. 2010. Determination of testes Regeneration Period For African catfish (*Clarias angullaris)* after Milt (semen) Collection through Ablation. *Current Research Journal of Biological Sciences.* 2(6): 375-379.

Einarsdottir, I. and Nilssen, K. J. 1996. Stress responses of Atlantic salmon (Salmosalar L.) elicited by water level reduction in rearing tanks. *Fish Physiology and Biochemistry* 15: 395-400.

Flodmark, L. E. W., Urke, H. A., Halleraker, J. H., Amekleiv, J. V., Vollestad, L. A. and Poleo, A. B. S. 2002. Cortisol and glucose responses in juvenile brown trout subjected to a fluctuating flow regime in an artificial stream. *Journal of Fish Biology* 60: 238-248.

Flodmark, L. E. W., Vollestad, L. A. and Forseth, F. 2004. Performance of juvenile brown trout exposed to fluctuating water level and temperature. *Journal of Fish Biology*. 65, 460 -470.

Golterman, H. L., Clymo, R. S. and Ohnstad, M. A. M. 1978. Some aspects of the Biology of the Catfish, *Bagrus bayad* Macropterus (Daget) of Shiroro Lake Ph.D. Thesis. Federal University of University of Technology, Minna Pp.74.

Haruna, A. B. 2003. Aquaculture in the Tropics: Theory and Practice. Kano: Alhassan Publishers Pp.12.

Hogendoorn, H. and Vismans, M. M. 1980. Control propagation of the African Catfish, *Clarias lazera* (C. and V.) II. Artificial reproduction, Aquaculture 21: 39-53.

Huisman, E. A. and Richter, C. J. J. 1987. Some aspects of the Biology of the Catfish, *Bagrus bayad* Macropterus (Daget) of Shiroro Lake PhD. Thesis. Federal University of Technology, Minna Pp.84-85.

Kahi, U., Hulsmann, R. J. and Radke, J. B. 2004. The impact of water level fluctuations on the year class strength of roach: implications for fish stock management. *Limnologia* 38 (3):258-268.

Lind, O. T. 1979. Hand book of common methods in Limnology. 2nd Edition, London press 185pp.

Ofojekwu, P. C. 1990. Practical hydrobiology manual for fish culturists. (copy right reserved). 67pp.

Oyelese, O. A. 2006. Water temperature a determinant of fertilization and hatchability rates in artificially induced breeding of *Clarias gariepinus* (*Teleostei: Clariidae*). *Research Journal of Biological Sciences* 1(4): 83-87.

Teugels, G. G. 1984. The nomenclature of African catfish *Clarias* species used in aquaculture, *Aquaculture*, 38:373-374.

Thomas, P. M., Pankhurst, N. W. and Bremner, H. A. 1999. The effect of stress and exercise on post-mortem biochemistry of Atlantic salmon and rainbow trout. *Journal of Fish Biology*.54: 1177-1196.

Verreth, J. 1993. A review of feeding practices, growth and nutritional physiology in larvae of the catfishes *Clarias gariepinus* and *Clarias batracus. Journal World Aquaculture Society*, 24:135-144.

Yisa, T. A. and Izuogu, N. E. 2015. Determination of Some Physico-chemical Parameters of Dan-Zaria Dam in Niger State, Nigeria. *Continental Journal of Environmental Sciences* 9(2):1-11.

Yisa, T. A., Lamai, S. L., Tsadu, S. M. and Kolo, R. J. 2016. Effects of Incision Variation Length on *Heterobranchus bidorsalis* Male Spawners to Extract Milt for Induced Breeding. *American Journal of Experimental Agriculture* 10 (2):1-7.