Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 2, No. 10, p. 35-39, 2012
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Growth and survival of hatchlings of *Clarias gariepinus* subjected to various pH

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Received: 14 June 2012
Revised: 14 October 2012
Accepted: 15 October 2012

Keywords: Growth, survival, *Clarias gariepinus*, pH.

Abstract

The study was designed to evaluate the growth performance and survival of *Clarias gariepinus* hatchlings subjected to various pH treatments. The tests were conducted in plastic baths of 3.5 litre capacity filled to 2 litre mark with freshly prepared experimental solution and labelled according to pH requirements for the test. Each bath was stocked with forty (40) hatchlings of body length of between 4.7 mm and 5.1 mm. They were exposed to the experimental solution for a period of four (4) days for growth estimation. For survival time, the test organisms were examined hourly for probable death. The hatchlings were not fed during the time of study, as their yolk at this stage of development still served as the only source of food. The length, measured as tip of the snout to tip of the caudal fin, was determined prior to stocking and daily, for the period. Every 24 hours the medium was checked for any change in pH and adjusted if any. The temperature of the culture media was constant (26.5^{o}c) and dissolved oxygen content remained approximately 6.0mg/l. Average daily increase in length of between 0.3mm and 0.7mm was recorded in pH 4,5,6,7,8,9 and 10. There was no surviving hatchling on day 2 in pH 2,3,11 and 12 i.e. 100% mortality 24 hrs of stocking. Percentage mortality in the other pH varied between 75% (in PH 7) and 63.33% (in PH 4). Optimal growth and survival was recorded in PH 7 while the median lethal pH (ML_{50}pH) is 4.25 and 10.10 for acidic and alkaline treatment respectively. The above result shows that reduced pH condition has a depressing effect on the growth rate of *Clarias gariepinus* hatchlings. This suggests the need for constant monitoring of pH changes in water especially where fish farming operations are practiced.

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Introduction

Marine and freshwater fishes are affected in their distribution by the chemistry of the water in which they live. In establishing water quality criteria for inland fisheries, the acidity or alkalinity of the water is an important factor to be considered (Alabaster and Lloyd, 1982). In water quality criteria for pH values, ORSANCO (1955) reported that although fish had been found at pH values between 4 and 10, the safe range is between 5 and 9, and for maximum productivity the pH value should be between 6.5 and 8.5. Stream with pH values as low as 2.0 to as high as 4.0 may occur in the vicinity of industries as a result of industrial pollutants (kneese and Bower, 1968). These pollutants may include acids such as sulphuric acid discharged by chemical and other industrial plants. pH changes in water are also affected by alkalis such as sodium hydroxide (NaOH) which is a waste from many industries including soap manufacturing, textile dyeing, rubber reclaiming and leather tanning (Kneese and Bower, 1968). However in acid waters, the absence of fish or reduction in its population may be associated with other factors, such as lack of nutrients, high temperature or super-saturation of dissolved gases other than the presence of hydrogen ions. The African catfish, *Clarias gariepinus*, is very popular for fish farming in Nigeria. It is hardy, tastier and can grow to large size thus attracting consumers in fish markets. However inability to get enough of the hatchlings for Nigerian fish ponds poses a major problem to fish farmers. Although the hatchlings are produced in large numbers in the hatcheries, poor survival of these larvae within the first month of life poses a big problem to hatchery operators (Madu And Ufodike, 2001). Several factors are responsible for this high mortality, one of which is the chemistry of the aquatic environment. Alterations in growth and survival rates of fish are amongst the most sensitive indicators of water chemistry change, and it is often desirable to conduct laboratory studies to obtain 'base-line' values useful in fish culture. This study was therefore designed to assess the performances of the hatchlings of *Clarias gariepinus* subjected to different pH treatments.

Materials and methods

The pH tolerance tests were carried out according to Alabaster and Lloyd (1982). The test was conducted in the African Regional Aquaculture Centre (ARAC) at Aluu, Port Harcourt.

Experimental fish

Fertilization, incubation and hatching of the eggs of the test fish were carried out in African Regional Aquaculture Centre (ARAC) Port Harcourt. The fish used for this study were hatchlings of *Clarias gariepinus*. The gravid female and male *Clarias gariepinus* used in this work had been kept in the facilities of the African Regional Aquaculture Centre (ARAC) Port Harcourt.

Female *C. gariepinus* were chosen on the basis of ovarian biopsy of the Oocytes as described by Legendre (1986). Males were chosen on the basis of possession of pointed and hyperamic urino genital papillar (Hogendorn, 1979). Hormone administration was carried out according to (Woynarovich and Horvarth, 1980) between 15.00 and 17.00 hours with Carp pituitary suspension at a dose of 6mg/kg body weight and at an induction temperature of 26.5^{o}C. A total of four female *Clarias gariepinus* were injected. After latency period of about 10 hours, ovulated eggs were removed from the induced female *Clarias gariepinus* into dry receptacle by hand stripping. The stripped eggs were thoroughly mixed together with plastic spoon. Two *Clarias gariepinus* males were killed. Milt extracted from these males into 0.9% sodium chloride (NaCl) saline solution were pooled together and used in fertilizing the *Clarias gariepinus* eggs. Fertilization was enhanced by addition of freshwater to the mixture of eggs and milt. The fertilized eggs were incubated on bunched strands of polyethylene fibers (kakaban) placed in 4.35m diameter circular concrete tanks. The tanks were filled to 0.25m depth with clean water. The eggs hatched between 24 and 30 hours after incubation to produce the hatchlings. The hatchlings were not fed because at this stage of development their yolk still serves as the only source

of food (Uka et al, 2000). About 2000 hatchlings were collected for the study.

pH treatments

Thirty-three (33) plastic containers of 3.5 litre volume were used for the study. 2 litre of bore-hole tap water was poured into each container. To obtain the required pH values, HCl was added dropwise (for acidity) or CaOH solution added (for alkalinity) while the values were read using a pH meter ATC pH meter HI 8915 (Alabaster and Lloyd, 1982). The pH values ranged between 2 and 12.

Table 1. Growth responses of *Clarias gariepinus* at the various pH treatments.

pH treatment	TL0 (mm)	TL1 (mm)	TL2 (mm)	TL3 (mm)	TL4 (mm)	Percentage increase
2	4.82 ±0.04	-	-	-	-	-
3	4.70 ±0.02	-	-	-	-	-
4	4.70 ±0.02	0.30 ±0.01	0.31 ±0.00	0.33 ±0.00	0.59 ±0.01	32.55
5	4.90 ±0.01	0.49 ±0.01	0.50 ±0.02	0.41 ±0.02	0.61 ±0.01	41.02
6	4.97 ±0.10	0.60 ±0.01	0.31 ±0.01	0.50 ±0.01	0.62 ±0.01	40.85
7	4.91 ±0.01	0.68 ±0.02	0.50 ±0.01	0.68 ±0.01	0.62 ±0.01	50.51
8	4.79 ±0.02	0.60 ±0.01	0.58 ±0.01	0.38 ±0.02	0.60 ±0.01	45.09
9	5.01± 0.04	0.40 ±0.01	0.50 ±0.01	0.49 ±0.02	0.60 ±0.01	39.72
10	4.81 ±0.01	0.48 ±0.02	0.59 ±0.01	0.27 ±0.01	0.49 ±0.01	38.05
11	4.88 ±0.02	-	-	-	-	-
12	5.00 ±0.02	-	-	-	-	-

TTL = Total Length, TL0 = Mean original Length (at stocking), TLI = Mean Length increase after 24hrs, TL2 = Mean Length increase after 48hrs, TL3 = Mean Length increase after 72hrs, TL4 = Mean Length increase after 96hrs.

Table 2. Percentage mortality and survival of *Clarias gariepinus* in the different pH treatments.

pH treatment	Mean no. exposed	Mean time of exposure	Mean no. of mortality	Mean no. of survival	Mean % mortality	Mean % survival
2.	40	96hrs	40	0	100	0
3	40	96hrs	40	0	100	0
4	40	96hrs	25.33	14.67	63.33	36.67
5	40	96hrs	8.67	31.33	21.67	78.33
6	40	96hrs	8.33	31.67	20.83	79.17
7	40	96hrs	3	37	7.50	92.50
8	40	96hrs	4.67	35..33	11.67	88.33
9	40	96hrs	6	34	15	85
10	40	96hrs	19.67	20.33	49.17	50.83
11	40	96hrs	40	0	100	0
12	40	96hrs	40	0	100	0

Stocking of fish and fish measurements

The bowls were stocked at a uniform distribution of 40 hatchlings per bowl for 96 hrs (duration of study). The experiment was done in three (3) replicates for each pH treatment. Growth was measured daily as body length, which is from tip of the snout to the end of the caudal fin. This was done by the use of Venier Calipers and a pair of dividers. Mortality in each bowl was recorded daily.

Water quality monitoring

Water temperature records in each container were taken twice daily, morning (8.00am -9.00am) and evening (5.00pm – 6.00pm) using mercury- in-tube thermometer. Dissolved oxygen (D.O) content was determined using Jenway D.O meter (model 3050, England). Dissolved oxygen and pH measurements were taken every morning (8.00am -9.00am).

Data analysis

Growth and survival values were subjected to analysis of variance (ANOVA) and treatment means were compared with each other for significant differences ($p<0.5$).

Results

Growth performance and mortality

Table1 shows the growth responses of the hatchlings at the various pH treatments. Highest percentage increase in length (50.51%) was recorded in pH 7 while 32.55% and 38.05% increase were recorded against pH 4 and 10 respectively. Table 2 shows the percentage mortality and survival with their corresponding pH treatments. 100% mortality was recorded in pH 2,3,11 and 12 twenty-four (24) hour post stocking. Data obtained in Figure 1 shows the median lethal pH (ML 50 pH) for acidic treatment as pH 4.25 while for alkaline treatment, ML 50pH was 10.10.

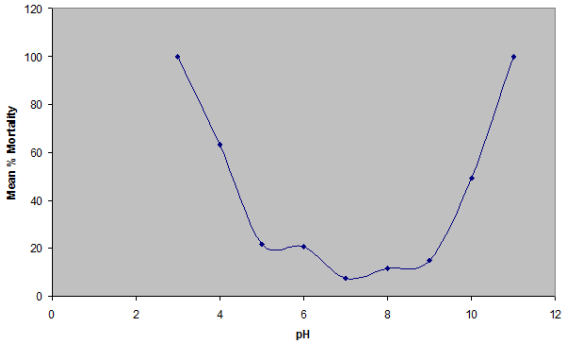

Fig. 1. Mean % mortality against pH.

Water quality records

Dissolved oxygen content of the medium was approximately 6.0 mg/l throughout the study. The temperature also remained approximately constant at 26.5°C.

Discussion

The low median lethal pH recorded for the hatchlings in this study in acidic treatment compared to data obtained for rainbow trout and roach (Lloyd and Jordan, 1964), and goldfish (Ellis, 1937) confirms the hardiness of *Clarias gariepinus* even as hatchlings. Data obtained show that the acidic environment had a depressing effect on the growth rates of the hatchlings. Nevertheless it is reported that the relationship between growth rate and hydrogen-iron concentration is unclear; but the presence of other ions such as sodium, calcium and chloride in a water body can exert a modifying effect on the growth rate (Alabaster and Lloyd, 1982). The gills of fish function as osmoregulatory organs. The gills quickly get rid of any excess monovalent ions in the blood; divalent ions are removed by the kidneys, leaving osmotically free water in the body (Odo and Inyang, 2001). Mucus observed accumulating on the gills of the fish (dead or alive) suggests osmoregulatory function of these organs. The precipitation of this mucus on the gill epithelium may have caused death by suffocation. Dively et al (1977) also reported accumulation of mucus on the gills of Brook trout in acid solutions when respiratory distress was at its maximum. The toxic action of hydroxyl ions is normally to destroy the gills and skin epithelium (Schaperclaus, 1956). Fish such as Stickleback, *Gasterosteus aculeatus* avoid alkaline solutions of pH above 11.0 for that same reason (Jones, 1948). The study shows the importance of monitoring and maintaining the chemistry of water where these pond fish are reared so that it is within survival limit for *Clarias gariepinus* hatchlings. This will improve the availability of *Clarias gariepinus* hatchlings for fish farmers. Industries discharge untreated or poorly treated wastes into the environment. One of the consequences of such indiscriminate discharge is reduction in pH (increase in acidity) in water. This can cause mortality of hatchlings in the wild. Efforts to instill discipline in Nigerian industries with regards to treatment of wastes should therefore not be relaxed.

Acknowledgement

We wish to acknowledge the efforts of the staff of African Regional Aquaculture centre (ALUU) Portharcourt, Nigeria. They were helpful during materials gathering and experimentation of this work.

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