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Mortality of Hybrid Catfish (*Clarias gariepinus* x *Heterobranchus bidorsalis*) Fingerlings at Varying Salinity Levels

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Abstract: About 100% mortality was recorded in hybrid catfish fingerlings that were exposed to 10 and 12 ppt at the 3rd and 12th h, respectively. Those in 6 and 8 ppt had 90 and 25% survival, respectively at the end of 96 h. Median Lethal Salinity (MLS_{96}) for 10 ppt was 5.55 h. The cumulative mortality at the various salinity concentrations did not differ in 4 and 6 ppt but differed in 8, 10 and 12 not differ from 12-48 h and between 72 and 96 h ($p>0.05$). Water temperature values ranged from 26.0°C, dissolved oxygen ranged from 5.2 mg c^{-1} to 6.8 mg L^{-1} while pH ranged from 5.2-6.6.

Key words: Mortality, salinity concentration, catfish breeding, fingerlings, hybrid, Nigeria

INTRODUCTION

Hybrid catfish (*Clarias gariepinus* x *Heterobranchus longifilis*) is a popular aquaculture product in Nigeria and is highly cherished by consumers because of its large size and excellent taste. This sub-specie is a product of artificial hybridization between freshwater catfish, namely; *C. gariepinus* and *H. longfilis* or sometimes *Heterobranchus bidorsalis* (Nwadukwe, 1995). There is high demand for these catfishes in both in freshwater and riverine brackish water communities in Nigeria. This has led to the need to investigate the possibilities of growing the hybrid catfish in saline water.

Various studies have been carried out on the salinity tolerance of some fish species (Gbulubo and Erondu, 1998; Fashina-Bombata and Busari, 2003; Ogunsheye and Sogbesan, 2005; Iyaji, 2008).

MATERIALS AND METHODS

The study was carried out using the fish hatchery and laboratory facilities at the African Regional Aquaculture Centre (ARAC), Aluu, near Port Harcourt during the rainy season of 2007.

Experimental fish: Brood *C. gariepinus* (females) and *H. bidorsalis* (males) were procured from a private fish farm at Aluu and identified as earlier described by Teugels (1982) and Teugels *et al.* (1990). Gravid females with mean weight of 800 g were injected intramuscularly with ovaprim at a dosage of 0.5 mL kg^{-1} of fish body weight as described by Okoro. Ovulated eggs were obtained by stripping the fish 8 h after injection. Mature male *H. bidorsalis* were scarified and the tastes dissected out. Milt from the testes was held in 0.9% saline and this was then mixed with the ovulated eggs. Fertilization was effected by the addition of fresh water to the mixture. Egg incubation and hatching follwed the pattern that was described for *C. gariepinus* by Vivieen *et al.* (1986). After hatching, the hatching were left for 3 days to allow for yolk restoration. They were then feed for 5 days with Artemia before being transferred to a fertilized earthen pond where they were fed for 3 weeks and then harvested as fingerlings for this study.

Test solution: Five different saline solutions were prepared by separately weighing 4, 6, 8, 10 and 12 g of salt (sodium chloride) with an electric balance (labtop balance, Yamato LE 180, Yamato scientific Co., Ltd. Tokyo, Japan). Each salt portion was dissolved in 1 L of 12 ppt, respectively. Freshwater was also used as control (0 ppt) during the experiment.

Experimental set up and procedure: About 3 L of each test solution and the control were introduced in a 5 L plastic aquarium and each concentration was in triplicate. Ten catfish fingerlings (mean weight: 6.20±0.64 cm) were then introduced into each concentration as well as in the control. The aquaria were covered with plastic net with small mesh size in order to prevent the fish from escaping.

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The fish were not fed 24 h before and throughout the experimental period. Fish mortality was monitored at hourly interval for 96 h. Fish was presumed dead when opercula movement stopped and fish did not respond to probing with a glass rod. Dead fish were removed, counted and recorded. The test solution in each aquarium was renewed daily with freshly prepared solution.

Physico-chemical parameters: Water temperature, pH, salinity and dissolve oxygen concentration were determined daily during the experimental was measured using a mercury in glass thermometer. pH was determined with a glass electrode pH meter (model HA191, Hannah. Instrument, Portugal) which was calibrated against standard buffer solution with pH values of 4, 7 and 10. Dissolved oxygen content was determined by the Wrinker method. Salinity was measured by means of a refractometer (ATAGO S/mill/E). The refractometer was initially standardized with water from ARAC bore hole to obtain the reading for 0 ppt before salinity values for the test solution were determined.

Data analysis: Probit analysis (Finney, 1978) was used to determine the Median Lethal Salinity (MLSs) and Media Lethal Time (MLTs). Mortality at the various salinity concentrations and duration were subjected to ANOVA and differences among means were separated by Duncan multiple range test (Wahua, 1999).

RESULTS AND DISCUSSION

The results of hybrid catfish fingerlings mortality in various salinity concentrations are shown in Table 1-3. About 100% mutuality was recorded among hybrid fingerlings that were exposed to 12 and 10 ppt at 3 and 12 h, respectively. At the end of 96 h exposure, 75% mortality was recorded among hybrid in 8 ppt while those in 6 ppt only recorded 10% mortality (Fig. 1). Median lethal salinity for 96 h (MLS_{96}) was 7.32 ppt while the values for 24 and 12 h were very similar as shown in Table 1. Median Lethal Time (MLT_{50}) for the hybrid fingerlings in 10 ppt was 5.55 h (Table 2). Duncan's multiple range test showed that the cumulative mortality at the various salinity concentrations did not differ between 4 and 6 ppt but showed significant difference between 8, 10 and 12 ppt ($p<0.05$). Cumulative mortality at the various time interval did not differ at 12-48 h and also at 72 and 96 h ($p>0.05$) as shown in Table 3.

The results of the physico-chemical parameters are presented in Table 4. Water temperature values ranged between 26 and 27.5°C during the experimental period pH values ranged from 5.2-6.6 while dissolved oxygen values were between 5.2 and 6.8 mg L^{-1} (Table 4). The results showed that hybrid catfish mortality occurred at a salinity value of ≥6 ppt during the 96 h study period indicating that the fish had problems with osmotic ion balance in those test media. Teleost fishes in diverse environments are known to attempt to control both the volume of water and the concentration of electrolytes in the internal body fluid in order to maintain of homeostasis. The hybrid catfish that were used in this study were form freshwater parents (*C. gariepinus* and *H. bidorsalis*) whose salinity tolerance had earlier been investigated (Britz and Hecht, 1989; Fagbenro *et al*., 1993; Iyaji, 2008).

Owing to heterosis, it was considered that the hybrid might have better tolerance to salinity than either parent.

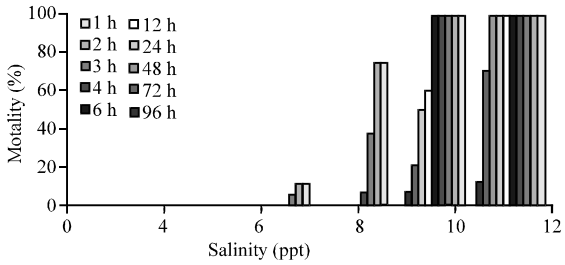

Fig. 1: Cumulative mortality (%) of 28 days old fingerlings of African catfish hybride (*C. gariepinus* ♀ x *H. Bidorsalis* ♂) transfared from 0 ppt to higher salinity for 96 h

Table 1: Median lethal salinity and associated 95% lower and upper confidence bounds (limits) of 28 days hybrid fingerlings (*C. gariepinus* x *H. bidorsalis*

Duration (h)	MLS_5	MLS_{50}	MLS_{85}	MLS_{90}	MLS_{95}	MLS_{99}
6	7.73 (6.80-8.30)	973 (9.34-10.12)	10.99 (10.55-11.66)	11.28 (10.80-12.05)	11.72 (11.17- 2.65)	12.55 (11.83-13.97)
12	7.21 (2.33-8.20)	8.90 (7.66-10.14)	9.96 (9.10-13.29)	10.21 (9.31-14.16)	10.58 (9.60-15.49)	11.28 (10.07-18.03)
24	7.67 (7.07-8.04)	8.85 (8.54-9.19)	9.60 (9.26-10.13)	9.78 (9.41-10.36)	10.04 (9.63-10.72)	10.53 (10.03-11.41)
48	7.16 (6.14-7.54)	8.28 (8.01-8.65)	8.99 (8.62-9.92)	9.15 (8.75-10.24)	9.40 (8.92-10.72)	9.87 (9.25-11.63)
72	5.69 (4.91-6.16)	7.32 (6.98-7.66)	8.35 (7.97-8.92)	8.59 (8.18-9.25)	8.95 (8.56-9.89)	9.62 (9.02-10.67)
96	5.69 (4.91-6.16)	7.32 (6.98-7.66)	8.35 (7.97-8.92)	8.59 (8.18-9.25)	8.95 (8.56-9.89)	9.62 (9.02-10.67)

Table 2: Median lethal time to death of 28 days old hybrid fingerlings (*C. gariepinus* x *H. bidorsalis*)

Salinity (ppt)	MLT_5	MLT_{50}	MLT_{85}	MLT_{90}	MLT_{95}	MLT_{99}
6	98.58	-49.55	-142.89	-164.97	-197.69	-259.06
8	47.03	52.47	115.16	129.99	151.96	193.19
10	2.31	5.55	7.34	7.76	8.39	9.56

Table 3: Cumulative mortality of 28 days hybrid fingerlings (*C. gariepinus* x *H. bidorsalis*) exposed to a) graded salinities and b) at various intervals (mean and associated 95% confidence limit = 1 for each data point)

		95% confidence limit				95% confidence limit	
(a) Salinity (ppt)	Cumulative mortality	Lower bound	Upper bound	(b) Duration (h)	Cumulative mortality	Lower bound	Upper bound
4	-1.224	-0.35	0.35	3	2.00[a]	1.61	2.39
6	0.25[d]	-0.10	0.60	6	2.67[c]	2.27	3.07
8	2.69[c]	2.34	3.03	12	3.33[b]	3.02	3.82
10	8.50[b]	8.15	8.85	24	3.34[b]	3.02	3.82
12	10.00[a]	9.65	10.35	36	3.75[b]	3.35	4.15
				48	3.92[b]	3.52	4.32
				72	4.75[a]	4.35	5.15
				96	4.75	4.35	5.15

Means with similar superscripts in the same column are not significantly different ($p<0.05$)

Table 4: Water quality parameters of the different test salinities for 28 days old fingerlings

	Temperature (°C)		Dissolved oxygen (mg L^{-1})		pH	
Salinity (%)	Range	Mean	Range	Mean	Range	Mean
0	26.0-27.5	26.9±0.53	5.2-6.2	5.7±0.3400	5.4-6.2	5.7±0.29
4	26.0-27.5	27.0±0.28	6.0-6.8	6.3±0.1729	5.8-6.2	6.0±0.14
6	26.0-26.5	26.2±0.25	6.6-6.8	6.3±0.1300	5.4-6.0	5.7±0.22
8	26.5-27.5	26.5±0.44	5.8-6.2	5.9±0.4500	5.8-6.6	6.1±0.21
10	25.0-27.5	26.5±0.76	5.4-6.8	5.9±0.4500	5.8-6.6	6.1±0.29
12	26.5-27.5	26.9±0.34	5.6-6.4	5.9±0.2500	5.6-6.4	6.0±0.34

Table 5: Median lethal salinity and associated 95% (Lower and upper confidence limits) of 28 days hybrid fingerlings (*C. gariepinus* x *H. bidorsalis*)

Duration (h)	MLS_5	MLS_{50}	MLS_{85}	MLS_{90}	MLS_{95}	MLS_{99}
6	7.73 (6.80-8.30)	973 (9.34-10.12)	10.99 (10.55-11.66)	11.28 (10.80-12.05)	11.72 (11.17-12.65)	12.55 (11.83-13.97)
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72	5.69 (4.91-6.16)	7.32 (6.98-7.66)	8.35 (7.97-8.92)	8.59 (8.18-9.25)	8.95 (8.56-9.89)	9.62 (9.02-10.67)

MLS_{50} from the present study was comparable to the results that were obtained by Iyaji (2008) for *C. gariepinus* (8 ppt during abrupt transfer and 10 ppt during gradual transfer).

For *H. bidorsalis*, Fagbenro *et al*. (1993) reported no fingerlings mortality from freshwater to 10 ppt. However, the results of the present study showed that morality (10%) occurred early in 6 ppt test medium and this was an indication of less resistance to salinity when compared to that of Fagbenro *et al*. (1993) for *H. bidorsalis* but was very similar to the results of Britz and Hecht (1989) who reported fry mortality of *C. gariepinus* at 5 ppt (Table 5). The present results on relatively, low resistance of hybrid catfish to low salinity values could be attributed to the relative acidic pH of the test media. The results of water pH value indicated slight acidity which according to Boyd (1982) was not ideal for fish culture. Adult *C. gariepinus* (0.6-1.5 kg) was reported to tolerate 10 ppt (25.6% sea water) for 100 h with no sign to stress and with acclimatization, the fish were able to tolerate a salinity of 20 ppt (51.3% sea water) (Clay, 1977). Chervinski (1984) in his study of the salinity tolerance of young *C. gariepinus* reported that 95% of those on direct transfer tolerance 25% sea water (9.5%) but that no fish survived in 30% sea water (11.7%) even through gradual transfer. This could slightly be compared to the present results where 100% mortality was recorded from 10-12%. In a study on *Heterobranchus longifilis*, Fashina-Bombata and Busari (2003) maintained that the species has low salinity tolerance which is typical of freshwater stenohaline fish. It should be noted that *H. longifilis* and *C. gariepinus* share very similar biological and ecological attributes and should not be raised in water bodies that exceed salinity values of 6° ppt. It becomes apparent therefore that the product (Hybrid) of both species will inherit the physiological characteristics of both parents indicated by the result of the present study that the fish had problems with osmotic ion balance in those test media.

Teleost fishes in diverse environments are known to attempt to control both volume of water and the concentration of electrolytes in the internal body fluid in order to maintain homeostasis. The hybrid catfish that were used in this study were from freshwater parents (*C. gariepinus* and *H. bidorsalis*) whose salinity tolerance had earlier been investigated (Britz and Hecht, 1989; Fagbenro *et al*., 1993; Iyaji, 2008). Owing to heterosis, it was considered that the hybrid might have better tolerance to salinity than either parent. ML_{50} from the present study was comparable to the results that were

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CONCLUSION

In a study on *Heterobranchus lonifilis*, Fashina-Bombata and Busari (2003) maintained that species had low salinity tolerance which is typical of freshwater stenohaline fish. It should be noted that *Heterobranchus lonifilis* and *C. gariepinus* share very similar biological and ecological attributes and should not be raised in water bodies that exceed salinity values of 6 ppt. It becomes apparent therefore that the product (Hybrid) of both species will inherit the physiological characteristics of both parents indicated by the results of the present study.

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