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Reproductive Fitness of Stressed Female Catfish Broodstock of *Clarias gariepinus* (Burchell, 1822)

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Abstract

Effect of stress on the hatchability rates of stressed female broodstock and fry survival rates was investigated in this study. Breeding performance of Clarias gariepinus (0.95±0.32g) under different stress conditions; Starvation (ST) for 7 days, Unguided Daily sampling (UD) of fish on the last 7 days before hormonal injection for breeding , Low water level (LW) in fish tank for the last 7 days prior to breeding exercise and Control (CT). Experimental fish were injected hormone (Ovaprim) intramuscularly at an angle of 30 – 45^o of the dorsal fin to artificially induce them for spawning at the rate of 0.5ml/kg of fish. Weight of eggs stripped ranged between 70g and 90g with recorded mortalities except in CT. Hatchability rate varied significantly (p<0.05) among stressed fish with values ranging from 64.92±0.15% (LW) to 88.25±0.22% in UD. Various stressed conditions i.nvestigated in the study showed can produce adverse effect in the following order LW>ST>UD. The significant better performance of fish under control experiment vindicated that stress is a major factor in broodstock performance which is capable of adversely affecting fry survival rates. It is therefore recommended that stress in fish should be minimized towards ensuring successful hatchery operations.

***Key words**: Clarias gariepinus, Breeding performance, Stress, Hatchability rates, Fry.*

Introduction

In Nigeria, the major family of catfish that is of commercial interest is the family Claridae. *Clarias gariepinus* is mostly farmed due to its fast growth rate and ability to tolerate wide range of temperature, low dissolved oxygen, and salinity. It hardly reproduces in captivity (Howerton, 2001). However, break-through have recorded in the artificial propagation of catfish seeds using different techniques which permit spawning, incubation, hatching of eggs and rearing under controlled environment. Induced breeding has made it possible for out of season propagation, thus making the seeds to be available all year round (Ayinla, 1988) thereby increasing farmers rate of generating income. Stress induced by bad cultural practices such as mishandling, unregulated sampling, transportation, undue confinement and poor feeding can increase the incident of poor performance and mortality. Fish seed production efficiency of many fish farms' hatcheries throughout sub-Saharan African countries or developing countries like Nigeria is mostly unsuccessful due to poor handling of broodstock (Aiyelari *et al*, 2007). Proper handling and health status of female brood fish has been reported to be of great importance in the reproductive performance of fish (Muchlisin *et al.*, 2006; Aiyelari *et al*., 2007). The stress of capture and handling either during sampling or selection of fish during breeding has significant effects on its physiology (Bamimore, 1994). To this effects growth of aquaculture has been reported hinging on the ability of the hatcheries to be able to produce and supply fish seeds for stocking production ponds on a sustainable basis (Bamimore, 1994). Sensitivity of fish to stress differs markedly among species (Huisman and Ritcher, 1987) and there is strong evidence that the degree of stress in female affects the quality of eggs in induced spawning (Pickering *et al*., 1995). Fecundity which is the total number of eggs produced by fish expressed in terms of eggs/spawns is known to be affected by stress and nutritional deficiency (Hogendoorn and Vismans, 1980). The physiological effects of stress are highly pronounced under induced spawning procedure, that using the right hormone at the right time can still result into failure (Ayinla, 1988). Broodstock are sensitive to handling stress and may consequently die due to the condition under which they are stressed. There is the need therefore to establish the effects of such improper treatment in order to prevent the problems of low output from fish hatcheries. The aim of this study is therefore to investigate the effects of stress conditions due to handling on the reproductive fitness of female *C. gariepinus* during fry production. Brood fish performance could be hindered due to adverse environmental conditions which directly tell on the gonad development in the fish (Izquierdo *et al.,* 2001). *Clarias gariepinus* is presently the most widely cultured fish species in Nigeria and many hatcheries in the country are facing the problem of poor spawning and low hatchability rates (Ayinla, 1988).

Materials and Methods

Fifty sexually matured female catfish broodstocks and twenty matured males were purchased from a reputable fish farm (Aeries farm in Sagamu, Ogun State, Nigeria) two weeks before the experiment and fed imported commercial fish feed (Coppens) at 3% body weight daily in an earthen pond for conditioning. Forty gravid and healthy female fishes of average weight of 0.95±0.32g were selected for the experiment at the end of the two-week conditioning and were subjected to four different forms of stress in separate tanks which are; Starvation (ST) for 7 days, Unguided Daily sampling (UD) of fish on the last 7 days before hormonal injection for breeding, Low water level (LW) in fish tank for the last 7 days prior to breeding exercise and Control (CT). Experimental fish were injected hormone (Ovaprim) intramuscularly at an angle of 30 – 45^{o} of the dorsal fin to artificially induce them for spawning at the rate of 0.5ml/kg of fish. Injected fish were kept in separate tanks and a latency period of twelve hours was given before the eggs were stripped. Eggs were stripped into dry plastic bowls, weighed immediately and fertilized with the milt of male fish from the same treatment. Within two to three minutes after fertilization, eggs were evenly spread on "Kakaban" (egg receiver) that was laid inside a (1.5 x 1 x 0.3) m rectangular plastic tank for incubation.

Determination of Broodstock Performance

At the expiration of the latency period of eleven hours, eggs were stripped, fertilized and incubated according to each stress conditions. Hatchability rates of the eggs was determined according to Aluko *et al.* (2001), an estimation which assumed hatching rate of flow through water system to be calculated on live/dead ratio of incubated eggs while survival rate was determined based on the methods of Jensen (1996). The normal healthy larvae were estimated on percentage basis of dead and deformed hatchlings. The physico-chemical parameters of the water used were such as pH, dissolved oxygen and temperature was all monitored using combined digital YSI meter (YSI model 57, VWR CompanyNew Jersey and Metler Toledo-320 model, U.K) to ensure water in the culture media remain within the acceptable ranges for catfish reproductive performance as recommended by Boyd (1990). Gamete quality of female brood fish was determined by fecundity/gonado-somatic index ratio (GIS) according to Fernandez-Palacios *et al.*, (1998). Data collected were processed and analyzed based on two ways analysis of variance (ANOVA).

Results and Discussion

All experimental fish injected with hormone oozed out eggs easily without causing bruises on the fish which suggests that the recommended dosage of 0.5ml/kg of the hormone (Ovaprim) by Syndel International Incorporation was adequate for latency period observed. But despite the ease of stripping mortalities were still recorded during the study suggesting that fish had experienced certain stress conditions before the stripping exercise (Table 1). This observation is line with the earlier reports of Aiyelari *et al* (2007) that broodstock mortality after stripping can result due to stress. This is however different from the reports of Sotolu (2010) who reported that zero mortality of stripped female but indicated no stress on the fish prior to hormonal treatment which may be reason for the differences. Hatchability rates of eggs vary significantly among treatments (Table 2).

Table 1: Weight, length and mortality records of the female broodstock

Stressed condition	Mean standard length (cm) Mean	Weight before stripping (kg)	Weight after stripping (kg)	No of fish injected	No of fish stripped	Broodstock mortality after stripping
CT	30.33 ±1.27	0.93 ± 0.40	0.85 ± 0.10	3	3	0
ST	32.30 ± 2.09	0.96 ±0.35	0.89 ±0.40	3	3	2
UD	32.24 ± 1.04	1.00 ±0.00	0.91 ± 0.20	3	3	1
LW	31.35 ± 1.70	0.92 ±0.10	0.83 ± 0.10	3	3	2

The survival rate of the fish significantly ($p<0.05$) vary among all treatments with the control experiment having the highest value. This was followed by UD but with observed bruises on the fish while fish under LW and ST treatments had the lowest survival rate with highest deformity after hatching. These results could be an indication of the effects of stress conditions they were subjected to but at varying degrees. Sufficient quantity good water quality for successful fish production has been enumerated by Pillay (1990) and corroborated by Boyd (1990). It is an essential requirement for good fish performance at various stages of growth including reproduction (FAO, 2006; Omitoyin, 2007). After twenty-one days of the hatching, fry survival rate varied significantly among treatments (Table 3) with the control having the best results. The variations among other treatments followed the same trend experienced in table 2 where hatchability rate was least in fish under low water level treatment (LW). Weight loss in fish after stripping ranged between 87g-90g from ST to UD and these values represent the weight of weight egg stripped in each case. These results are within the range of egg fish weight ratio observed by Sotolu (2010) in a related study.

Table 2: Hatchability rates at 7 days after incubation among treatments

Stressed condition	Weight of eggs stripped (g) and incubated	Hatchability rate (%)		
		Survived	Deformed	Dead
CT	80±0.10	91.71±0.22^{a}	6.23±0.21^{d}	2.06±0.10^{b}
ST	70±0.30	76.58±0.13^{c}	18.02±0.16^{b}	5.40±0.10^{b}
UD	90±0.21	88.25±0.21^{b}	8.17±0.14^{c}	3.58±0.10^{b}
LW	89±0.10	64.92±0.15^{d}	23.08±0.11^{a}	12.00±0.10^{a}

Mean values on the same column with different superscript are significantly different ($p<0.05$)

There was strong evidence that the degree of stress affects the quality of eggs produced as indicated with significant differences among the treatment means. This is in agreement with the findings of Morehead *et al*., (2000) that stress appears to reduce reproductive fitness in fish. It could therefore be inferred from these results that fish under UD was in a better condition relative to ST and lastly LW since the milder the stress, the lower the egg quality as elaborated by Morehead *et al*., (2000). It was observed in this study that frequent contact with nets and hands during unregulated fish sampling which probably resulted in significant high fry mortality after hatching. It was reported that such situation could be responsible for both broodstock and fry mortality through infection (Morehead *et al*., 2000). Table 3 showed the number of survived fry under the various stress conditions and the significant variation s in the percentage survival rates of fish. It was also observed that reduction in gamete quality manifested directly in live/dead ratio of resulted fry. Healthy fry was highest in CT while the highest death of fry was recorded in LW. Jensen (1996) reported that there was a gonadal regression as by re-absorption of oocytes other than peritellogenic when fish is subjected to stressed and used as broodstocks. This condition is capable of causing deformity in eggs even after hatching since they are gravid and successfully fertilized. There was no significant fluctuation in the physicochemical parameters of the water.

Table 3: Fry survival rates at 21 days after hatching among different stress conditions

Stressed condition	Mean survival rate	Pooled (%) survival rate
CT	4379.33^{a}	38.02^{a}
ST	2215.00^{c}	19.22^{c}
UD	3302.67^{b}	28.67^{b}
LW	1623.00^{d}	14.09^{d}

Mean values on the same column with different superscript are significantly different (p<0.05)

Conclusion

The present study revealed that external factors such as starvation, low water level in fish tanks and unregulated fish sampling resulting in frequent handling are all capable of affecting brood fish performance and eventual fry survival rates due to resultant poor gamete quality. Insufficient water depth in fish tanks could constitute a devastating effect on fish health status and also affect the quality of fry that is produced more than starved broodstocks. Therefore, it is recommended that stress should be minimized to guarantee optimal gamete quality and quality fish production. It is pertinent to state that aquaculturist need to understand the effects of stress in brood fish and the relationship with the developmental stages in their life in order to reduce the cumulative effects of stress on reproductive stage of fish and ensuring high fry survival and successful hatchery operations.

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