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THE EVALUATION OF GROUNDWATER QUALITY ON SUCCESSFUL HATCHERY CULTURE OF AFRICAN CATFISH (CLARIAS GARIEPINUS) IN IKWUNO OBORO, ABIA STATE

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ABSTRACT

Groundwater samples were taken from Oboro community to evaluate the hatchability and survivability of African Catfish *(Clarias gariepinus*) broodstock of average weight 1.16kg for male and 1.15kg for female. The percentage (%) fertility and hatchability was determined subjectively after 12hours of fertilization. Survival percentage (5) was evaluated for a period of 2 – 3 weeks and post hatching survivability was calculated. pH, Temperature, Alkalinity, Dissolved Oxygen and Salinity were calculated using standard measurement for significance differences. The result for percentage survival rate and percentage hatchability rate of *Clarias gariepinus* fry in this study were not within acceptable range and were not significantly different ($P > 0.05$).

KEYWORDS: Water quality, Hatchability, Breeding, Survival rate, Broodstock.

INTRODUCTION

Catfish (*Clarias sp*) are the major commercialized species in Nigeria for good market culture reasons. (Anentekhai *et al.*, 2004). *C. gariepinus* (Claridae) is very popular to fish farmers for high market price, fast growth rate, good food conversion ratio, resistance to diseases infection and ability to withstand adverse pond conditions especially low oxygen content and high turbidity. Fish culture production in Nigeria includes stocking of lakes and production in

ponds, cages and tanks (Ita, 1985). Pond culture is the most prevalent (Akinwole *et al.*, 2006). Virtually all aspect of pond culture of African catfish (C*larias gariepinus*) in Nigeria has been developed and documented to ensure profitable production of the species (Adebayo et al., 2007; Alatise et al., 2004; Amo et al., 2007; Nlewadim and Madu, 2004). The appreciable quality of water and large expense of land require for pond culture has however limited the expansion of African catfish culture in Nigeria (Akinwole *et al*., 2006). Fish seed production efficiency of many fish farms' hatcheries throughout sub-Saharan Africa or developing countries like Nigeria is mostly low due to poor handling of brood stock (Aiyelari *et al*., 2007). Many hatcheries in Nigeria are facing the problem of poor spawning and low hatchability of *C. gariepinus* although it is widely cultured in Nigeria (Oladosu et al., 1991). Poor egg quality and low hatching rates are amongst the difficulties most often reported by fish farmers. Fertilization, hatching and early survival of larvae are vital for successful aquaculture of the African catfishes (Legendre (1996), Hoffman et al., (1991) and this has been investigated earlier (Ataguba *et al*., 2009). There is a need to create awareness of the potential roles played by water hardness in the breeding of *C. gariepinus.* One of the few attempts in this regard was by Molokwu and Okpokwasili (2002). Water is a vital resource for fish, it is the medium in which the fish lives and therefore the growth of any fish is directly relate /dependent to the quality of the water (Ajana *et al.*, 2006). It is a well known fact that water quality conditions are constantly being threatened by pollution; this has resulted in the widely distributed sources of pollution and therefore created a significant problem in groundwater, rivers, lakes, and dams (Arvind, 2004). The increase level of using chemical herbicides, pesticides, insecticides, fertilizers, improper disposal of sewage as well as global warming in Nigeria has created a growing awareness of the rationale management of aquatic resources and control of waste discharge from the environment (Egborge, 1991). Environment contamination is commonly exposing aquatic organisms like fish to pollution and other problems of the biology including growth and reproduction and both of which are important considerations (Lamai *et al*., 1999).

Fertilization, hatching and early survival of larvae are vital for successful aquaculture of the African catfishes (Ataguba *et al.*, 2009). Although the environment of aquaculture fish is a complex system, consisting of several water quality variables, only few of them play decisive role. The critical parameters are temperature, pH, and concentrations of dissolved oxygen, salinity, total hardness, carbon dioxide and alkalinity. However, dissolved oxygen is the most important and critical parameter, requiring continuous monitoring in aquaculture production

systems. This is due to fact that fish aerobic metabolism requires dissolved oxygen (Timmons *et al*. 2001). The insufficient supply and relatively high cost of fingerlings of *Clarias gariepinus* and *Heterobranchus longifilis* (Ofor, 2007), resulting from low output per breeding attempt, indicates the need to widen the scope of factors affecting the low output. Water hardness influences development of juvenile fathead minnows (Blanksma *et al.*, 2009), eggs (Townsend *et al.*, 2003) and larvae (Silva *et al.*, 2003) of *Rhamdia quelen* and tilapia (Guerrero, 1982) and *Hypophthalmichthys molitrix* (Rach *et al.*, 2010). Water hardness has been shown to affect the toxicity of silver to early life stages of *Oncorhynchus mykiss* (Morgan *et al.*, 2005), as well as the toxicity of some common aquaculture chemicals used in protecting fish eggs from fungus infection (Adhikari, 2003). The effects of temperature (Ajuzie and Appelbaum, 1996), salinity (Oladosu *et al*., 1999), water hardness (Molokwu and Okpokwasili, 2002a) and bacterial load (Ariole and Okpokwasili, 2012) on the embroyonic development and larval survival of *Clarias gariepinus* have been reported. The effect of fertilizer effluent (Ekwezor *et al*., 2001) and heavy metal content (Obasoham and Oronsaye, 2000) of adult *Clarias gariepinus* have been established. A study was carried out to determine the effect of pH on hatching success and larval survival of *Clarias gariepinus* which is the dominant fresh water fish produced in Nigeria. Larval activity depressed at low and high pH whereas larvae were very active at pH 7.5-8.5. The results indicate that the optimum pH range for normal hatching and larval survival of *Clarias gariepinus* is pH 7.5-8.5. (Ariole and Okpokwasili, 2012). Generally research studies had focused on hatching success in relation to environmental variables such as temperature (Oyelese, 2006) and CaCO3 water hardness dissolved oxygen and pH are the more frequently investigated factors affecting the fertilisation and hatching success of fish species (Silva *et al.*, 2003). This study is aimed at the investigation of the efficacy of borehole groundwater quality on fertility, hatching rate and larval survival of *Clarias gariepinus.*

MATERIALS AND METHODS

The experiment was carried out in Fish farm unit of the Department of Fisheries and Aquatic Resources Management, Michael Okpara University of Agriculture, Umudike, Nigeria. Two (2) African Catfish (*Clarias gariepinus*) *brood* stock of average weight+/- 1.16kg at the ratio of 1:1 males to females respectively were purchased from a reputable fish farm were transported in plastic container and on arrival at the experimental site were allowed to remain in the plastic container for two days to allow them recover from transportation stress and acclimatize to the new environment prior to the time of usage. 15-month old female *C.*

gariepinus, the female fish was injected with ovaprim following standard procedures. The hormone was administered intramuscularly, a little distance from the head down, after which the treated fish was returned back into the container and covered tightly. After a latency period of 10 hour following inducement injection, the final maturation and ovulation rate was reached. The male was scarified, the belle dissected vertically and the gonads was removed, blood and other stains was removed from the gonads. Saline solution (20ml saline solution was prepared by dissolving common salt in 1itre of water) (FAO, 1996), saline minimised pre-egg contact motility of sperm. Prior to stripping, the abdomen of the female was dried with tissue paper to prevent water coming into contact with the eggs prematurely. The eggs were stripped out of the female fish by applying gentle pressure on the abdomen of the female fish towards the genital papilla. Milt was spread over the stripped eggs and the whole content was mixed together with the addition of saline solution, Eggs and milt were homogenised by stirring with chicken feather for fertilization to effectively take place. The eggs were spread evenly on pretreated Kakaban of 1mm mesh and floater which is placed in a 15-litre aquarium container three treatments of three replicates of water sample gotten from Ahuwa, Ndioro and Umuigu. Every other conditions of the incubator were strictly controlled. Immediately after fertilization occurs, new development commenced, the eggs absorbed water, sticked to the kakaban. Also, red spot were observed on the brownish colour of the eggs indicating life. Healthy developing eggs were transparent brownish in colour while the white coloured eggs are those that are opaque (dead eggs). Incubation was without aeration. Hatching commenced at around the 24 hours after fertilization. The newly hatched fries escaped through the 1mm mesh into the vat underneath while the unhatched eggs remain on the kakaban. After 24 hours, hatched eggs were collected and the fry were not fed until the third day after the hatching. One third of the water in each aquarium was changed with clean water daily. The hose and the bowl were placed not more than 20cm below the bottom surface of the hatchery container (Viveen, *et al.*, 1986) when distributing the 30 fry per aquarium for acclimatization before the feeding began 3 days after hatching to enable the observation of the larvae survival rate. About 1/3 of the water in each aquarium was changed every two days in order to create favourable condition for the fry. (Viveen *et al.*, 1986).

To prevent water pollution, un hatched eggs were removed from the incubator by siphoning. Feeding commences on the 3th day after their yolk sac have been completely absorbed. They were fed with small quantity of processed Coppen *Artemia*. Excess feed and waste were siphoned out using 1mm diameter hose. Data were collected on egg fertilisation rate,

hatching rate and survival rate. All eggs brownish, 8 hours after placement, were considered fertilised, and counted (Hogendoorn, 1979). The incubation period lasted from placement to the attainment of hatching success. Hatching period started from placement of eggs in media and ended when eggs stopped hatching. The percentage (%) fertility and hatchability was determined subjectively after 12-15 hours of fertilization by identifying the healthy developing eggs which were transparent brownish in colour. while the dead eggs were also estimated.

$$\% \text{ Fertility} = (\text{No. of fertilized eggs} / \text{No. of incubated eggs}) \text{ X } 100\%$$

$$\% \text{ Hatchability} = \frac{(\text{Total no.of fertilized eggs} - \text{Total no.of unfertilized eggs})}{\text{Total no.of fertilized eggs.}} \text{ X } 100\%$$

This was done by allowing the newly hatched larvae of all the treatments to live on the remains of their yolk sacs for the first 3 days after hatching out of the eggs and were fed with Coppen Artemia on a regular basis (*i.e.*, twice per day). Irregularities in the activities of the fry in terms of feeding, movement in water was observed at the same time taking note of the dead fry which were removed immediately to avoid contamination of water. Survivability evaluation which was observed for a period of about 2 – 3 weeks was done. The post-hatching survivability was evaluated as follows:

$$\% \text{ Survival} = \frac{\text{No of Surviving fries}}{\text{Total no.of hatched fries used}} \text{ X } 100$$

Borehole Water samples were taken from the Ahuwa, Umuigu and Ndioro. The water samples were analysed for pH, Temperature, Dissolved oxygen, Salinity, Alkalinity, Total Hardness in this study is defined and determined according to Boyd and Tucker (1992). Dissolved oxygen, pH and temperature were measured using a Hanna Instruments portable waterproof dissolved oxygen meter (Model HI 9142) and Hanna microprocessor pH meter and logging pH/ORP meter (Hanna Instruments Inc. Woonsocket, RI, USA).

RESULTS AND DISCUSSION

Table 1: Water quality before breeding.

Parameters	Ahuwa	Umuigu	Ndioro
pH	8.07± 0.31^{a}	7.04±0.04^{b}	7.21±0.59^{b}
Temperature	28.4±0.31^{a}	28.1±0.21^{a}	28.2±0.31^{a}
Alkalinity	64.6±0.61^{a}	57.2±2.32^{b}	66.7±0.80^{a}
Dissolved Oxygen	6.23±0.31^{ab}	5.73±0.25^{b}	6.40±0.30^{a}
Salinity	10.2±1.90^{a}	9.90±2.60^{a}	10.1±2.43^{a}
Total Hardness	57.8±0.40^{a}	54.7±0.70^{c}	56.5±0.60^{b}

abc Means ± SD of values with the same superscript in the same row are not significantly different (p>0.05). abc Means ± SD of values with the different superscript in the same row are significantly different (p <0.05).

The monitored water quality parameters before breeding in this study are showed in Table 1. The result showed that Temperature and Salinity for each of the treatment Ahuwa, Umuigu and Ndioro in all the treatments were not significantly different (p>0.05) from each other. The result showed that Total Hardness for each of the treatment Ahuwa, Umuigu and Ndioro in all the treatments were significantly different (p<0.05) from each other. The average pH, Temperature, Dissolved oxygen, Total alkalinity, Salinity and Total hardness for the various treatment observed in this study were within acceptable range (Adewumi, 2009).

Table 2: Water quality for Fertility and Hatchability.

Parameters	Ahuwa	Umuigu	Ndioro
pH	7.70 ± 0.21^{b}	8.11 ± 0.26^{a}	7.81 ± 0.14^{ab}
Temperature	27.8 ± 0.40^{a}	27.6 ± 0.50^{a}	28.1 ± 0.21^{a}
Alkalinity	56.2 ± 0.50^{b}	54.1 ± 0.51^{c}	65.7 ± 1.53^{a}
Dissolved Oxygen	6.30 ± 0.20^{a}	5.43 ± 0.30^{b}	6.60 ± 0.12^{a}
Salinity	11.2 ± 0.30^{a}	8.13 ± 0.35^{b}	12.1 ± 0.40^{ab}
Total Hardness	59.7 ± 1.46^{b}	53.5 ± 4.73^{c}	67.2 ± 0.40^{a}
Fertility	42.3 ± 4.51^{a}	44.3 ± 4.04^{a}	41.7 ± 3.21^{a}
Hatchability	38.7 ± 2.52^{a}	42.0 ± 4.40^{a}	39.0 ± 2.65^{a}

The result showed that Temperature for each of the treatment Ahuwa, Umuigu and Ndioro in all the treatments were not significantly different (p>0.05) from each other. The result showed that Total Hardness and Alkalinity for each of the treatment Ahuwa, Umuigu and Ndioro in all the treatments are significantly different (p<0.05) from each other. The result also showed that pH and Salinity for each of the treatment Ahuwa and Umuigu are not significantly different (p<0.05) with Ndioro but are significant different (p>0.05) with each other. The finding revealed that treatment from Umuigu had Mean±SD 44.3 ± 4.04^{a} and 42.0 ± 4.40^{a} highest values for fertilization and hatchability while Ndioro had d lowest in Fertility 41.7 ± 3.21^{a} and Ahuwa had lowest in Hatchibility 38.7 ± 2.52^{a}.

Table 3: Water quality for Survival Rate.

Parameters	Ahuwa	Umuigu	Ndioro
pH	8.05 ± 0.10^{a}	7.97 ± 0.14^{a}	8.05 ± 0.40^{a}
Temperature	28.1 ± 0.21^{ab}	27.9 ± 0.20^{b}	28.5 ± 0.32^{a}
Alkalinity	55.8 ± 1.37^{a}	50.4 ± 1.30^{b}	56.6 ± 2.19^{a}
Dissolved Oxygen	6.10 ± 0.31^{a}	5.20 ± 0.15^{b}	6.63 ± 0.12^{a}

Salinity	11.3±0.60[a]	8.10±0.60[b]	11.2±0.30[a]
Total Hardness	55.8±2.10[a]	48.2±0.61[b]	58.2±0.80[a]
Survival Rate	21.3±2.08[a]	24.0±3.61[a]	20.0±2.65[a]

The result showed that pH for each of the treatment Ahuwa, Umuigu and Ndioro in all the treatments are not significantly different ($p>0.05$) from each other. The result also showed that Temperature for each of the treatment Umuigu and Ndioro are not significantly different ($p<0.05$) with Ahuwa but are significant different ($p>0.05$) with each other. Alkalinity for treatment Ahuwa and Ndioro are not significantly different ($p>0.05$) with each other but are significantly different ($p<0.05$) with treatment Umuigu. Dissolved Oxygen for treatment Ahuwa and Ndioro are not significantly different ($p>0.05$) with each other but are significantly different ($p<0.05$) with treatment Umuigu.

The results of percentage survival rate of *C. gariepinus* fry in this study are showed in Table 3. The percentage survival rate of the fry of treatments 'Ahuwa' (21.3±2.08[a]), 'Umuigu' (24.0±3.61[a]) and 'Ndioro' (20.0±2.65[a]) were not significantly different ($p>0.05$) from each other while treatment 'Ndioro' (20.0±2.65[a]) was the lowest. The percentage survival rate of all the treatments are within acceptable range according to Alatise *et al.*, (2004).

Temperature: The water temperature recorded during the experimental period ranged 27.6^0C to 28.4^0C (tables 1, 2, 3). The temperature readings in all the treatment were within the same range and this shows that the readings were within the tolerable range for the culture of catfishes as recommended by Swann *et al*, (1990), the acceptable range of temperature for catfish (*Clarias gariepinus*) is between 26^0C-30^0C.

Hydrogen-ion Concentration (pH): The hydrogen ions concentration pH recorded during production cycle for the three treatments ranged between 7.04 and 8.11. Treatment Umuigu had the lowest pH value of 7.04 and also had a value of 8.11. These shows that the concentration of pH in all the three treatments were alkaline and were within the tolerable range (6.0-9.0) for the culture of catfish, although high level may have influenced elevation of some of the water quality parameters (Akinwole *et al.*, 2006).

Dissolved Oxygen (DO): At the beginning of the of the study period concentration of oxygen were initial being higher but gradually reduced as growth of fingerlings were achieved especially in treatment Umuigu, dissolve oxygen fell as low as 5.20mg/l (table3). This gradual reduction was attained at as the result of metabolism of the fish and of bacteria

decaying organic material such as underutilized feed were the major contributors to these demands. As stated by Brown, (1957), the survival of *Clarias* is not dependent oxygen in the water since it is equipped to obtain energy by gulping air. While inadequate dissolve oxygen is not itself lethal, it may seriously affect the health of fish and facilitate the spread of disease Mayer, (1970) for example indicates that the role of low dissolve oxygen levels in promoting bacterial infections is often unsuspected.

Alkalinity: Throughout the production period the alkalinity level never reached significant that could affect the fish's health or growth. The ranged between 50.4mg/l to 66.7mg/l with treatment Umuigu had the lowest value of while the highest value occurred in treatment Ndioro. High alkalinity levels are dependent on the presence OH^-, HCO_3^- and CO_2^- ions. Alkalinity levels greater than 400mg/l are considered toxic for the culture of catfish (*C. gariepinus*) as recommended by the Federal Ministry of Environmental (2006).

Total Hardness: The American Society of Engineers classifies water of 0-60, 61-120, 121-180, and above 180 mg/l CaCO3 total hardness as soft, moderately hard, hard, and very hard respectively. *C. gariepinus* eggs were tolerant of both soft and moderately hard. The results of the present study on hatching of *C. gariepinus* eggs agree with Molokwu and Okpokwasili (2002) that total hardness level of 30-60 mg/l was optimal for the hatching of *C. gariepinus* egg. Total Hardness concentration throughout the study period for the three treatment ranged from 48.2mg/l to 67.2mg/l (table 1, 2 and 3) and the highest level was recorded in treatment Ndioro (67.2 mg/l) while the lowest level was obtained in treatment Umuigu (48.2mg/l). The results of the present study on hatching of *C. gariepinus* eggs agree with Molokwu and Okpokwasili (2002) that total hardness level of 30-60 mg/l was optimal for the hatching of *C. gariepinus* eggs.

Salinity**:** which is in form of chlorine is one of the major anions in water, it is known for maintenance of acid-base balance, and hence excess of it might cause edema. The presence of chloride where it does not occur naturally indicates possible water pollution. Chloride contaminates rivers and ground water and can make it unsuitable for human consumption. High level of chloride kills plants and wild life (Oboh and Edema, 2007) (Ogabiela *et al.*, 2007) (Amo and Akinbode, 2007). The value of chloride ranged from 8.10 to 12.1mg/l. These water samples would be regard as suitable for *C. gariepinus* breeding.

Conclusion and Recommendation

Groundwater borehole quality is underestimated and under-reported in which water quality parameters whose effect on the culturing of catfish *Clarias gariepinus* specie has been shown in this study. The effect of the total water quality parameters on fertilisation and hatching varies between the three treatments though they compete favourably with each other.

From the research work my results indicated that there was no significant deviation from the fetility, hatchability and survival rate production using ground borehole water from Ahuwa, Umuigu and Ndioro in the research experiment. Therefore it is recommended that any of this site ground borehole water can be used and is favorable in the culturing of African catfish *Clarias gariepinus.*

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