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Effects of Temperature on Embryonic Development Time and Yolk Absorption Period of *Oreochromis Niloticus*

Peter Gudo Ogira[1], David Liti[2], James Wanga[3]

[1]Masinde Muliro University of Science and Technology, Department of Biological Sciences, Kenya

[2,3]University of Eldoret, Department of Biological Sciences, Kenya

Abstract: ***The aim of the study was to determinate the effects of temperature on embryonic development time and yolk absorption period of Oreochromis niloticus. Water quality parameters were measured weekly and room temperature was controlled using adjustable fan heater and thermostat dipped in water. The results showed that embryonic development time varied with temperature with an inverse relationship. At a temperature range of $19^0 – 20^0$C it took six days for the eggs to hatch while the period was reduced to a half when the range was $31^0 – 32^0$C. The yolk absorption period was also inversely proportional to temperature.***

Keywords: temperature, embryonic, yolk absorption ,Oreochromis niloticus

1. Introduction

Tilapia is often cultured primarily in freshwater ponds without supplementary feeding. Research has been conducted to determine the influence monoculture and polyculture on growth tilapia nilotica and tilapia aurea in intensive culture by using low cost raw material as protein source for tilapia diets (4, 8). Nile tilapia, Oreochromis niloticus, is one of the most important fish species for aquaculture worldwide. It represents the species of choice due to its high growth rate, significant tolerance to environmental stress, ease of reproduction, and high market demand (5).

The increasing human population pressure and the ensuing land demarcation in Kenya have stimulated use of alternative farming methods and animal species in rural development efforts, which were previously ignored (15). With this, the role of aquaculture in food production, economic development and food security is increasingly becoming important in the country and the whole world. It is evident that aquaculture is currently the fastest growing segment of food production in the world. According to FAO (6), capture fisheries and aquaculture supplied the world with about 148 million tonnes of fish in the year 2010, of which about 128 million tonnes was utilized as food for people, and preliminary data for 2011 indicate increased production of 154 million tonnes, of which 131 million tonnes was destined as food. With sustained growth in fish production and improved distribution channels, world fish food supply has grown dramatically in the last five decades, with an average growth rate of 3.2 percent per year in the period 1961–2009, outpacing the increase of 1.7 percent per year in the world's population (6). However, fish consumption in Africa is still lowest relative to other parts of the world.

Effects of Temperature Fluctuation on Tilapia

In fish, the degree of tolerance to lethal temperatures is dependent upon environmental effects, history of the fish and genetic effects (2) as well as fish health and nutrition status. It has been reported for many ectotherms that animals can extend their thermal tolerance range through acclimatization and acclimation (3). In tilapia, prior acclimation temperature and rate of temperature reduction are considered important factors in determining mortality at a given temperature (17, 18). It is thought that the ability of fish to adapt to different temperatures is closely linked to the lipid composition in their muscles (10, 9). Fatty acid composition is in turn influenced by the fish's diet (11). Since it is well known that temperature can dramatically influence the structure and function of proteins and other macromolecules, temperature fluctuations as are encountered by fish in different habitats could alter sex-determination pathways and influence the probability that development would be male or female. Temperature-dependent sex determination has been extensively studied in reptiles, where exposure to elevated temperature results in female development in some species (1).

The aim of this study was to determine the Effects of temperature on embryonic development time and yolk absorption period of *Oreochromis niloticus* in order to provide a better understanding on temperature fluctuation and its effects during egg incubation period in the hatchery and yolk sac absorption time.

2. Materials and Methods

2.1 Sources of Experimental Fry

Fish were seined from Eldoret fish farm and those brooding eggs and fry were selected. The eggs and fry were transferred from the mouths into a bucket containing aerated water. The fry and eggs were then transported to the laboratory for further processing. The fry were placed in the aquarium while the eggs were incubated in incubation jars until hatching

2.2 Mini Hatchery System

Mini hatchery System consists of two – 3 litre jars fitted in two slots on a wooden board. On top of the jars was a head basin of 10 litres which supplied the jars with aerated water, through 2 cm horse pipes. Drain horse pipes were fitted to the jars near the upper brim. The inlet pipe was connected to a supply tap. A thermostat was immersed in the supply basin to regulate the water temperature to range between 31 -32^{0}C.

2.3 Experimental Set-Up

The fry were sorted into two categories according to whether they had yolk sac or not. Fry which had no yolk sac were stoked in two aquaria, each measuring 45 x 30 x 30 cm length, width and depth, respectively at a rate of 150 fry per aquarium. The yolk sac fry were stoked in four aquaria of similar size as above and also at the same stoking rate. Room temperature was maintained at 25^{0}C using fan heater. Water temperature ranged from 28 - 31^{0}C. The higher temperature of the water was due to higher specific heat capacity of water compared to air.

2.4 Water Quality

The water in the aquaria and incubation jars was monitored for various water quality parameters, which included temperature, pH, DO, salinity, TDS and Conductivity. Measurements were taken weekly using YSI 3D Interactive model Professional Multi-parameter meter. The egg development time was also determined at two temperature ranges.

3. Results

3.1 Physiochemical parameters and egg development time

The results of physicochemical parameters and egg development time are shown in Tables 1, 2.

Temperature ranged from 23.2 – 31.4^{0}C, pH ranged from 6.02 -8.58, DO ranged from 0.1 ppt, salinity ranged from 0.19 - 0.28 ppt., TDS ranged from 217.1 - 383.6 mg/l and conductivity ranged from 334.4 - 588 µS/cm. The embryonic development time varied with temperature with an inverse relationship. At a temperature range of 19^0 – 20^{0}C it took 6 days for the eggs to hatch while the period was reduced to a half when the range was 31^0 – 32^{0}C. The yolk absorption period was also inversely proportional to temperature. It took almost a half of the time to absorb the yolk when the temperature was increased by 10^{0}C from 22^{0}C to 32^{0}C.

Table 1: Physicochemical mean water quality parameter

Environmental water quality parameters					
Temperature	pH	DO	Salinity	TDS	Conductivity
28.3±3.7^{0}C	7.3±1	1.95±2mg/l	0.24±0.11ppm	300.4±3mg/l	461.2±4 µS/cm.

Table 2: Effects of temperature on embryonic development time and yolk absorption period

Hatching of eggs and yolk absorption time in the hatchery in relation to temperature		
Hatch/ Yolk Fry absorption	Days	Temperature
Embryonic development time	6	19^{0}C – 20^{0}C
	3	31^{0}C – 32^{0}C
Yolk Fry absorption	12	20^{0}C – 23^{0}C
	5	31^{0}C – 32^{0}C

4. Discussion

The results of the present study indicated that high temperature reduced the fry development rate by half. At the temperature of 19^{0}C embryonic development time was 6 days while when the temperature was increased to 31^{0}C the development time was reduced to 3 days. This observation demonstrates that temperature is an important factor in fish development. The observation is in agreement with the reports in the literature (7, 13, 14). The relationship can be used to accelerate the rate of fingerlings production by regulating temperature. This experiment also revealed that yolk fry absorption varies with temperature with high temperature leading to faster yolk absorption.

The values of physicochemical water quality parameters measured in the present study were low in the beginning of the experiment. Temperature was close to 19^{0}C, a very low value below the range of 25 – 30^{0}C, which *O. niloticus* is known to grow optimally (16). At the temperature of 19^{0}C fish were observed to be inactive and had slow response to offered diets. When temperature was increased fish became active and responded well to the feed. In the present experiment *O. niloticus* was exposed to low dissolved oxygen at 0.1 mg/l for at most six hours. This finding agrees with that of Kamal e*t al.* (12) and Yang Yi and Kwei Lin (19) who stated the lower DO limit of *O. niloticus* as 0.1 mg/l of DO. Other physicochemical water quality parameters in the current experiment occurred within the ranges which have been reported for good growth of *O. niloticus* (12).

5. Conclusion

It was found that temperature was a key factor for faster egg and fry development. To maintain faster growth and good health of *Oreochromis niloticus* egg and fry development, fry should be under controlled conditions and at optimal temperature of 31 – 32^{0}C.

6. Conflict of Interest

The authors confirmed that this article content has no conflicts of interest.

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