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Effects of Temperature Variation on Behaviour and Growth Performance of African Catfish *Clarias gariepinus*

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ABSTRACT

The effect of temperature variation on the behaviour and growth performance of *Clarias gariepinus* was studied. Temperature has both direct and indirect influence on fisheries and aquaculture. This study was set to evaluate how changes in temperature of the aquatic environment influence the behaviour and growth of *Clarias gariepinus* as one of the best aquaculture candidates especially in central and western Africa. The fish were subjected to different temperature conditions over a period of eight (8) weeks. Changes in fish behaviour were determined by careful observation of feeding behaviour as well as swimming patterns. Changes in the growth of fish were determined by measuring the weight of the fish and the standard length of the fish accordingly. The outcome of the current study reveals that temperature significantly affects the behaviour and growth performance of *Clarias gariepinus.* The effect is more significant in the weight than the length of the fish. Temperature values between 20-27 ℃ are more suitable for proper growth and well-being of *Clarias gariepinus,* any further increase in temperature above 27 ℃ causes a decline in the growth that fish species.

INTRODUCTION

African catfish (*Clarias gariepinus*), is the most desirable aquaculture species particularly in central and western Africa [1-5]. It is found predominantly in lakes, rivers, swamps, floodplains, and man-made oxidation ponds or urban sewage systems of Africa and the Middle East. The species is of major economic importance and also an important aquaculture species, thus it was introduced all over the world for farming purposes in the early 1980s. [2,6]. Temperature has both direct and indirect influence on fisheries and aquaculture[7-10]. The direct implications of temperature are on the physiology and behaviour of aquatic animals that affect growth and reproduction, mortality and distribution [11-14]. The indirect impact affects the productivity, structure and composition of the ecosystem in which the aquatic animals depend for food [10,15,16]. Changes in biophysical characteristic of the aquatic environment and frequent occurrence of extreme events (Temperature) will have significant effects on the ecosystem that support fish and aquatic animals [17-24].

Water temperature is a major factor that directly affects feed intake, metabolic rates and energy consumption of catfish [25]. At low temperatures, carbohydrates are the sources of energy while at high temperatures, proteins are the primary sources [25-27]. Temperature has a direct effect on the growth of fish [25]. However, in fish as well as other aquatic organisms, the body's physiological and biochemical process functions according to the dictates of prevailing water temperature [28]. Elevated temperature positively alters breathing rates, feed consumption, enzyme activities, oxygen consumption and feed metabolism, thereby affecting growth [29]. The growth rate will determine how fast maturity size is attained, the fecundity, recruitment into the exploitable phase of the population and ultimately influence the increase in population size [30]. The preferred temperature of fish species is indirectly measured based on their oxygen consumption rates (OCRS), these rate is related to the metabolic rates of fish and have been widely used to indicate the health of animals, as well as their overall energy expenditure or activity levels [31,32]. Therefore, this study was set to assess the effects of temperature variations on the behaviour and growth of African catfish (*Clarias gariepinus*).

MATERIALS AND METHOD

Procurement of Experimental Fish

The *Clarias gariepinus* with an average length of 23.24 cm and an average weight of 39.684 g were obtained from a fish farm in Kwadon Town, of Yamaltu Deba local government area of Gombe state and brought to the fisheries laboratory in the Department of Biological Sciences, Gombe State University for the experiment.

Acclimatization of Experimental Fish

Fish were acclaimed into laboratory condition by keeping them in a plastic aquarium containing chlorine-free tap water for 7 days before the commencement of the experiment [33]. The fish were fed using a commercial pellet (5% body weight) twice every day. Water change and replacement were done every week or when the water became turbid or lost due to evaporation and or transpiration [34].

Experimental Design

Five aquariums were used for the purpose of this experiment containing nine (9) fish each, aquarium heaters were placed at adjusted temperatures except the control where no heater was placed in it. The experiment lasted for a period of 8 weeks. Other important water quality parameters such as pH and dissolved oxygen were monitored throughout the experiment and their values fall within the accepted range for proper production of *Clarias gariepinus.*

Fish Feeding and Removal of Leftover Feed

The feed given to tested fish was commercial pellets, such as Cuppens 2 mm, and later Blue Crown 3 mm, [31], with a feeding frequency of 3 times a day, at 8:00, 12: 00, and 16: 00 oclock. Tap water was used as a medium for fish culturing. It was filtered and aerated using filters and aquarium pumps. The leftover was removed 30 min after the feeding to avoid contamination of the water environment.

Fish Anesthesia

On a weekly basis, three (3) fish from each tank were randomly and gently removed with the help of a handheld net and sedated with the use of clove oil, for at least 5 min before taking the length and the weight of the fish in order not to cause any injury to the fish.

Determination of behavioural changes and fish growth pattern

The behavioural changes were determined by making observations of their feeding behaviour and their swimming habits on a weekly basis. The growth of the fish was determined by measuring the standard length (SL) of the fish with a centimetre ruler (cm) and the weight of the fish using a weighing balance and recorded in grams (g) at weekly interval.

Data Analysis

Data were subjected to analysis of variance (ANOVA) using Graph pad Prism San Diego multiple test analysis version 6, and mean differences were analyzed using Dunnett's comparison test at a 95% confidence level.

RESULTS AND DISCUSSION

Effects of Temperature Variation on Behavioural Changes of *C. gariepinus*

The results of the effect of temperature variation on the behaviour of *C. gareipinus* are presented in **Table 1**. The Table revealed that fish in the control group, those subjected 25 °C and 27 °C, exhibit active swimming speed, active rushing for feed, higher feeding activity, resting and are aggressive, while those subjected to a higher temperature of 30 and 32 °C show signs of inactive swimming speed, inactive rushing for feed, low/less feed consumption, resting and they are not aggressive which is an indication of the effects of temperature on the behaviour of the fish.

The changes in the behaviour of fish exposed to higher temperatures observed in the present study are similar to the findings of [35], which stated that drastic fluctuation in water temperature creates many complications for fishes and adversely affects their physiology such as air-breathing, food consumption, digestion and reproduction. The food intake rate and enzyme efficiency reduced at temperatures even below 25 °C [36]. [37] also reported behavioural changes by observing the feeding activity, the fish equilibrium in the water beside the changes in the skin and fins.

Table 1. Effects of temperature on the behaviour of *Clarias gariepinus*.

Control	25 °C	27 °C	30 °C	32 °C
ASS	ASS	ASS	IASS	IASS
ARF	ARF	ARF	IARF	IARF
A	A	A	NA	NA
HFC	HFC	HFC	LFC	LFC
R	R	R	R	R

Note:
A.S.S: Active swimming speed
ARF: Active Rushing for Feed
A: Aggressiveness
HFC: Higher feeding consumption
R: Resting
I.A.S.S: Inactive swimming speed
I.A.R.F: Inactive rushing for feed
L.F.C: Less/low feed consumption
NA: Not aggressive

Effects of Temperature Variation on Growth Performance of *C. gariepinus*

The growth performance in terms of weight of *C. gariepinus* is presented in **Fig. 1**. The results of the weight of *Clarias gariepinus* (Figure 1a) indicated no significant difference ($p<0.05$) between the fish subjected to 25 and 27 ℃ respectively. Whereas a significant difference ($p<0.05$) existed between fish subjected to 25 and 27 ℃ when compared with those subjected to 30 and 32 ℃. This is an indication that increased temperature affects the growth performance of *Clarias gariepinus.* On the other hand, only fish subjected to 32℃ indicated variation in length (**Fig. 2**) compared to the other fish groups (25, 27 and 30 ℃) which is an indication that temperature variation slightly affects the length of *Clarias gariepinus.*

The findings of this study on the effects of temperature variation on the growth of *Clarias gariepinus* agree with the findings of [35] who reported an increase in the growth pattern in farm fishes but at high temperatures, a decline in growth was recorded.

It was also reported by many researchers such as [38-40]; who reported that best growth is obtained when water temperature ranges between 23 and 30 °C. In another experiment, [1] reported that 25 to 28 °C is a suitable temperature range appropriate for proper growth and well-being of *Clarias gariepinus.*

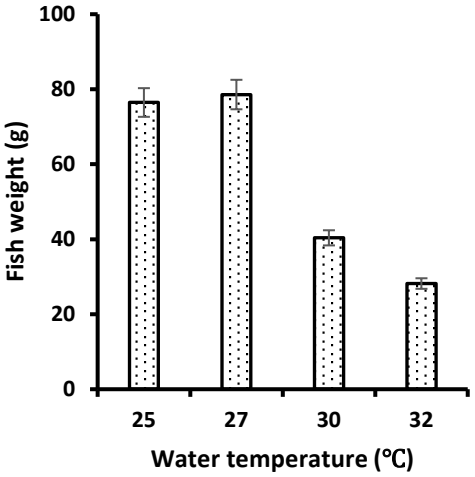

Fig. 1. Effects of temperature variation on growth performance of *C. gariepinus* measured as fish weight.

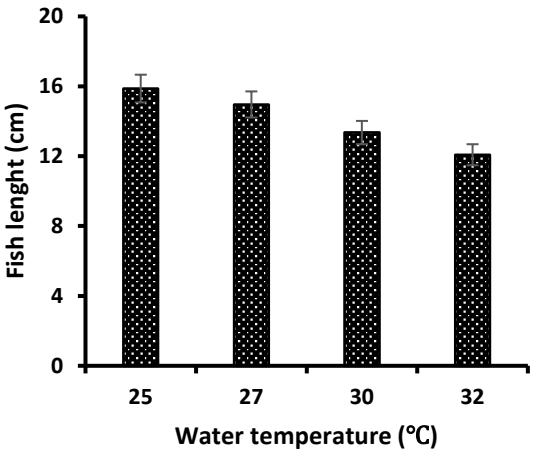

Fig. 2. Effects of temperature variation on growth performance of *C. gariepinus* measured as fish length.

CONCLUSION

Temperature variation significantly affects the behaviour and growth performance of *Clarias garieepinus*. The temperature ranges between 20 and 28 ℃ is suitable for proper growth and wellbeing of most tropical fishes including *Clarias garieepinus*. Any increase in temperature above 30 ℃ is not suitable though does not cause mortality but negatively affect the behaviour and growth performance of *Clarias garieepinus*.

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