

THE HAEMATOLOGICAL RESPONSE OF *CLARIAS GARIEPINUS* TO CHANGES IN ACCLIMATION TEMPERATURE

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The effect of different acclimation temperatures on physiological parameters of Clarias gariepinus over a period of eight weeks was assessed. Thirty-two fishes weighing approximately 400.0±5.0g were divided into four groups (A-D) of eight fish each, based on the water temperature to which they were subjected: Group A (29±1°C) was the control while groups B (23±1°C), C (35±1°C) and D (41±1°C) were the test groups. Haematological and biochemical parameters were considered after eight weeks. The result showed that there was no significant difference (at p<0.05) in the values at 23±1°C, 35±1°C and 41±1°C, except for haematocrit (Ht), haemoglobin (Hb) and total plasma protein (TPP) values, which were significantly different at 23±1°C and 41±1°C relative to the control (29±1°C). The implication of temperature fluctuation of aquatic ecosystem on flora and fauna is discussed in the text.

Key Words: Acclimation, Temperature, Hematological, Response, *Clarias Gariepinus*,

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INTRODUCTION

Fish live in very intimate contact with their environment, and are therefore very susceptible to physical and chemical changes which may be reflected in their blood components (Wilson and Taylor, 1993).

Temperature of aquatic environment is important for ensuring survival, distribution and normal metabolism of fish, failure to adapt to temperature fluctuations is generally ascribed to the inability of fish to respond physiologically with resultant mortality, which is related to changes in the metabolic pathways (Forghally *et al*, 1973). The result is a collapse in osmoregulatory functions during temperature extremes (Smith *et al*, 1981, Stouthart *et al*, 1996, Gubbins *et al*, 2000). The normal range of temperature in the tropics to which fish are adapted is 22-35°C (Blaxhall, 1972, Smith *et al*, 1981, Howerton, 2001). In three salmonids studied by Rijzhkor (1976), oxygen consumption fell at 20-25°C or about 7°C above the acclimation temp. Also, Korovin, 1976, Wilson and

Taylor, 1993 observed this phenomenon in common carp (*Cyprinus carpio*) at 28-32°C. Further studies was carried out on *L. lichenskie* by Hillbricht-Ilkowska *et al*, 1970 which showed that phytoplankton production decreased when flow of heated water to it almost doubled out in moderately affected neighbouring lakes, it is increased by about 30%. Also, *Sarotherodon mosambicus*, *Cyprinus carpio* and *Salmo gairdneri* were acclimatized at temperatures of 15, 20 and 25°C in order to study physiological responses of blood to temperature fluctuations in the laboratory. *Cyprinus carpio* exhibited the greater ability to survive at these temperatures. *Sarotherodon mosambicus* experienced osmoregulatory collapse at 15°C, which also occurred in trout at 25°C. This was associated with acid-base malfunction in the trout Connors *et al*. (1978).

This present work is a report of our findings of the changes in haematological and biochemical parameters during

temperature fluctuations in *Clarias gariepinus*.

MATERIALS AND METHODS

Thirty-two apparently healthy *Clarias gariepinus* fish of both sexes weighing approximately 400.0±5.0g each were purchased from a commercial fishpond in Ibadan and were acclimatized in the laboratory for a week at 29±1°C. They were thereafter divided into a sample size of eight each and grouped as A (29±1°C) which is also the control, B (23±1°C), C (35±1°C) and D (41±1°C). The different groups were kept in thermostat controlled water baths and mercury-in-glass thermometer was used to monitor the temperature for eight weeks.

The fish were then bled from the ventral region near the anal opening using plastic disposable syringes containing 4mg/ml heparin in four replicates. Blood pH, bicarbonate ion (HCO₃⁻), haematocrit (Ht), haemoglobin (Hb), red blood cell (RBC), total plasma protein (TPP), sodium ion (Na⁺), chloride ion (Cl⁻), potassium ion (K⁺), blood glucose, mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), mean corpuscular volume (MCV) and osmolality (OSM) were determined as described by Jain, 1986. The results

were subjected to statistical analysis to assess the effect of temperature on the fish samples, the response of the blood parameters to the varying temperature Mean (M), standard deviation (SD), standard error of mean (SE), the range of the analysis of variance (ANOVA) were calculated.

RESULTS

The haematological and biochemical values of *Clarias gariepinus* at 23±1°C, 29±1°C, 35±1°C and 41±1°C are listed on Tables 1 and 2 respectively.

Using 29±1°C as the baseline temperature as it corresponds to the temperature of the natural habitat of *Clarias gariepinus*, the statistical analysis showed that there was no significant difference (at p<0.05) in the physiological response of the fish at the various temperature levels for HCO₃⁻, Na⁺, K⁺ Cl⁻ and osmolality for the biochemical analysis and RBC, MCH, MCV, glucose level for the haematological analysis. However, at 23±1°C and 41±1°C there was a significant difference (at p<0.05) in Ht, Hb and TPP values when compared with the control (29±1°C). There was therefore no significant difference in the values obtained at 35±1°C in both the haematological and biochemical parameters relative to the control.

TABLE 1:
Hematological Values for *Clarias Gariepinus* at 23°C, 29°C, 35°C and 41°C Temperatures

Parameters	23°C± 1 °C	29°C± 1 °C	35°C± 1 °C	41°C± 1 °C
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
PCV (%)	29 ± 0.00	27 ± 2.18	40 ± 1.93	25 ± 1.93
Haemoglobin (mg%)	4.5 ± 0.77	5.4 ± 0.69	5.51 ± 0.43	2.28 ± 0.05
RBC (x10 ⁶ /mm ³)	1.5 ± 0.24	2.2 ± 0.47	2.30 ± 0.27	1.25 ± 0.07
MCV	193 ± 23.3	168.0 ± 31.3	174 ± 15.54	202.17 ± 13.42
MCH	30 ± 6.48	24.7 ± 3.59	24 ± 1.09	18.24 ± 119
MCHC	15.5 ± 1.32	14.9 ± 1.92	13.83 ± 2.43	9.23 ± 0.85
GLUCOSE (mg%)	98 ± 12.3	74 ± 1.25	93 ± 18.64	75 ± 0.92
Total plasma protein (mg%)	3.8 ± 0.11	6.1 ± 0.09	5.90 ± 0.12	4.90 ± 0.43

TABLE 2:
Biochemical values for *Clarias gariepinus* at 23°C, 29°C, 35°C and 41°C

Parameters	23°C± 1 °C			29°C± 1 °C			35°C± 1 °C			41°C± 1 °C		
	Mean	SD	SE	Mean	SD	SE	Mean	SD	SE	Mean	SD	SE
HCO ₃	18	2.90	1.44	19	1.15	0.58	20	1.26	0.68	19	1.29	0.65
Na ⁺	120	5.54	2.73	128	3.20	0.80	126	8.39	4.20	122	3.65	1.83
K ⁺	4.2	0.45	0.23	4.30	1.52	0.76	3.90	0.66	0.33	4.00	0.26	0.13
Cl ⁻	89	7.80	3.90	99	1.29	0.65	98	4.08	0.24	92	5.32	2.66
Osm.	332.8	30.62	15.21	325.8	7.00	3.50	343.9	26.02	13.01	314.9	6.53	3.27

DISCUSSION

Acclimation is the sum total of the adjustments, which fish make to long-term changes in their environment. The changes are most frequently thought of in terms of seasonal or other temperature changes but can also occur in response to changes in oxygen level, salinity or other environmental factors. The changes are complex mixtures of adjustment in hormones, metabolic pathways, enzymes and behaviour, which occur at all functional levels from the molecular and cellular to the whole organism and population. Temperature has a profound effect on chemical and biological processes. As chemical and biological reaction rates double for every 10°C increase in temperature, the metabolic activity of aquatic organisms also increases and animals uses twice as much oxygen (Howerton, 2001)

The result of this investigation showed a decrease in haematocrit (Ht), haemoglobin (Hb) and total plasma protein (TPP) at 23+1°C and 41+1°C relative to control (29+1°C). It is well known that a reduced quantity and quality of erythrocytes and a decreased haemoglobin level lead to a deteriorated oxygen supply. In addition to the transport of oxygen, erythrocytes have other functional tasks in the body, an insufficient quantity and quality of red cells would therefore consequently have several additional effects on metabolism beyond the simple oxygen supply for tissue metabolism, decrease TPP has also been reported to be suggestive of malabsorption (Gross *et al*, 1996). The highest blood glucose level however was observed at 23+1°C and high blood glucose levels at low temperatures is

indicative of retarded metabolism, and is also an index of sub-lethal stress (Hattingh, 1976, Connors *et al*, 1978, Best *et al*, 2001).

The HCO₃⁻, Na⁺, K⁺, Cl⁻ and osmolality were temperature independent, this is an indication that *Clarias gariepinus* seems to have the ability to conserve osmolality over a wide and/or higher temperature range. According to Smith *et al* (1981), osmolality values remained relatively stable in carp at all temperatures, whereas in *S. mossambicus* a wide span was observed at 15°C and at 25°C in trout. There was no significant difference in the Ht, Hb and TPP at 35+1°C. The MCV, MCH, MCHC were temperature independent. It can therefore be concluded that *Clarias gariepinus* has a high adaptive ability.

However, it should be noted that fish differ in their tolerance to extremes in temperature depending on the species involved, stage of development, environmental temperature dissolved oxygen (D.O.), pollution, season and extent to which the environment is heated and that temperature fluctuations affects feeding rate, spawning, D.O. uptake, pH level and other water quality parameters which would then affect the well-being of the fish. When water is highly heated, much energy, oxygen and vapour is released into the air, leaving behind a high concentration of CO₂, which makes the water more acidic. Wastewater therefore has a high acidity (pH 1.6-1.8) and this renders it especially harmful to fish. The temperature of water had a direct influence on the toxicity of many pollutants and on the growth of microorganism. Temperature of inland water fluctuates with industrial use.

It is therefore recommended that the temperature of effluents disposed into our water bodies from the industrial sectors be regulated and properly monitored since the resultant temperature fluctuation can completely destroy the entire flora and fauna in extreme cases.

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Received: April 2002

Accepted: December 2002