Chronic Effects of Different Temperature in the Blood Parameters of Common Carp (Cyprinus carpio)

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Abstract—The common carp (Cyprinus carpio) is an important species for rearing in temperate climate in Iran. Temperature is an important factor which effected immunology response in fishes. Blood factors changed by different temperatures in fishes. The effect of different water temperatures (22 °C control), (15, 25 and 32 °C) on hematological parameters in blood of 24 fishes mean weight 100±11gr and mean length 21/5±1cm was investigated in this species following chronic (21 days) exposure. Red blood cell level increased at 25 °C and decreased at 15 °C when compared to control and had significant different. Hemoglobin, hematocrit, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) in RBC were changed at 21 days. In chronic experiment the number of WBC level increased at 32 °C and decreased at 15 °C when compared to control. Taken together, these results suggest that temperature and time of exposure influence blood parameters of cyprinus carpio.

Keywords: Fish; Temperature; Blood; Common carp

I. INTRODUCTION

Temperature is known to affect the functional immunology response in ectothermic animals like fishes. Both the habitat and a change of temperature can influence the catalytic properties of enzymes [7]. However, the adaptability of fishes and their ability to exhibit normal activity at extremes of temperature suggest that cellular processes may be maintained at appropriate levels following a period of thermal acclimation or adaptation [5]. In ectothermic organisms, physiological rates can be adjusted to compensate for some changes in temperature. In fish, thermal acclimation is generally determined by blood parameters changes, during which an initial period of thermal stress is followed by a gradual compensation. When a stable blood parameters level that is consistent between the old and new thermal state is reached, the animal is considered to be fully acclimated [8]. Hematological parameters are increasingly used as indicators of the physiological stress response to endogenous or exogenous changes in fish [1]. In Iran, there is interest in the aquaculture of fish species that can survive and grow fast in the warm water. The common carp (Cyprinus carpio) have such characteristics [6]. However, questions on the hematological traits of the species and its ability to cope with environmental stressors have received little attention. Moreover, data on comparison and selection of species based on their biochemical potential are still lacking. Effects of three different temperatures during a acute treatment on the blood parameters of the freshwater fish Cyprinus carpio were studied to investigate the ability of this species to cope with temperature stress. The range of temperatures selected in these trials was based on the environmental temperatures which the common carp encounters in Iran. The questions posed in this study were: (i) Is thermal shock equally effective as long-term exposures? (ii) Is cold shock as stressful as heat shock? (iii) Are the blood parameters changes, observed under temperature variations, a relevant tool to evaluate stress? This is a primary study to assess the thermal biochemical responses of Cyprinus carpio for future biological comparisons.
II. MATERIALS AND METHODS

A. Fish

Common carp *Cyprinus carpio* obtained from a local fish farm were maintained in 100-l tanks with constantly aerated water for 7 days at a constant temperature of 22±0.4 °C. The animals were fed commercial fish food (GFC) daily to avoid the accumulation of food residues in the tanks.

B. Experimental procedure

Twenty-four common carp (body weight 100±11 g; length 21.5±1 cm; n=6 mean±S.E.M.) were distributed evenly among four 100-l continuously aerated tanks. These were static systems cleaned by suction daily, where approximately 10% of the water in the tanks was replaced daily. The temperature was then changed over a period of 6–7 days to the target temperature of 15, 25 or 32 °C, whereas the control group was kept at 22 °C. The fish were maintained at these four temperatures for 3 weeks and then sampled[2]. Consequently the chosen temperatures were nonlethal but close to the thermal limits of this species.

C. Water quality

DO₂, pH and temperature were monitored daily. Hardness and alkalinity were measured weekly according to standard methods for analysis of waste water [2], and total ammonia nitrogen (TAN), un-ionized ammonia-N and nitrite were not changed by the different temperatures.

D. Blood component analysis

Blood samples were quickly collected from the caudal vein of serially netted and manually immobilized common carp without anesthesia. Blood was collected with heparinized syringes and plasma was obtained after centrifugation at 5400×g for 10 min and stored at -20 °C for subsequent analysis. The percentage of hematocrit and hemoglobin concentration (g/dl) was determined in whole blood.

E. Statistical analysis

All statistical analyses were carried out using the spss Instat program (spss software, version 9–2006). Data for water quality, hematocrit, hemoglobin, obtained in each experiment were tested for significant differences by one-way analysis of variance followed by the Tukey Kramer test. P values <0.05 were considered to be significant.

III. RESULTS

The water quality parameters (DO₂, pH, hardness, alkalinity, total ammonia nitrogen un-ionized ammonia-N and nitrite) were not changed by the different temperatures (data not shown). Red blood cell level increased at 25 °C and decreased at 15 °C when compared to control and had significant different. Hemoglobin there was significant(p<0.05) increased at 32 °C compared to control. Mean corpuscular volume value was significant(p<0.05) increased at 32 °C compared to control. Mean corpuscular hemoglobin value was significant(p<0.05) increased at 15 °C compared to control. Mean corpuscular hemoglobin concentration value was significant(p<0.05) decreased at 32 °C compared to control. Hematocrit was not to differ significantly(p>0.05) at 21 days (Table1). Hematological Red Blood Cell data for fish exposed to different temperature for 21 days. White blood cell level was significant(p<0.05) increased at 32 °C when compared to control (Table2).

IV. CONCLUSION

Water temperature significantly affects some physiological fish processes such as growth and metabolism. Nonoptimal water temperature, insufficient food and low dietary protein have been found to inhibit fish growth [4]. Hematological indices are of different sensitivity to various environmental factors and chemicals [14]. Hematological studies, although not often used in fish medicine, can provide substantial diagnostic information. Studies have shown that when the water quality is affected by different temperature, any physiological changes will be reflected in the values of one or more of hematological parameters [15]. On the basis of hematological studies, it would be possible to predict the physiological state of fish in natural water bodies. Hematology studies in teleosts have indicated that hematocrit values might be useful as a general indicator of fish health, since fish given iron deficient diets, or those exhibiting anaemia, all possess reduced hematocrit (HCT) values [13]. Previous hematological studies of nutritional effects [9], infectious diseases [10] and pollutants [11] brought knowledge that erythrocytes are a major and reliable indicator of various sources of stress [12]. As shown in Table 1, hematocrit concentrations were not altered by the different water temperatures. The values detected in our experiment are in agreement with those found by Houston et al (1974) who studied hematologic characteristics *Cyprinus carpio*. The result of experiment shown with increased a temperature rbc level increased. When increased temperature activity of oxygen absorbing by rbc reducing, thus body for compensation with this reduced, increased number of rbc in blood. Thus mcv level reduced in blood. Hb level connected with number of rbc. When the number of rbc increased, hb level increased. The number of wbc one of the important indicator of healthy or disease in fishes. When increased temperature the number of wbc increased in blood.

This fact attests good tolerance of the species to this range of temperature variation. This result plus the observed hematological responses indicate that the range of temperature employed in these experiments act as a stressor. The present results demonstrate that common carp show the classical stress response either to cold or heat shock. However, despite the lack of change in hematological values with temperature, the metabolic responses were distinct. Cold shock was more stressful to common carp than heat shock. We can conclude that the present set of data can partially explain the ability of *Cyprinus carpio* to resist a wide range of environmental temperatures.
### TABLE 1. Hematological Red Blood Cell Data for Fish Exposed to Different Temperature for 21 Days

<table>
<thead>
<tr>
<th>Temperature</th>
<th>22°C (control)</th>
<th>15°C</th>
<th>25°C</th>
<th>32°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC × 10^9/ (mm³)</td>
<td>155 ± 4.08</td>
<td>146 ± 13.08*</td>
<td>181 ± 3.62*</td>
<td>169 ± 3.31*</td>
</tr>
<tr>
<td>HCT (%)</td>
<td>21.6 ± 0.52</td>
<td>23.9 ± 0.81</td>
<td>27.3 ± 1.21*</td>
<td>27.9 ± 0.58*</td>
</tr>
<tr>
<td>Hb (gr/dl)</td>
<td>7.7 ± 0.56</td>
<td>8.4 ± 0.67</td>
<td>10 ± 0.79*</td>
<td>8.7 ± 0.5</td>
</tr>
<tr>
<td>MCV (fl)</td>
<td>139.1 ± 2.12</td>
<td>163.4 ± 1.46*</td>
<td>150.8 ± 1.17</td>
<td>164.9 ± 0.7*</td>
</tr>
<tr>
<td>MCH (pg)</td>
<td>49.7 ± 0.81</td>
<td>57.5 ± 1.38*</td>
<td>55.2 ± 0.65*</td>
<td>51.5 ± 0.74*</td>
</tr>
<tr>
<td>MCHC (%)</td>
<td>35.6 ± 0.52</td>
<td>35.1 ± 0.37</td>
<td>36.6 ± 1.16</td>
<td>31.2 ± 0.9*</td>
</tr>
</tbody>
</table>

The values represent the mean ± S.E.M. (n=6).

* *p<0.05 compared to control.

### TABLE 2. Hematological White Blood Cell Data for Fish Exposed to Different Temperature for 21 Days

<table>
<thead>
<tr>
<th>Temperature</th>
<th>22°C (control)</th>
<th>15°C</th>
<th>25°C</th>
<th>32°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC × 10^3 / (mm³)</td>
<td>14.56 ± 0.3</td>
<td>14.30 ± 0.4</td>
<td>14.45 ± 0.6</td>
<td>14.74 ± 0.2</td>
</tr>
<tr>
<td>Lym/ (mm³)</td>
<td>84 ± 2.8</td>
<td>88 ± 4.8</td>
<td>78 ± 4.2</td>
<td>80 ± 2</td>
</tr>
<tr>
<td>Mon/ (mm³)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Neu/ (mm³)</td>
<td>14 ± 1.7</td>
<td>12 ± 1.7</td>
<td>22 ± 1.7*</td>
<td>18 ± 1.26*</td>
</tr>
<tr>
<td>Eso/ (mm³)</td>
<td>2 ± 0.66</td>
<td>-</td>
<td>-</td>
<td>2 ± 0.66</td>
</tr>
</tbody>
</table>

The values represent the mean ± S.E.M. (n=6).

* *p<0.05 compared to control.

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