EFFECT OF STARVATION ON THE BODY TISSUES OF A FRESHWATER TELEOST, CHANNA PUNCTATUS

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KEYWORDS

Starvation
Body tissues
Freshwater
Teleost
Effects of complete and restricted starvation, for 20 and 40 days, were observed on certain biochemical constituents of the body tissues of male *Channa punctatus*. After 20 days of starvation cholesterol levels of muscle, liver and gonad showed a significant decrease (range: 5.75±0.02 to 9.86±0.01 mg/g) as compared to that of control animals (range: 7.60±0.01 to 14.36±0.03 mg/g). Blood cholesterol of starved fish were also found to be significantly reduced (control: 312.95±0.63, test: 176.43±0.59 mg/100mL). Protein levels of fish, under starvation, indicated significant decline in liver, muscle and gonad (control: 121.0±0.29 to 161.22±0.48, test: 70.93±0.38 to 150.62±0.24 mg/g). In case of plasma protein, significant reduction was noted after 40 days. Starvation resulted in significant drop in liver and muscle glycogen (8.13±0.04 to 60.09±0.29 mg/g) as compared to control fish (13.31±0.12 to 97.79±0.41 mg/g) just after 20 days. Blood glucose was also found to be significantly lower in starved fish (64.87±0.16 mg/100mL) than control (99.45±0.15 mg/100mL). Significant decrease in gonad glycogen was recorded only after 40 days. The results suggest a significant effect of starvation, in causing reduction of the biochemical parameters studied in the body tissues of *Channa punctatus*, under the present conditions.

INTRODUCTION

Starvation produces pronounced effects on the body tissues of various classes of animals including man (Kirian and Talesara, 1985; Baqui *et al.*, 1993; Borah and Yadav, 1996). Sometimes fishes experience absence of food under natural conditions due to various factors like changes in food availability, spawning preparation, spawning migration or may be due to changes in the temperature of water. Infact many, if not all, species of fish are naturally exposed to short or long periods of starvation. This produces significant effects on the body tissues (Deng *et al.*, 1993). Effects of starvation on nutrient depletion in various tissues of fish may be different (Hung *et al.*, 1997). In case of fishes, diet restriction may affect the sexual maturation and thereby the reproductive capacity of the animal. The effects of starvation on the gonads of fishes have been comparatively less studied. Short term effects of starvation have been studied in certain fishes (Kiessling *et al.*, 1993; Tripathi and Verma, 2003). There is paucity of information on prolonged effects of starvation on tissues of *Channa punctatus*. Therefore, the objective of the present study was to observe the effects of complete and restricted starvation conditions on the male gonads and other body tissues like liver, muscle and blood of a freshwater teleost, *Channa punctatus*.

MATERIALS AND METHODS

Male freshwater fish, *Channa punctatus*, weighing 50 - 60 grams were caught from local ponds with the help of fishermen. They were brought to laboratory and acclimatized in aquarium containing tap water for two weeks before starting the experiment. They were given food consisting of wheat flour pellets and minced goat liver. Aquaria were cleaned and the water changed daily. The fishes were then divided into the following three groups of twenty animals each.

**Group I:** Fishes were subjected to a condition of complete starvation (No food)

**Group II:** Fishes were fed on alternate day (Restricted food)

**Group III:** Fishes were fed daily (full food)

Animals of Group III served as control for Groups I and II. Ten fishes from each group were sacrificed on day 20 and 40 of the start of experiment. Blood was collected and processed for estimation of protein (Varley, 1980), cholesterol (Sackett, 1925) and glucose level (Asatoor and King, 1954). Gonad, liver and muscle were removed, weighed on a microelectrical balance and processed separately for the biochemical estimation of total protein content (Lowry *et al.*, 1951), cholesterol level (Sackett, 1925) and glycogen content (Kemp and Heijningen). The data was analysed statistically with the help of Student’s t test.

RESULTS

Results are presented in Tables 1 to 3. Complete and restricted starvation significantly reduced the total protein content of gonad, liver and muscle after 20 and 40 days whereas plasma protein level showed a significant reduction after 40 days (Table
The cholesterol levels of all tissues were significantly lower in animals exposed to complete and restricted starvation for 20 as well as 40 days as compared to that of control animals receiving full food (Table 2). The glycojen content of liver and muscle and blood glucose level showed a significant reduction in animals under complete and restricted conditions of starvation as compared to controls after 20 and 40 days. A significant reduction in gonad glycogen level was noted only after 40 days of complete and restricted starvation (Table 3).

**DISCUSSION**

Quantity of food plays an important role in the body functions of the animal. Most fishes experience absence of food every year of their lives and, therefore, they must be well adapted to mobilize the body constituents as fuel for survival. During starvation the body thrives on its own component tissues for mobilize the body constituents as fuel for survival. During starvation the different organs are not depleted at the same rate. Some organs may show an initial rise in the growth and its biochemical constituents (Creach and Cournede, 1965). A loss in weight of the testes but an increase in the size of maturing ovaries during the first few weeks of starvation has been reported in C. carpio (Creach and Cournede, 1965). However, in the present study a depletion of the biochemical constituents was observed. The present investigation also indicated a significant depletion of protein in the gonads, liver and muscle just after 20 days whereas in the case of plasma protein it was noticed that complete and restricted starvation could cause no significant change after 20 days. Only after starvation period of 40 days a significant drop in plasma protein was exhibited. This finding showed that there is a slow depletion of plasma protein after starvation of the fish. Previous studies have shown a reduction in the blood serum protein in S. canicula after 15 days of starvation (Cordier and Brandon, 1957). The blood protein of Salmo trutta changed after 30 days, whereas in Cyprinus carpio a period of six months was needed to produce a change. Starvation for 52 days resulted in a decrease in blood protein content of male and female Antarctic fish, N. coriceps (Stepanowska et al., 2006) significant reductions in plasma glucose and lipid, but not protein, have been observed in sturgeon starved for ten weeks (Hug et al., 1997). Starvation decreases the synthesis of liver protein and RNA (Howard et al., 1986). Protein levels in different body tissues of different animals have been measured after starvation (Kiran and Talesara, 1985). Starvation leads to enzymatic changes in tissues of various fish (Borah and Yadav, 1996; Soundarapandan et al., 1997; Tripathi and Verma, 2003). Glycolytic enzymes in skeletal muscle of barred sand bass showed changes in response to starvation. The present results indicate starvation induced decline in protein levels of different tissues of C. punctatus. This may be associated with decline in metabolic enzymes. It is also evident from the results that duration of starvation is an important factor for protein depletion in this fish. Starvation led to a significant depletion in the cholesterol content of all the tissues just after 20 days. It can be suggested that these tissues contribute maximum cholesterol as is evident from the decrease in their levels after complete and restricted starvation conditions. Previous studies have also indicated depletion of cholesterol content during

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**Table 1:** Effect of complete starvation (CS) and restricted starvation (RS) on the protein content of gonad, liver, muscle (mg/g wet wt.) and plasma (mg/100mL) of male C. punctatus

<table>
<thead>
<tr>
<th>Days</th>
<th>Full food</th>
<th>C.S.</th>
<th>R.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gonad</td>
<td>121.0 ± 0.29</td>
<td>121.70 ± 0.27</td>
<td>102.14 ± 0.59</td>
</tr>
<tr>
<td>Liver</td>
<td>161.05 ± 0.49</td>
<td>161.22 ± 0.48</td>
<td>149.82 ± 0.31</td>
</tr>
<tr>
<td>Muscle</td>
<td>144.56 ± 0.51</td>
<td>144.30 ± 0.39</td>
<td>105.33 ± 0.32</td>
</tr>
<tr>
<td>Plasma</td>
<td>7.21 ± 0.01</td>
<td>7.21 ± 0.01</td>
<td>7.20 ± 0.01</td>
</tr>
</tbody>
</table>

Significance of difference from control: *, p < 0.001

**Table 2:** Effect of complete starvation (CS) and restricted starvation (RS) on the cholesterol content of gonad, liver, muscle (mg/g wet wt.) and blood (mg/100mL) of male C. punctatus

<table>
<thead>
<tr>
<th>Days</th>
<th>Full food</th>
<th>C.S.</th>
<th>R.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gonad</td>
<td>14.36 ± 0.03</td>
<td>14.34 ± 0.05</td>
<td>9.22 ± 0.01</td>
</tr>
<tr>
<td>Liver</td>
<td>29.93 ± 0.22</td>
<td>48.45 ± 0.37</td>
<td>11.05 ± 0.27</td>
</tr>
<tr>
<td>Muscle</td>
<td>7.60 ± 0.01</td>
<td>7.46 ± 0.03</td>
<td>4.99 ± 0.01</td>
</tr>
<tr>
<td>Blood</td>
<td>312.95 ± 0.63</td>
<td>312.88 ± 0.48</td>
<td>152.18 ± 0.68</td>
</tr>
</tbody>
</table>

Significance of difference from control: *, p < 0.001

**Table 3:** Effect of complete starvation (CS) and restricted starvation (RS) on the glycogen content of gonad, liver, muscle (mg/g wet wt.) and blood (mg/100mL) of male C. punctatus

<table>
<thead>
<tr>
<th>Days</th>
<th>Full food</th>
<th>C.S.</th>
<th>R.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gonad</td>
<td>13.63 ± 0.14</td>
<td>13.53 ± 0.15</td>
<td>13.63 ± 0.10</td>
</tr>
<tr>
<td>Liver</td>
<td>97.79 ± 0.41</td>
<td>97.70 ± 0.37</td>
<td>45.90 ± 0.21</td>
</tr>
<tr>
<td>Muscle</td>
<td>13.31 ± 0.12</td>
<td>13.42 ± 0.08</td>
<td>8.13 ± 0.04</td>
</tr>
<tr>
<td>Blood</td>
<td>99.45 ± 0.15</td>
<td>99.34 ± 0.13</td>
<td>64.87 ± 0.16</td>
</tr>
</tbody>
</table>

Significance of difference from control: *, p < 0.001
starvation (Idler and Bitners, 1958). Starvation effects have been reported on the lipid contents of thoracic muscles of blowflies, Lucilia cuprina and also on the secretion of thyroid hormone and corticoids (Tang et al., 1983; Wu et al., 1984). Lipid losses have been shown to occur in rainbow trout and in white sturgeon (Hung et al., 1997). Carbohydrate metabolism during starvation has been studied. During food restriction glycogen is broken to glucose which is supplied through blood to needy organs. Glucose may be produced from glycogen stored in liver or through other tissues like muscles, gonad and brain. In the present study the highest level of glycogen was found to be present in the liver. Starvation led to a significant decrease in glycogen level of all tissues just after 20 days except in gonad where the reduction was evident only after 40 days. Thus, glycogen depletion occurred earlier in the case of liver and muscle as compared to gonad. This suggests that liver glycogen is a readily available nutrient reserve and is mobilized in the first three weeks of starvation. Large reduction of liver glycogen has been observed in just two weeks of starvation in Acipenser transmontanus (Hung et al., 1997). Starvation reduces glycogen levels in livers of Salmo gairdneri (Hochachka and Sinclair, 1662). The rate of muscle glycogen depletion was found to be lower than that in liver (Inui and Oshima, 1966). After the glycogen stores of liver and muscle had dropped down the store of gonad glycogen started falling. Starvation has been reported to have a profound influence on the glucose metabolism and glucose transport in skeletal muscles, ileum and brain (Debnam and Sharp, 1993). In the present animal blood glucose level of the starving fishes was maintained after starvation. It may fall during the first week and then remain constant. (Kamra, 1966). A small reduction (10%) in plasma occurs in the first two days of starvation of sturgeon (Hung, 1991). The results of this study indicate that during starvation the present fish readily utilizes the body constituents for its survival.

REFERENCES


