EFFECT OF STARVATION AND REFEEDING ON RED MUSCLE
ORGANIC CONSTITUENTS OF TILAPIA MOSSAMBICA (PETERS)

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ABSTRACT

Short-term starvation and refeeding caused slight depletion in total proteins, total carbohydrates and total lipids. But the long-term starvation and refeeding recorded increase in the carbohydrate content, with marked depletion in the total protein and lipid contents, particularly the cholesterol, indicating overshoot accumulation of carbohydrates in the tissue. The process of starvation and refeeding seems to decrease effectively the cholesterol content in the muscle.

The effect of long-term starvation on the branchial tissue glycosis of the fish Tilapia mossambica has been described by Bhaskar Haranath et al (1983). As the red muscle of the fish form an important site of organic reserves and as starvation involves mobilization of organic substances, the changes in the organic constituents of red muscle during short-term and long-term starvation and refeeding are described in this note. Since younger fishes are known to possess higher resistance to stress conditions, only the younger ones, of 8 ± 1 g, have been selected.

The fishes after acclimatization were divided into 3 batches of 20 each. The first batch, which formed the control, was fed regularly with a mixture of groundnut cake, wheat flour and rice bran, while the other two batches were kept starved for 5 days and 30 days respectively for the short-term and long-term experiments. The red muscle was isolated, chilled in ice chamber and taken for experimentation.

Total proteins (Lowry et al 1951), total carbohydrates (Carroll et al 1951), total lipids (Folch et al 1957), phospholipids (Zilversmit and Davis 1950), cholesterol and triglycerides (Natelson 1971) and glycerol (Colowick and Kaplan 1957) were estimated as per the methods respectively given in parantheses. Dry matter and water content were estimated gravimetrically.

During short-term starvation, the dry weight of red muscle recorded nonsignificant change from the control, with considerable depletion in water content, indicating the tissue osmotic derangement.
Table 1. The different variables as observed on the starvations and refeeding in *Tilapia mossambica*. Each value is the mean of 8 individual observations with the Standard deviation. (P = significant; NS = nonsignificant.)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Control</th>
<th>Starved</th>
<th>Short term</th>
<th>Refed</th>
<th>Starved</th>
<th>Long term</th>
<th>Refed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry weight (mg/g wet wt)</td>
<td>200.65 ±14.5</td>
<td>212.02 ±7.93</td>
<td>211.55 ±7.86</td>
<td>164.72 ±6.59</td>
<td>216.95 ±14.83</td>
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<tr>
<td>Water content (% )</td>
<td>79.93 ±1.45</td>
<td>78.22 ±0.86</td>
<td>78.83 ±0.78</td>
<td>83.53 ±1.94</td>
<td>78.3 ±1.48</td>
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<tr>
<td>Total proteins (mg/g wet wt)</td>
<td>144.2 ±3.97</td>
<td>122.34 ±2.21</td>
<td>132.13 ±2.11</td>
<td>82.78 ±3.64</td>
<td>123.54 ±1.47</td>
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<tr>
<td>Total carbohydrates (mg/g wet wt)</td>
<td>+4.6 ±0.34</td>
<td>+4.09 ±0.15</td>
<td>+4.15 ±0.15</td>
<td>+2.04 ±0.15</td>
<td>+6.0 ±0.39</td>
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<tr>
<td>Total lipids (mg/g dry wt)</td>
<td>88.81 ±3.11</td>
<td>77.79 ±3.7</td>
<td>83.44 ±8.44</td>
<td>42.57 ±2.64</td>
<td>59.71 ±1.94</td>
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<tr>
<td>Triglycerides (mg/g dry wt)</td>
<td>10.34 ±0.64</td>
<td>10.05 ±0.39</td>
<td>10.55 ±0.34</td>
<td>8.49 ±0.68</td>
<td>8.0 ±0.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glycerol (mg/g dry wt)</td>
<td>1.71 ±0.17</td>
<td>1.6 ±0.16</td>
<td>1.66 ±0.16</td>
<td>1.39 ±0.14</td>
<td>1.52 ±0.16</td>
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</tr>
<tr>
<td>Phospholipids (mg/g dry wt)</td>
<td>7 ±0.8</td>
<td>5.56 ±0.51</td>
<td>5.81 ±0.82</td>
<td>5.93 ±0.7</td>
<td>5.25 ±0.6</td>
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</tr>
<tr>
<td>Cholesterol (mg/g dry wt)</td>
<td>4.01 ±0.31</td>
<td>4.33 ±0.23</td>
<td>4.24 ±0.24</td>
<td>7.12 ±0.7</td>
<td>7.22 ±0.15</td>
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</tr>
</tbody>
</table>
The levels of total proteins, total carbohydrates, total lipids and phospholipids were considerably depleted. Since the red muscle mobilizes its organic reserves for white muscle metabolic activities (Wittenberger and Daciaus 1965; Murthy et al 1981), such a change in the levels of proteins and lipids of red muscle suggests the possibility of mobilization of these compounds towards the activity of white muscle. The refeeding recorded nonsignificant change in the dry weight and water content from the control level, indicating restoration of osmotic properties of the tissue. The extent of depletion in the proteins and carbohydrates from control levels was decreased, indicating the reaccumulation of these organic constituents in the starved tissue during the course of refeeding. However, these components, on refeeding, were considerably elevated over the starved levels. The total lipid content was regained to the control level from the depleted condition of starvation after refeeding. Such an elevated lipogenic activity of the tissues on refeeding has been reported by Jansen et al (1966) and Chang and Johnson (1976). The phospholipid content was also regained to the control level, suggesting the possible synthesis and/or decreased degradation of lipid components on refeeding. The cholesterol content of the tissue was depleted suggesting its possible efflux into the blood.

On long-term starvation there was an elevation of water content in the red muscle, as evidenced by the decrease in the dry matter, suggesting a degradation of tissue constituents with osmotic derangement. On refeeding the dry matter was elevated almost to the control level, indicating a corresponding reduction in the water content and suggesting the activation of the red muscle synthesis.

The long-term starvation resulted in an overall depletion in total proteins, total carbohydrates, total lipids, triglycerides and phospholipids, suggesting their mobilization towards the energy metabolism of the tissue. However, the cholesterol content was elevated suggesting the accumulation of cholesterol in the tissue after starvation. Since cholesterol forms a membrane constituent (Guyton 1971), its accumulation might suggest the possible decrease in the permeability of the myofibrils. The cholesterol thus accumulated may act as a precursor for the synthesis of steroid hormones, which have been reported to be elevating in stress conditions my Smith and Hoijer (1962).

On refeeding the total proteins, total carbohydrates and total lipids remained considerably depleted, compared to the control, while the total carbohydrates were elevated. The triglycerides and phospholipids were depleted along with cholesterol. Thus the red muscle metabolism is oriented towards higher degradation of proteins with sparing of carbohydrates. Since carbohydrates maintain osmolarity of the tissues (Umminger 1971), their accumulation appears to be responsible for maintaining the water content of the tissues in refeeding, while refeeding after short-term starvation led to near restoration of
control condition of organic reserves. On refeeding after prolonged starvation, there was still significant depletion of these compounds indicating that the long-term starvation induces deleterious effects in tissue metabolism.

In general, it can be concluded that the muscular organic constituents are largely mobilized during early as well as prolonged periods of starvation. The cholesterol content was decreased from the muscle during early as well as delayed refeeding. Hence periodical starvation and refeeding seems to reduce the muscular cholesterol content.

References


