Effect of tannery effluent on lipid profiles in reproductive tissues of freshwater fish Channa striatus

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INTRODUCTION

The pollution of aquatic environment by tannery effluent adversely affects the survival of aquatic organisms including the commercially important fish species which form the dominating group of aquatic system [1]. Increased disposal of tannery effluent in fresh water resulted in increased effluent residues in freshwater. Tannery effluent industries have increased in the recent period due to urbanization. Rapid industrialization lead to the contamination of natural waters with metal due to dumping of untreated wastes in the aquatic habitats, causing deleterious effects to fish [2]. The accumulation of metals in an aquatic environment has direct consequences to man and to the ecosystem also. Heavy metal pollution affects not only aquatic organisms, but also public health as a result of bioaccumulation in food chain. Contamination of freshwater with heavy metals causes devastating effects on ecological balance of the aquatic environments. Chromium is an environmentally significant metal used in various industrial processes [3]. Chromium compounds enter natural waters mainly through the effluents from electroplating and tanning industries, from dyeing, from sanitary land fill leaching and from water - cooling towers and can also enter drinking water distribution system and the corrosion inhibitors used in water pipes [4]. Nearly 90% of all leather produced is tanned using chromium and its determination in environmental samples is of great importance due to its toxicity. The metal pollutants are present in water bodies in a mixture of two or more major metals, often forming complexes which are more toxic than individual toxicant [5]. Thus for healthy fish production, it is very important to evaluate the harmful effects of heavy metals known to cause instantaneous physiological disorders [5]. Heavy metals may produce damage to organs as a result of significant alterations in various metabolic activities. The use of biochemical approach has been advocated to provide an early warning to potentially damaging changes in stressed organisms. The health of any organism is influenced by the physiological activities taking place in body. Lipids are important constituent of cellular structures. Lipids are also essential for maintenance of normal cell permeability and structural integrity of cell membranes. Govindan et al., [7] reported a significant decline in the levels of lipids in muscle, liver and brain of Gambusia affinis exposed to pesticide, phophamidon. The lipid composition of testis plays vital role in their functional activities and the maintenance of structural integrity [8].

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Hence this necessitates studies on biochemical changes in the reproductive tissues with tannery effluent toxicity. The present study is to assess the reproductive toxicity of tannery effluent on fresh water fish *Channa striatus*.

**MATERIALS AND METHODS**

Healthy adult male fishes weighing 200-225 g and about 30-35 cm in length were used as the experimental model to evaluate the toxicity. The fishes procured from a local fish market at Chennai, were acclimatized under laboratory conditions for a period of three weeks and fed. The fishes were maintained in a rectangular plastic tubs (64X44X29.5cm) filled with 20 L of dechlorinated tap water. The tubs were disinfected with potassium permanganate solution and washed thoroughly prior to introduction of fishes to prevent fungal infection [9].

Preliminary toxicity tests were carried out to find the median lethal tolerance limit of experimental fishes to tannery effluent for 96 days after Sprague. The sub lethal concentrations were found to be 1 and 10%. The Fishes were maintained for a period of 30 days at sub lethal concentrations. Group I served as the control, while group II was exposed to sub lethal concentrations of Tannery effluent for 30 days. Biochemical analysis was carried out at a period of 15 days interval till 30 days to assess the changes in various tissues.

**Preparation of tissue homogenate**

Testis were dissected out and washed thoroughly with 0.9 N saline solutions. Lipids were extracted by the method of Folch et al., [10].

**Biochemical estimations**

Various lipid classes estimated were cholesterol by the method of Parekh and Jung [11], Phospholipid by the method of Marinetti [12], triglycerides by Foster and Dunn [13] and free fatty acids by Itaya [14].

The data collected on different parameters of the experimental study were subjected to statistical analysis [15] by one way analysis of Variance (ANOVA) followed by Duncan’s multiple range tests and statistical significance was tested at 1% and 10% levels. The percentage change in experimental groups over controls was calculated to determine % elevation (+) or % reduction (-) during different days of exposure.

**RESULTS AND DISCUSSION**

Table 1 shows various lipid classes on exposure of the fishes to the toxicant along with control. The cholesterol levels of the Testis showed a significant increase (P<0.05) in the different periods of exposure, while the elevation was predominant on 30th day which was significant (P<0.05). The levels of phospholipid in testis were reduced significantly (P<0.05) during the exposure of fishes at different days. A significant increase in triglycerides (P<0.05) was noticed at 15th and 30th day of exposure in testis, while there was significant decrease in the free fatty acid levels in testis.

Cholesterol is needed for structural maintenance of tissues, maximum growth and survival of animals [16]. In the present study, lipid content is affected by showing an increase in testis and decrease in phospholipid in exposed fishes. The observation suggests decreased utilization of cholesterol for steroidogenesis due to a direct effect of tannery effluent on reproductive tissues. Reproductive disturbances were also observed in Atlantic salmon, *Salmo salar* [17] and a common carp, *Cyprinus carpio* [18] when exposed to synthetic pyrethroids. Abnormal ratio of cholesterol and phospholipids in the fish in the present study indicates hampered structural integrity of the testicular membranes. Testosterone is essential for the synthesis and turnover of phospholipids in testis and seminal vesicle [8]. The alterations probably may have resulted from an indirect action through hypothalamo-hypophysial-gonadal axis or direct action on the specific lipid classes causing reproductive disruptions in animals exposed to tannery effluent in the present investigations. Triglycerides are implicated as source of energy for metabolic and reproductive processes in testis and seminal vesicle in fishes [19]. The accumulation of triglycerides in the testis is due to impaired utilization of glycerol, associated with disturbances in biochemical process in reproductive tissues. The available glycerides are diverted for providing energy to a few developing spermatocytes and their survival. Impaired biochemical responses and copulatory behavior were observed in *Gammarus pulex* after exposure to sub lethal concentration of Lambda cyhalothrin [20].

Decrease in free fatty acids in the testis explains increased vulnerability of the membrane [21] after exposure of fishes to reproductive toxic compound. Fatty acids are mobilized to meet various energy needs.
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needs necessitated under stressful situations to adapt in the toxic medium [22]. These tannery effluents were found to be antiandrogenic [23, 24, 25, 26 & 27] (Pesticide Action Network, 2000). The effect of antiandrogens on lipid synthesis is well confirmed by the present observations [22]. The dynamics of lipid classes in reproductive tissues was found to be altered in fishes, Channa striatus exposed to tannery effluent. The observations of the present study provides useful information about the hazards of tannery effluent on aquatic organisms and their reproductive aspects, thus creating a need to spread awareness about the proper treatment procedures in view of the safety of natural aquatic ecosystems and aquaculture practice areas and to preserve the declining biodiversity of the native organisms of these habitats. For protection of global agricultural ecosystems and their multitude of inhabitants more sediment associated research is needed on the growth, effects and toxicities of tannery effluent on benthic animals.

Table 1. Effect of Tannery effluent on cholesterol, phospholipid, triglyceride and free fatty acid content in reproductive tissues of Channa striatus

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Tissue</th>
<th>Control</th>
<th>Experimental groups</th>
<th>f-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0 Days 15 Days</td>
<td>30 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cholesterol</td>
<td>Testis</td>
<td>3.81±0.42</td>
<td>03.81±0.42</td>
<td>04.15±0.28</td>
<td>04.31±0.27</td>
</tr>
<tr>
<td>Phospholipid</td>
<td>Testis</td>
<td>18.43±0.22</td>
<td>18.43±0.22</td>
<td>17.41±0.33</td>
<td>16.16±0.10</td>
</tr>
<tr>
<td>Triglyceride</td>
<td>Testis</td>
<td>2.24±0.09</td>
<td>2.24±0.09</td>
<td>02.76±0.17</td>
<td>03.19±0.27</td>
</tr>
<tr>
<td>Free fatty acid</td>
<td>Testis</td>
<td>9.37±0.07</td>
<td>9.37±0.07</td>
<td>8.85±0.35</td>
<td>8.15±0.10</td>
</tr>
</tbody>
</table>

values are mean ± SD (n=6); expressed as mg/g wet tissue, P value< 0.01** denotes significance at 1% level of (highly significant).

P value 0.011 to 0.05* denotes significance at 5% level, P value > 0.05 not significant (NS). since P value is less than 0.01 there is significant difference between days of exposure in higher as well as lower concentration. different alphabets in means between days in a row denote significance at 5% level. Means carrying atleast one common superscript do not differ significantly (P<0.05). values in parenteses in experimental groups are % reduction (-) or % elevation (+) over control.

Fig 1. Effect of Tannery effluent on cholesterol, phospholipid, triglyceride and free fatty acid content in reproductive tissues of Channa striatus

REFERENCES
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