Biochemical alteration in glucose content in blood of *Anabas testudineus* (Bloch) due to the effect of pesticides

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(Received: December 10, 2008; Revised received: April 08, 2009; Accepted: May 02, 2009)

Abstract: In the present work an attempt has been made to study the alteration in the plasma glucose level in a fresh water air breathing fish, *Anabas testudineus* (Bloch) exposed to three pesticides namely metacid, malathion and lindane under 24, 48 and 72 hr of exposure periods. The treatment of above mentioned pesticides cause a significant fall in the plasma glucose level on exposure to longer duration of lindane and malathion. While in the case of metacid treated fishes an exposure to longer duration depletion in the plasma glucose was insignificant. The blood glucose level in the control fishes range between 94.80 to 98.70 mg 100 mL⁻¹. In the case of exposure to lindane for 24, 48 and 72 hr to LCₙ₀ dose of pesticide, the level of blood glucose recorded was 72.47 mg 100 mL⁻¹ (24% fall), 70.47 mg 100 mL⁻¹ (26% fall) and 66.67 mg 100 mL⁻¹ (30% fall) less than the control value. In the case of malathion for 24, 48 and 72 hr to the LCₙ₀ dose of pesticide, the level of blood glucose recorded was 84.93 mg 100 mL⁻¹ (14% fall), 89.43 mg 100 mL⁻¹ (9% fall) and 76.8 mg 100 mL⁻¹ (22% fall) from the control value. While in the case of metacid for 24, 48 and 72 hr to LCₙ₀ dose of pesticide the level of blood glucose recorded was 90.17 mg 100 mL⁻¹ (8% fall), 95.7 mg 100 mL⁻¹ (2% fall) and 97.23 mg 100 mL⁻¹ (1% fall) from the control value. The required quantity of metacid to constitute LCₙ₀ dose for 24, 48 and 72 hr of exposure was 19.28, 13.18 and 9.2 mgL⁻¹ respectively. While those of malathion and lindane was 16.22, 9.88 and 8.92 mgL⁻¹ respectively. The safe concentration of metacid was 8.56 mgL⁻¹ while the quantity of malathion for safe concentration was 7.97 mgL⁻¹ and the quantity of lindane for safe concentration was 5.02 mgL⁻¹.

Key words: *Anabas testudineus*, Metacid, Malathion, Lindane and pesticide

Introduction

Aquaculture practices are common in India, where fish, the non-target organisms are directly exposed to various pesticides used for the control of insects and pests in agricultural. Aquatic ecosystem that run through agricultural areas have high probability of being contaminated by run off and ground water leaching by a variety of chemicals. Highly effective pesticides are used tremendously, which on entering the aquatic environment bring multiple changes in organism by altering the growth rate, nutritional value, behavioural pattern, metabolism etc (Ramesh and Saravanam, 2008). A major part of the world’s food is being supplied from fish source, so it is essential to secure the health of fishes (Tripathi and Harsh, 2002). In India as much as 70% of the chemical formulations employed in agriculture are believed to affect non-target organisms and to find their way to fresh water bodies, ultimately polluting them (Bhatnagar and Bana, 1992). Raino and Nikinmaa (1985) reported that the blood parameters readily respond to incidental factor such as physical stress and environmental stress due to water contaminants.

The pesticides affect the survival, metabolism, growth rate, fecundity and reproductive activity of fish (Hirose, 1975). Toxic substances even in very low concentration which is sub-lethal have been reported to interfere with basal metabolism and suppressed reproduction (Kondal et al., 1989), steroidogenesis (Saxena et al., 1986; Wester and Vos, 1994; Singh and Canario, 2004), lipid metabolism (Sangalang et al., 1981; Lal et al., 1987; Singh and Singh, 1992; Singh and Canario, 2004), degenerative changes in gonadotropin cells and reduction in interstitial cells size (Zutshi, 2005), gonadotropin levels (Van Der Kraak et al., 1992; Singh et al., 1994) act as reproductive biomarkers (Sepulveda et al., 2004) and also as endocrine disruptors (Pawlowski et al., 2004). Although the effects of pesticides on fishes are studied extensively and also reviewed (Edwards, 1974; Holden, 1974; Gupta, 1977; Murty, 1986), there is need for more information on the toxicant effect.

The indiscriminate and extensive uses of pesticides have not only adversely affect organisms of aquatic ecosystem but also affect biological system according to their chemical properties which leads physiological stress and alteration in biochemical components among organisms. Number of changes in biochemical parameters of aquatic organisms due to pesticide toxicity have been reported by several investigators. Sastry and Siddiqu (1982), Ahmad (1985), Bakthavathasalam (1983) observed decrease in glucose level of blood under stress condition caused due to the sublethal concentration of Sevin toxicity. Glycogen level of liver and muscles was found to deplete in mystus vittatus on exposure to different concentration of...
A systemic investigation on the effects of pesticides on the biochemical composition of fresh water Indian fish has not been undertaken in detail as such. The present work deals with the effect of three pesticides namely Metacid, Malathion and Lindane on Anabas testudineus to evaluate the hazardous effect of on the biochemical content.

Since early detection of specific physiological abnormalities provide an indication of exposure prior to manifestation of any gross damage, the measurement of biochemical changes in blood and tissue of fish under exposure to the toxicant may be used to predict the toxic effects of toxicants.

Materials and Methods

Fishes were collected from fishermen of Patna (Bihar, India). The fish was properly washed in tap water and treated with 0.02% KMNO₄ and 0.004% formalin solution to remove external infection of fungi, algae, etc. Prior to the experimentation the normal uninfected healthy fish were selected for experiment. The fish were acclimatized to laboratory conditions for 10 days before taken for experimentation.

A static bio assay test was done to determine LC₅₀ of Metacid, Malathion and Lindane to Anabas testudineus following the method of APHA (1985). For each experiment 10 fishes were exposed to a sub-lethal concentration of above three pesticides for 24, 48 and 72 hr. Side by side a control was also run in equal volume of water, fishes both from control and experimental aquarium were taken out gently and water on the body was soaked with dry towel. The blood was then collected in cleaned vial. The blood from the vial was used for quantitative estimation of blood glucose. It was done colorimetrically by the method of Nelson Somogy (Nelson, 1944).

Results

The blood glucose level in the control fishes ranged between 94.80 to 98.70 mg 100 mL⁻¹. Fishes exposed to LC₅₀ for 24, 48 and 72 hr to Metacid, the level of blood glucose recorded was 90.17 mg 100 mL⁻¹ (fall of 8%) 95.70 mg 100 mL⁻¹ (fall of 2%) and 97.23 mg 100 mL⁻¹ (fall of 1%) from the control value. A fall in the blood glucose level was observed initially which later improved in longer duration of exposure to Malathion for 24 and 48 hr to the LC₅₀ dose of the pesticides, a sub-lethal fall in the blood glucose level in all the three cases was observed. The level of blood glucose recorded was 84.93 mg 100 mL⁻¹ (fall of 14%), 89.43 mg 100 mL⁻¹ (fall of 9%) and 76.8 mg 100 mL⁻¹ (fall of 22%) from the control value. This clearly indicates that initially a sharp fall occurs in blood glucose level of fishes which gradually improves as the duration of exposure increases but finally a very longer duration of exposure to the pesticides again exhibits a substantial fall in the blood glucose level of fishes.

In the case of exposure to Lindane for 24, 48 and 72 hr to the LC₅₀ dose of pesticides , the level of blood glucose recorded was 72.47 mg 100 mL⁻¹ (a 24% fall), 70.47 mg 100 mL⁻¹ (a fall of 26%) and 66.67 mg 100 mL⁻¹ (a fall of 30%) less than the control value. As such in this case a sharp progressive depletion in blood glucose level in proportion to duration of exposure was observed.

Discussion

Toxicologists are searching for sensitive indicators of the effects on fish of aquatic pollutants in order to understand their mode of action and sensitivity and also to develop a basis for corrective action in cleaning up water bodies before the health of aquatic populations is seriously threatened. Since blood forms a unique compartment between the external and in internal environments, agents including pesticides that cause stress in fish can alter the composition of the blood. Hence, the study of the hematological parameters

The exposure of fishes to pesticides cause such a stressful condition that normal metabolic and physiological activities of fishes get impaired due to the toxicity of the pesticides. The poisoning due to the pesticide affects many natural metabolic processes of animals and inhibits intermediary metabolic process resulting in depletion of energy sources (Ghosh and Chatterjee, 1989). A similar finding has also been observed in an Indian cat on exposure to methyl parathion by Srivastava and Singh (1981).

In the present study blood glucose level of control fishes ranges from 94.80 to 98.70 mg 100 mL⁻¹. When the fishes were exposed to the sub-lethal doses of LC₅₀ of Metacide, Malathion and Lindane for 24, 48 and 72 hr duration, hypoglycemic condition was observed. A hypoglycemic condition in Channa punctatus was reported by Sastry and Siddiqui (1982) due to sub lethal concentration of Sevin.

Table 1: Changes in the blood glucose level when exposed to LC₅₀ dose of some pesticides in Anabas testudineus (value in mg 100 mL⁻¹)

<table>
<thead>
<tr>
<th>Pesticides</th>
<th>Control</th>
<th>24 hr</th>
<th>48 hr</th>
<th>72 hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metacid</td>
<td>98.00±2.01</td>
<td>90.17±1.66&lt;sup&gt;S&lt;/sup&gt;</td>
<td>95.70±0.70&lt;sup&gt;S&lt;/sup&gt;</td>
<td>97.23±0.45&lt;sup&gt;S&lt;/sup&gt;</td>
</tr>
<tr>
<td>Malathion</td>
<td>98.70±1.85</td>
<td>84.93±1.39&lt;sup&gt;S&lt;/sup&gt;</td>
<td>89.43±1.30&lt;sup&gt;S&lt;/sup&gt;</td>
<td>76.8±2.24&lt;sup&gt;S&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lindane</td>
<td>94.80±1.43</td>
<td>72.47±2.74&lt;sup&gt;S&lt;/sup&gt;</td>
<td>70.47±2.13&lt;sup&gt;S&lt;/sup&gt;</td>
<td>66.67±2.03&lt;sup&gt;S&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

* = Standard deviation, S = Significant at 5% probability level, NS = Not significant at 5% probability level
Stressors induce some changes that alter the homeostasis of the animal (Schreck, 1981). The stressors first activate the chromaffin cells present in the walls of the cardinal veins and in some cases the heart and kidney (Mazeaund and Mazeaund, 1981). Chromaffin cells release adrenalin and a small amount of noradrenalin that stimulates the conversion of liver glycogen into blood glucose and the utilization of glucose by muscle. Ahmad (1985) reported hypoglycemic during, early phase of toxicosis of cythian and mixture of cythian and carbaryl in cuchia. The hypoglycemic condition of fishes in the present study suggests that the reinforcement of glucose to the blood supply from the tissue were not done. As the tissue need their own glycogen to meet the energy requirement to overcome the stress caused by damage to the tissue as well as by the toxicosis of pesticides. A significant fall in the blood glucose level was observed in the experimental fishes on exposure to longer duration of lindane and malathion. While in the case of Metacid treated fishes, an exposure to longer duration, depletion in the blood glucose was insignificant.

The important findings of the present study was that the lindane, an organo chlorine pesticide was found to be more toxic than the malathion and metacid, an organo phosphate pesticides. Tilak and Veeraiah (2001) also reported that organo phosphate pesticides are more toxic than organo chlorine pesticide.

References


