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Impact of Deltamethrin on Serum Calcium and Inorganic Phosphate of Freshwater Catfish, *Heteropneustes fossilis*

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Pyrethrum insecticides have attracted our interest as they have potent insecticidal properties and are practically nontoxic to most non-target animals, especially mammals (Haya 1989). However, pyrethroids have been reported to be extremely toxic to fish and some beneficial aquatic arthropods, for example, lobster and shrimp (Bradbury and Coats 1989; Haya 1989). Due to their lipophilicity, pyrethroids have a high rate of gill absorption, which in turn would be a contributing factor in the sensitivity of the fish to aqueous pyrethroid exposures. Pyrethroids have a short-life in most animals as they are readily metabolized. Fish are an exception, since they seem to be deficient in the enzyme system that hydrolyzes pyrethroids (Haya 1989). Bradbury and Coats (1989) have stated that among synthetic pyrethroids the deltamethrin is the most toxic to salmonids.

The gill is a multifunctional and complex organ with which fish make intimate contact with the surrounding water. The gills comprise over half the body surface area and only a few microns of delicate gill epithelium separates the internal environment from a continually flowing external environment (Wood and Soivio 1991). Thus branchial function is very sensitive to environmental pollutants. In freshwater fish, blood electrolyte concentration is regulated by many interacting processes -- absorption of electrolytes from surrounding medium through active mechanisms, predominantly at the gill; control of water permeability; and selective reabsorption of electrolytes from urine. Any alteration in one or more of the above mentioned processes would result in a change in the plasma electrolyte composition. Although, several investigators have reported the toxicity of pyrethroids in fishes, there exists no information on the effect of pyrethroid exposure on blood electrolytes of fish. Hence, the present study was aimed to study the effects of short-term (96 hr) and long-term (28 days) sublethal exposure of deltamethrin on serum calcium and phosphate levels of the fish, *Heteropneustes fossilis.*

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MATERIALS AND METHODS

Adult freshwater catfish, *Heteropneustes fossilis* (both sexes; body wt 38-47 g) were collected locally. Prior to the experiment, the fish were acclimatized for 15 days in plastic pools under laboratory conditions (natural photoperiod -- 11.58-12.38 and temperature 25.8 ± 1.8 C). They were fed daily 2-3 times with wheat flour pellets and ground dried shrimp.

Four-day static acute toxicity test (APHA *et al.* 1985) was performed to determine the LC_{50} value of deltamethrin [trade name of pesticide is decis, manufactured by Evid and Company Chemicals Ltd., Ankleshwar (India) in technical collaboration with Hoechst India Limited]. Physico-chemical conditions of the tapwater used in the experiment were -- pH 7.21 ± 0.06; hardness 167.32 ± 5.81 mg/L as $CaCO_3$; dissolved oxygen 7.78 ± 0.30 mg/L; electrical conductivity 306.18 ± 68.52 µmho/cm and no free chlorine.

After determining the LC_{50} value of deltamethrin for 96 hr (which is 1.86 µg/L), the experiments were performed for short-term and long-term durations. The fish, *H. fossilis* (after 15 days acclimation to laboratory conditions) were subjected to 1.49 µg/L (0.8 of 96 hr LC_{50} value) and 0.37 µg/L *(* 0.2 of 96 hr LC_{50} value) solution of deltamethrin for short-term and long-term, respectively. After every 24 hr, the test solution was renewed. Concurrently, a control group was exposed to tapwater containing the solvent (acetone). Food was withheld 24 hr prior to the start of the experiment and during the experiment. The fish were sacrificed after 24, 48, 72 and 96 hr in the short-term experiment and after 7, 14, 21 and 28 days in the long-term experiment. After collection of blood, determinations of serum calcium (Trinder 1960) and inorganic phosphate (Fiske and Subbarow 1925) levels were performed.

Student's t test was used to analyse the statistical significance between the control and deltamethrin treated fish.

RESULTS AND DISCUSSION

After short-term deltamethrin exposure, the serum calcium levels of *H. fossilis* exhibit no change at 24 hr. The levels indicate a decrease after 48 hr exposure. This response persists till 96 hr (Figure 1). Up to 48 hr following exposure of the fish to deltamethrin, the phosphate levels remain unaffected. The values exhibit a progressive decrease from 72 hr onwards (Figure 2).

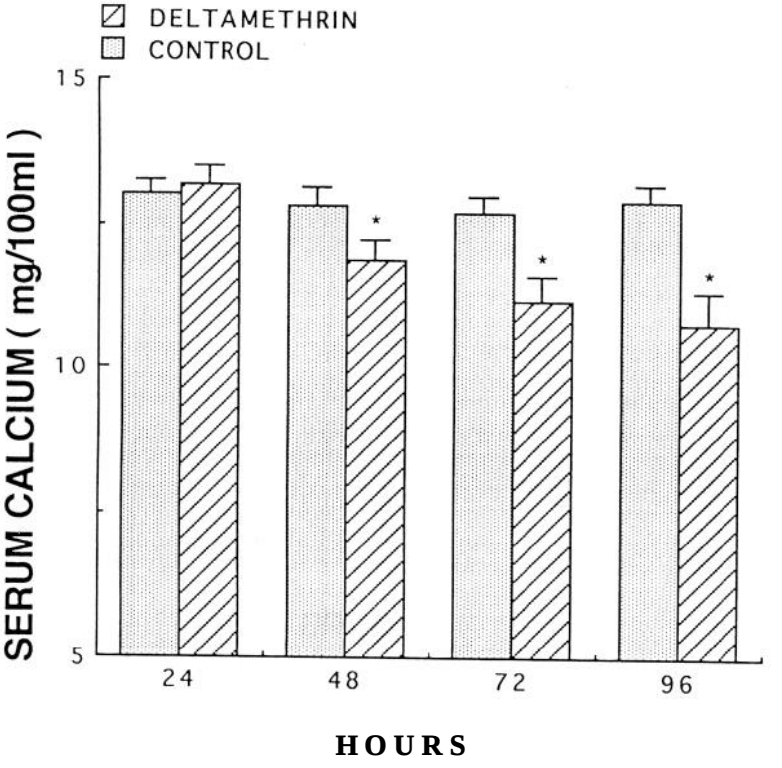

Figure 1. Serum calcium levels of short-term deltamethrin treated *Heteropneustes fossilis*. Values are mean ± S.E. of six specimens. Asterisk indicates significant differences ($P < 0.05$) from control.

The fish chronically exposed to deltamethrin exhibit a decrease in the serum calcium level on day 7. This decrease persists progressively till the close of the experiment (28 days; Figure 3). The serum phosphate levels of deltamethrin treated fish remain unaffected till day 7. The levels decrease progressively from 14 days onwards (Figure 4).

Exposure of *H. fossilis* to deltamethrin caused hypocalcemia. This is supported by studies of earlier investigators who have reported decreased blood/plasma content of fish treated with toxicants -- malachite green (Srivastava *et al.* 1995), cadmium (Larsson *et al.* 1981; Pratap *et al.* 1989; Pelgrom *et al.* 1995) and aldrin (Singh *et al.* 1996). However, other investigators have observed elevation of plasma calcium levels of pesticide exposed fish (Dalela *et al.* 1981; Sharma *et al.* 1982). The hypocalcemia observed in the present study in deltamethrin exposed *H. fossilis* could be attributed to the impairment of either net electrolyte influx at the gill or renal function.

In the present study deltamethrin exposure caused hypophosphatemia in *H. fossilis*. In contrast, hyperphosphatemia has been reported in fish

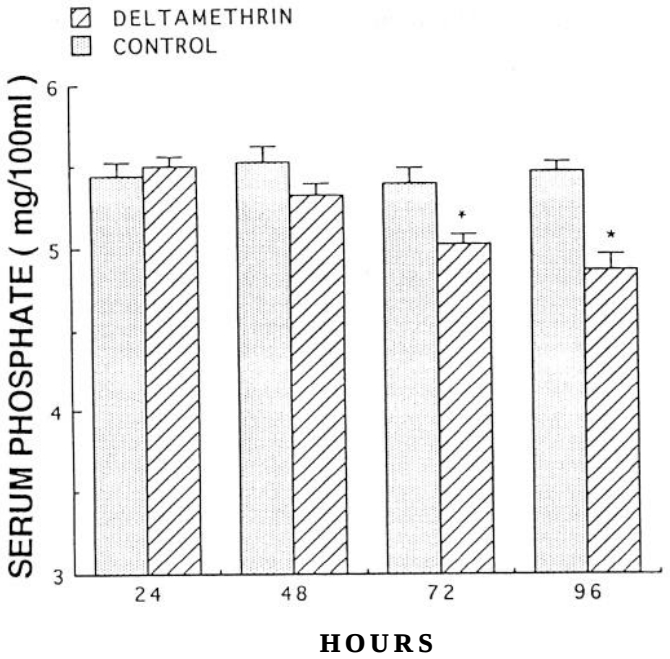

Figure 2. Serum phosphate levels of short-term deltamethrin treated *Heteropneustes fossilis*. Values are mean ± S.E. of six specimens. Asterisk indicates significant differences ($P < 0.05$) from control.

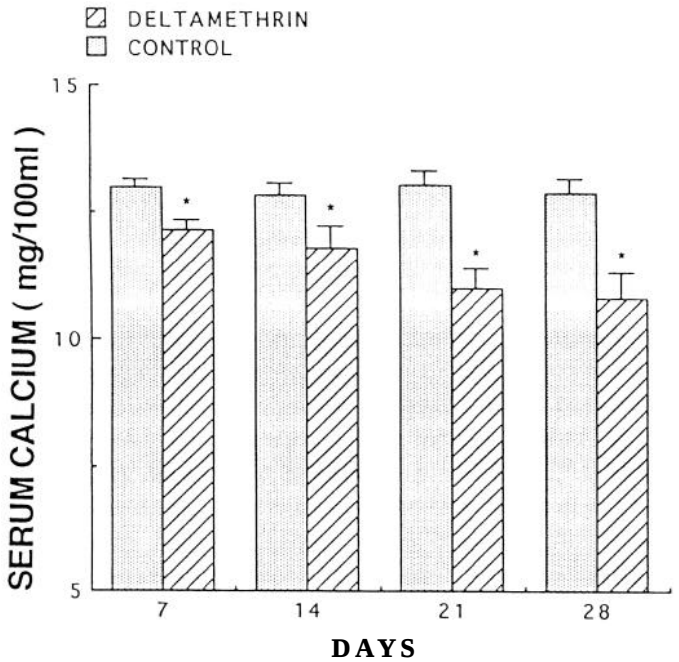

Figure 3. Serum calcium levels of long-term deltamethrin treated fish. Values are mean ± S.E. of six specimens. Asterisk indicates significant differences ($P < 0.05$) from control.

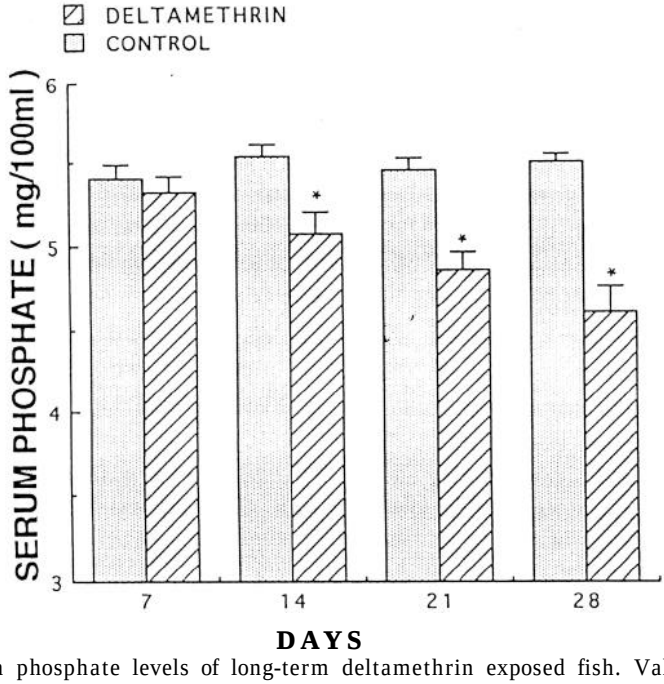

Figure 4. Serum phosphate levels of long-term deltamethrin exposed fish. Values are mean ± S.E. of six specimens. Asterisk indicates significant differences ($P < 0.05$) from control.

after exposure to various toxicants -- endrin (Colvin and Phillips 1968), endosulfan (Gill *et al*. 1991) and aldrin (Singh *et al*. 1996). Moreover, Pratap *et al.* (1989) observed no effect on plasma phosphate levels of fish exposed to cadmium in water. In fish, phosphate is absorbed exclusively via the gut (Flik *et al*. 1985). Keeping this in view, the hypophosphatemia observed in deltamethrin exposed *H. fossilis* could be linked to redistribution of electrolytes between intracellular or extracellular compartments and/or impairment of renal function.

From the results presented in this study, it can be concluded that deltamethrin may disturb the calcium and phosphate homeostases which are the important ions for synthesis of vitellogenin -- a female-specific lipophosphoprotein, thus affecting the reproductive state of the fish.

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