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Deltamethrin Induced Physiological Changes in Freshwater Cat Fish *Heteropneustes fossilis*

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Deltamethrin, a synthetic pyrethroid insecticide has been extensively used in households, agriculture and veterinary practices. It has a high safety factor, (insect/mammals toxicity ratio) rapidly metabolized, limited soil persistence (Armelle et al. 1987) and known to enter into the fishes body via gills (Elliot 1976). However, it is highly toxic to fish and other aquatic organisms (Haya 1989; Bradbury and Coats 1989). Deltamethrin induced behavioural alteration has been reported in fresh water teleost (Srivastava et al. 1997). In the present study, attempts were made to evaluate the toxicity and to explore the impact of deltamethrin on the physiological consequences in fresh water cat fish H. fossilis.

MATERIALS AND METHODS

Healthy specimens of fresh water cat fish Heteropneustes fossilis (weight 30-35 g, length 12-15 cm), collected locally from natural resources were brought to laboratory and acclimatized for 15 days under standard laboratory conditions. Physico-chemical characteristics of the water used were analysed for pH (6.9 ± 0.02), temperature (26.0 °C ± 2) electrical conductivity (268.24 ± 16.59 µmho/cm), dissolved oxygen (8.8 ± 2.5 mg/L), alkalinity (90-100 mg/L) and hardness (118-120 mg/L as $CaCO_3$). During acclimatization, fishes were fed with flour pellets and dried ground shrimp. All aquaria were cleaned and water was changed at alternate days. Only healthy fish of both sexes were used in the experiment.

A static acute toxicity bioassay was performed according to standard method (APHA 1992) to determine the 96 hr. LC_{50} value of deltamethrin (Hoechst Schering Agro Evo Limited Ankeleshwer, EC 2.8%) for H. fossilis recorded as 0.52 mg/L. For haematological and biochemical studies, two separate groups of 12 fish each were exposed to a sublethal concentration of 0.17 mg/L. Fish of the control group was also maintained in tap water containing 2 mL acetone. After 30 days of exposure, fish were blotted dry with absorbent paper and dissected with a sharp blade. The blood and tissues such as liver, gills, kidney, spleen, heart and muscle were collected

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in ice cold condition for haematologicat and biochemical observations (Dacie and Leris 1977; Barker and Summerson 1967; Srikantan and Krishanamoorthi 1955).

RESULT AND DISCUSSION

Deltamethrin caused significant increase of erythrocyte counts, however, a small decrease in haemoglobin (Hb), mean cell volume (MCV), mean cell haemoglobin (MCH) and haematocrit (PCV) were noticed in treated fish (Table 1). It seems that erythropoiesis has been accelerated to avoid anaemic state leading to higher production of erythrocytes. Since young RBC of fish that contains less haemoglobin than the older cells, the small reduction of Hb and MCH in H. fossilis may be an indication of altered turnover of circulatory erythrocytes (Hardig 1978). A slight decrease in Hb showed that the oxygen carrying capacity of fish has not been affected by deltamethrin. Similar results were reported in H. fossilis and Ictalurus punctatus exposed to malathion (Areechon and Plumb 1990; Lal et al. 1986). Significant ($P < 0.05$) increase was noticed in total leukocyte counts (Table 1). Since leukocytes combat against any toxicant introduced into the blood stream, this increase suggests that fish has developed a certain degree of tolerance during stress conditions.

Table 1. Haematological effects in H. fossilis exposed to deltamethrin for 30 days.

Parameter	Control	Experimental
Erythrocytes ($10^6/mm^3$)	4.6 ± 1.2	6.5 ± 1.5
Haemoglobin %	14.5 ± 2.5	13.5 ± 2.8
Haematocrit %	34.8 ± 3.5	30.5 ± 2.7
ESR (mm/hr)	6.0 ± 2.0	8.5 ± 1.8*
Clotting time(sec)	90.0 ± 5.0	122.0 ± 9.7*
MCH (Pg)	31.1 ± 3.2	24.5 ± 2.0
Total leukocytes($10^3/mm^3$)	11.5 ± 1.2	18.5 ± 2.6**
Large lymphocytes %	6.5 ± 1.8	5.8 ± 1.6
Small lymphocytes %	56.0 ± 5.5	85.0 ± 6.5**
Monocytes %	5.5 ± 1.3	4.3 ± 1.8
Basophils %	1.5 ± 0.2	2.5 ± 0.4
Neutrophils %	28.5 ± 3.5	34.5 ± 7.5*

Each value represents the mean ± SE of five observations; * = $P < 0.05$; ** = $P < 0.01$ (Students 't' test).

The differential leukocyte count has a significant ($P < 0.01$) increase in small lymphocytes and ($P < 0.05$) increase in the neutrophil count (Table 1). It is suggested that lymphocytosis and a stimulated immunological response in the fish occurs in the present study. Therefore, this stimulation may be the

result of cell and tissue damage or immunological consequences during the exposure of deltamethrin.

In the present investigation depletion of lactate in blood, liver, muscle, heart, gills, kidney, and spleen was noticed after 30 days of exposure (Table 2). This is in accordance with an earlier observation on Channa punctatus and Anabas testudineus exposed to quinalphos (Bhakthvatsalam 1984; Sastry and Siddique 1984). In the present study, these changes in fish seems to be due to the impaired function in the liver induced by deltamethrin. The blood glucose level of treated fish was found to be significantly ($P < 0.001$) decreased (Table 2). This response in exposed fish may be due to deltamethrin induced morphological and functional changes in renal tubules and liver cells. Similar

Table 2. Blood glucose and lactic acid level in H. fossilis exposed to deltamethrin for 30 days.

Parameters	Control	Experimental
Blood glucose (mg/100 ml)	40.5 ± 4.3	18.50 ± 5.8***
Blood lactate (mg/100 ml)	7.29 ± 3.6	3.60 ± 1.5**
Liver lactate (mg/g)	1.52 ± 0.5	0.74 ± 0.3*
Muscle lactate (mg/g)	2.80 ± 0.8	1.90 ± 0.5*
Heart lactate (mg/g)	2.21 ± 0.4	1.33 ± 0.28
Gills lactate (mg/g)	0.66 ± 0.5	0.56 ± 0.25
Kidney lactate (mg/g)	0.58 ± 0.8	0.49 ± 0.51
Spleen lactate (mg/g)	0.43 ± 0.05	0.39 ± 0.06

Each value represents the mean ± SE of five observations; * = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$ (Students 't' test).

observations were noticed in the aldrin exposed H. fossilis (Singh et al. 1993). According to them, hypoglycemic response in fish is due to rapid turnover of blood glucose during hyperexcitability. Sastry and Siddique (1984) observed hypoglycaemia in Channa punctatus exposed to lindane. Inhibition of LDH activity in liver and other vital tissues showed more utilization of lactate (Table 3). Similar decrease in lactate dehydrogenase was noticed in the liver of Cyprinus carpio exposed to an organochlorine phosphorus insecticide (Dragomirescu et al. 1979). They suggested that pesticide induced glycolytic capacity of fish and this inhibitory effect on glycolytic enzymes may be due to the formation of enzyme inhibitory Complexes. Conclusively, it is suggested that the deltamethrin affects the overall physiological profile in fish with particular reference to the energy metabolism and haematological characteristics.

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Table 3. Effect of deltamethrin on the activity of lactate dehydrogenase (µg/mg wet wt.) in H. fossilis exposed for 30 days.

Parameters	Control	Experimental
Liver	18.5 ± 5.5	10.8 ± 1.8**
Muscle	21.8 ± 6.2	13.6 ± 2.5**
Heart	16.9 ± 4.5	11.8 ± 3.7*
Gills	13.3 ± 3.4	9.5 ± 3.5**
Kidney	8.8 ± 2.8	6.2 ± 1.6*
Spleen	7.5 ± 2.3	6.8 ± 2.5

The values are expressed as (µmole) of pyruvate converted into lactate per hour per gm wet wt. Each value represents the mean ± SE of five observations * = $p < 0.05$; ** = $p < 0.01$ (Student 't' test).

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