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Hematological changes in common carp exposed to sub-lethal concentrations of sumithion

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Abstract

The effects of an organophosphorous pesticide Sumithion on hematological parameters of common carp (*Cyprinus carpio*) were investigated in the present experiment. The experiment was conducted with three treatments, each with three replications. Two sub-lethal concentrations (0.85 and 1.70 mg/L) were selected representing treatment two (T2) and treatment three (T3), respectively. A control set was also run for the same time with the same number of fish without Sumithion representing treatment one (T1). For hematological parameters fish were sacrificed at 7, 14 and 21 days after exposure. The values of hemoglobin (Hb), Red Blood Cells (RBCs) and hematocrit (Hct) were significantly decreased with the increasing concentration of Sumithion during the experimental periods. On the other hand, White Blood Cells (WBCs) were significantly increased with toxicity of Sumithion. The present study revealed that Sumithion has negative effects on the hematological parameters and macromolecular metabolism of common carp.

INTRODUCTION

In Bangladesh, more than 300 types of pesticides and insecticides are used for crop protection in agriculture (1). Over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species, including non-target species, air, water, bottom sediments, and food (2). Sumithion, the O, O Dimethyl O-(3-methyl-4-nitrophenyl), is an organophosphates pesticide. It is also widely used in aquaculture ponds for eradication of aquatic insect (mainly tiger bug) prior to release of larvae. Sumithion is considered somewhat toxic to fish (3). Hematological parameters like hemoglobin, hematocrit, and blood cell counts can be used to find physiological response of contaminated environment (4).

The common carp, *Cyprinus carpio* is an economically important freshwater fish, native to China and has been introduced all over the world to form a significant part of freshwater fishery. It is a highly palatable and preferred for culture due to its high growth rate and prolific breeding in confined water. In the present study, an effort was made to examine the prolong effects of Sumithion on hematological parameters to this fish species.

MATERIALS AND METHODS

A. Selection of test fish species

The common carps (*C. carpio*) were collected from the local fish farm and maintained in aquaria under a controlled natural photo-regimen (14/10 h, light/dark) and suitable temperature to acclimatize for a period of at least 21 days before starting the experiment. The average length and weight of fish ranged from 13 to 17 cm and 35 to 65 g, respectively.

The experiment was conducted in the wet laboratory of the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh during January to June 2014.

B. Selection of Insecticide

Organophosphorous insecticide Sumithion (60 E/C) which is commonly used in carp cultured pond was used for the present study. This insecticide was collected from retailer shop in Mymensingh town.

C. Experimental design for measurement of hematological parameters

The experiment was conducted with three treatments, each with three replications. Control set (0 mg/L) was used as Treatment one (T1) and two concentrations, such as 0.85 mg/L and 1.70 mg/L were used as Treatment two (T2) and Treatment three (T3), respectively. For hematological parameters fish were sacrificed at 7, 14 and 21 days after starting experiment.

D. Blood sampling and measurement of hematological parameters:

Blood samples were collected from the caudal peduncle into citrated tuberculin syringes and immediately analyzed for

the estimation of hematological parameters. Hemoglobin (Hb; g/dL) of samples were measured by EasyMate® GHB, using hemoglobin strips. Hematocrit (Hct; %) values were determined by micro-hematocrit centrifuge using hematocrit tube. The Red Blood Cell (RBC; $\times 10^6/\text{mm}^3$) and White Blood Cell (WBC; $\times 10^3/\text{mm}^3$) count was made using Neubauer haemocytometer. The mean corpuscular volume (MCV; μm^3), the mean corpuscular hemoglobin (MCH; pg) and the mean corpuscular hemoglobin concentration (MCHC; %) were calculated using the following formulas (5):

$$\text{MCV} = (\% \text{ of Hct/RBC in millions}) \times 10 \mu\text{m}^3$$

$$\text{MCH} = (\text{Hb in g/RBC in millions}) \times 10 \text{ pg}$$

$$\text{MCHC} = (\text{Hb in g/} (\% \text{ of Hct}) \times 100 \text{ g per } 100 \text{ mL}$$

RESULTS

A. Effects of Sumithion on Hb in common carp

We measured the blood hemoglobin (Hb) after exposure of fish to Sumithion (Fig. 1). Hb was significantly ($P < 0.05$) decreased with toxicity of sumithion at 7, 14, and 21 days of exposure periods in both concentrations (T2 and T3) compared to control (T1).

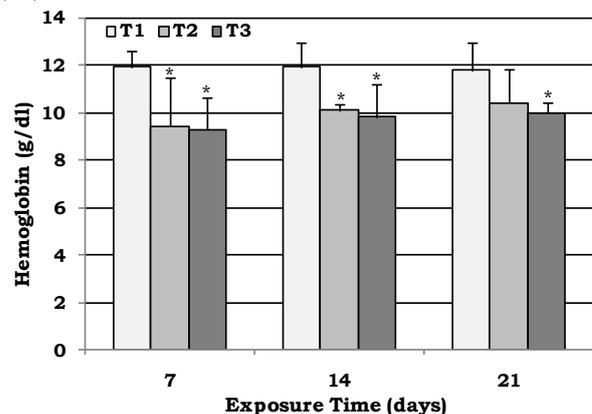


Fig. 1. Effects of sub-lethal exposure of sumithion on blood hemoglobin (Means \pm SD) at different time intervals in common carp. The blood hemoglobin of T2 and T3 were compared to the control (T1). Asterisk (*) indicate the statistically significantly different ($P < 0.05$, $n=6$).

B. Effects of Sumithion on RBC in common carp

Similar to Hb, the RBCs ($\times 10^6/\text{mm}^3$) values were showed decreasing tendency during the toxicity of sumithion at 7, 14, and 21 days of exposure periods in both concentrations (T2 and T3) compared to control (T1), though no significant ($P < 0.05$) difference in T2 at 14 and 21 days of exposure periods (Fig. 2).

C. Effects of Sumithion on Hct in common carp:

In the present study, Hematocrit (%) showed almost similar decreasing tendency of Hb and RBCs during the toxicity of Sumithion at 7, 14, and 21 days of exposure periods (Fig. 3).

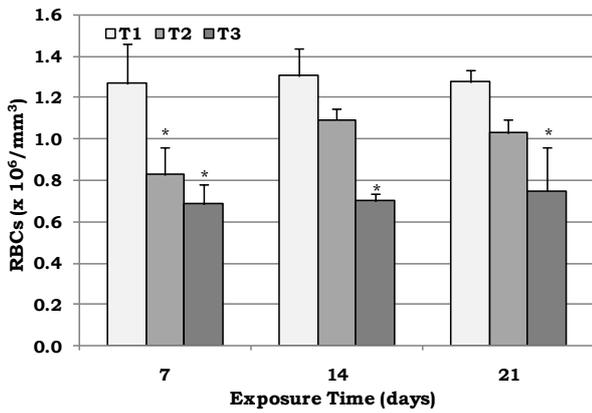


Fig. 2. Effects of sub-lethal exposure of sumithion on blood RBCs (Means ± SD) at different time intervals in common carp. The blood RBCs of T2 and T3 were compared to the control (T1). Asterisk (*) indicate the statistically significantly different (P<0.05, n=6).

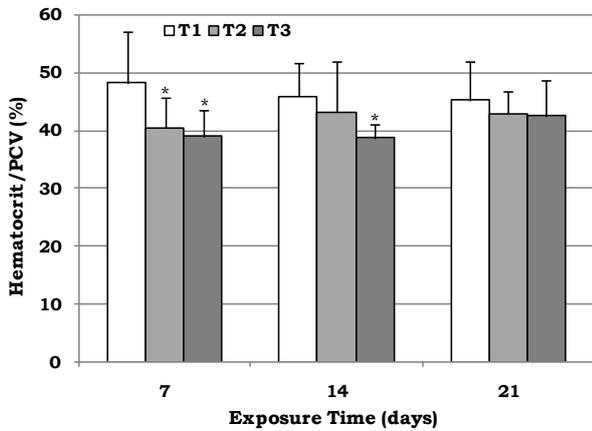


Fig. 3. Effects of sub-lethal exposure of sumithion on blood Hct (Means ± SD) at different time intervals in common carp. The blood Hct of T2 and T3 were compared to the control (T1). Asterisk (*) indicate the statistically significantly different (P<0.05, n=6).

D. Effects of Sumithion on WBC in common carp

The results of WBCs (×10³/mm³) values are presented in Fig. 4. The WBCs were significantly (P<0.05) increased with increasing the toxicity of Sumithion at 7, 14, and 21 days of exposure periods in both concentrations (T2 and T3) compared to control (T1).

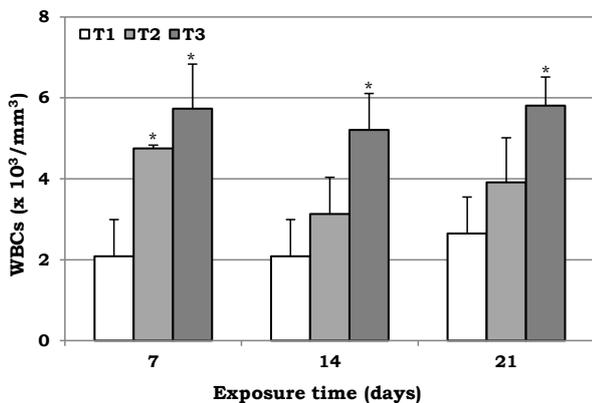


Fig. 4. Effects of sub-lethal exposure of sumithion on blood WBCs (Means ± SD) at different time intervals in common carp. The blood WBCs of T2 and T3 were compared to the control (T1). Asterisk (*) indicate the statistically significantly different (P<0.05, n=6).

E. Effects of Sumithion on MCV, MCH and MCHC in common carp

We calculated the mean corpuscular volume (MCV), the mean corpuscular hemoglobin (MCH) and the mean corpuscular hemoglobin concentration (MCHC) in the present study. The

MCV and MCH showed significant (P<0.05) increasing tendency with the increasing of toxicity of Sumithion at 7, 14, and 21 days of exposure periods in both concentrations (T2 and T3) compared to control (T1), while MCHC showed no noticeable changes during the experimental periods (Table 1).

Table 1. Changes in MCV, MCH and MCHC of common carp exposed to different concentrations of sumithion.

Parameters	Treatments	Exposure time (days)		
		7	14	21
MCV (µm ³)	T1	379.53	350.99	354.90
	T2	488.55*	413.49*	561.64*
	T3	653.75*	552.81*	568.00*
MCH (pg)	T1	90.55	91.09	88.63
	T2	113.86	92.24	142.92*
	T3	135.11*	140.71*	129.78*
MCHC (%)	T1	23.86	25.95	24.97
	T2	23.30	22.31	25.45
	T3	20.67	25.45	22.85

Asterisk (*) indicate the statistically significantly different (P<0.05, n=6).

DISCUSSION

In the present study, main hematological response of common carp to the sub-lethal exposure to sumithion, organophosphorous pesticide in different concentrations were a significant decrease (P<0.05) of RBC, Hb and Hct values compared to the control. Decreased RBC count and Hb content in *Cyprinus carpio* after acute exposure to another organophosphorous pesticide, diazinon were also reported by Svoboda *et al.* (6). Other effective substances of organophosphorous pesticides also induce changes which give evidence for decreased hematopoiesis followed by anemia induction in fish. It regards, e.g., changes in erythrocyte profile induced by acute effect of dichlorvos in *Clarias batrachus* (7), formothion in *Heteropneustes fossilis* (8), malathion in *Cyprininus watsoni* (9), and trichlorphon in *Piaractus mesopotamicus* (10). The decrease in erythrocyte number and hemoglobin content observed in this study may be due to the disruptive action of the pesticides on the erythropoietic tissue as a result of which the viability of the cells might be affected. Alterations in the hematological parameters were recorded exposed to diazinon as an anemic condition due to decreased synthesis of red blood cells and erythrocyte in bone marrow equivalents (11). Another type of hematological response to the effect of organophosphorous compounds was a significant increment of MCV and MCH. This response was registered in common carp after acute effect of phenitrothion, imidan and dichlorvos (12).

CONCLUSION

We examined the effects of Sumithion on hematological parameters in common carp. Reduction of Hb, RBCs and Hct might be because of failing of hematopoietic system. Increased WBCs count established leucocytosis, which is considered to be of an adaptive value for the tissue under chemical stress. Taken all together, the present study revealed that the Sumithion has adverse effects on various blood parameters in common carp.

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