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Hematology as Index of Sublethal Toxicity of Zinc in a Freshwater Teleost

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Zinc is one of the common water pollutants and even a very low concentration of 5 mg/l of zinc may be toxic to aquatic life (KRENKEL 1974). Zinc in solution has been found to cause gill damage (SKIDMORE 1970, SKIDMORE and TOVELL 1972) to rainbow trout. Considering the growing importance of hematological parameters in monitoring physiological responses of fish to toxic substances (HICKEY 1976; McLEAY and GORDON 1977) including heavy metals (McLEAY 1975, SRIVASTAVA and AGRAWAL 1978, SRIVASTAVA and MISHRA 1978), an attempt is made in this study to investigate blood dyscrasia that may occur in a fresh water teleost, Colisa fasciatus, after acute exposure to sublethal concentration of zinc, as zinc sulphate. A review of the literature reveals that only one report (McLEAY 1975) is available on the sensitivity of the leucocyte-thrombocyte count following acutely sublethal toxicity of zinc in juvenile coho salmon (Oncorhynchus kisutch).

MATERIALS AND METHODS

All experiments were performed on adult female specimens (average weight, 4.63 g) of a fresh water teleost, Colisa fasciatus. Fish, collected locally, were held for 10 days in tap water prior to testing. The properties of the test water were as follows : temperature, 25 + 1°C; pH, 7.3; dissolved oxygen content, 6.4 mg/l; hardness, 120 mg/l $CaCO_3$; electrical conductivity, 55 µmhos/cm. The fish were fed powdered dried shrimp daily, but food was withheld during testing period. Five groups of twelve fish each were exposed for 90 h to zinc sulphate at sublethal (average mortality, 40%) concentration of 100 ppm. The LC50 for Colisa determined concurrently for zinc by static bioassay (APHA 1975) was 107.5 ppm at 96 h. Parallel groups of fish were held in water for the duration of above treatment.

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Each fish was anesthetized with MS 222 and dried with filter paper. Fresh blood samples were collected from the caudal artery by severing the caudal peduncle. Hematological techniques have been previously described (SRIVASTAVA 1968a, 1968b, 1969; AGRAWAL and SRIVASTAVA 1976, SRIVASTAVA and AGRAWAL 1978).

RESULTS AND DISCUSSION

Table I shows the hematological changes in Colisa 90 hours after acute exposure to 100 ppm of zinc sulphate. Total red cell counts, hematocrits, total white cell counts, and the number of small lymphocytes/1000 cells decreased significantly, while erythrocyte sedimentation rate increased markedly from corresponding control values. The hemoglobin content, clotting time, and total and differential thrombocyte counts remained well within limits observed in controls. Significantly higher hepatosomatic index was recorded for zinc-treated fish as compared with unexposed animals.

The decreases in the total erythrocyte counts and hematocrit values, and accelerated rate of erythrocyte sedimentation for fish exposed to zinc for 90 h are comparable with similar results obtained previously in Colisa exposed to sublethal concentration of lead for the same duration (SRIVASTAVA and MISHRA 1978). A similar decrease in the red blood cell count was also recorded in coho salmon (McLEAY 1975) and rainbow trout (McLEAY and HOWARD 1977) following exposure to high sublethal concentrations of bleached kraft mill effluent.

Leucopenia in Colisa is mainly due to reduction in the number of circulating small lymphocytes. Both stress and exposure to sublethal strength of toxicants have been shown to cause lymphopenia in this fish (AGRAWAL and SRIVASTAVA 1976; SRIVASTAVA and AGRAWAL 1978) as well as in other teleosts (HICKEY 1976; McLEAY and HOWARD 1977). The increase in the hepatosomatic index in zinc-treated fish is not uncommon; elevation of this index was also reported in previous studies on fish following exposure to pollutants (EISLER and KISSIL 1975, SRIVASTAVA and AGRAWAL 1978) and was associated with internal detoxification processes.

The hematological results of this investigation suggest that both total erythrocyte and leucocyte

TABLE I

Effect of zinc on hematological values of a fresh water teleost[a]

Parameter	Control (water)	Experimental (zinc)
Erythrocytes x 10^6/mm^3	5.93 ± 0.15	4.83 ± 0.23[b]
Leucocytes x 10^3/mm^3	79.25 ± 13.93	52.00 ± 5.62[b]
Thrombocytes x 10^3/mm^3	31.25 ± 5.73	31.67 ± 3.34
Total differential count (no./1000 blood cells of all types)		
Erythrocytes	964.50 ± 1.26	981.63 ± 0.75
Small lymphocytes	33.50 ± 1.26	16.50 ± 0.71[b]
Large lymphocytes	0.83 ± 0.17	0.50 ± 0.19
Thrombocytes	1.17 ± 0.17	1.38 ± 0.26
Hematocrit (%)	52.31 ± 0.67	43.73 ± 1.43[b]
Erythrocyte sedimentation rate (mm/h)	1.17 ± 0.17	1.81 ± 0.31[b]
Hemoglobin (g%)	9.46 ± 0.13	9.98 ± 0.30
Clotting time (sec)	30.00 ± 1.53	29.00 ± 0.82
Hepatosomatic index[c]	1.46 ± 0.13	2.36 ± 0.12[b]

[a] Fish (Colisa fasciatus) were exposed to 100 ppm of zinc sulphate for 90 h. All values are mean ± S.E. (N = 6).

[b] Significantly different from the controls (P = 0.001 - 0.05).

[c] Hepatosomatic index = liver wt/body wt x 100.

counts, including the hematocrit and erythrocyte sedimentation rate are sensitive parameters for monitoring toxic responses of the fish following exposure to zinc.

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