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# IMPACT OF ELECTROPLATING EFFLUENT ON THE NUCLEIC ACIDS PROFILE IN THE LIVER OF FRESHWATER FISH, *HETEROPNEUSTUS FOSSILIS* (Bl).

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## ABSTRACT

**The effect of three sublethal (2.5%, 5.0% and 7.5% v/v) concentrations of the electroplating factory effluent was studied on the nucleic acid profile in the liver of freshwater fish during exposure for 120 days. A significant decline in the liver RNA/DNA ratio of the female fish following exposure to 5.0% and 7.5% concentrations of the effluent was recorded. Also there was a significant decline following exposure to 5.0% and 7.5% concentration of the effluent, when compared with the fish exposed to 2.5% concentration of the effluent. The results also recorded greater decline in the RNA/DNA ratio with increase in the effluent concentration in case of females, but no significant alteration was observed in the liver of male fish following exposure to the three sublethal concentrations of the effluent.**

**Key words:** Effluents, fish, liver, nucleic acid profile.

Since most of the industrial units do not have satisfactory waste-disposal systems or waste treatment plants, the waste is discharged indiscriminately into the nearby waterbodies. This leads to pollution with physical, chemical and biological deteriorations of the water, when the natural purifying capacity of water is exceeded. Such discharges, at sublethal levels, have been found to bring about alterations at the morphological and physiological levels in the liver of fish, a major organ of xenobiotic metabolism.

The present paper deals with the alterations in the levels of DNA and RNA in the liver of the freshwater teleost, *Heteropneustus fossilis*, following exposure to three sublethal (2.5%, 5.0% and 7.5% v/v) concentrations of the electroplating industry effluent for 120 days.

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## MATERIALS AND METHODS

Specimens of the freshwater catfish, *Heteropneustus fossilis* (Bloch) (25–35 g in weight and 15–20 cm in total length) were collected from the ponds situated in the vicinity of Ludhiana city. The fish were examined for the pathological symptoms and washed with potassium permanganate solution (1 mg per litre) to remove any dermal infection during acclimation. The fish water was acclimated to the laboratory conditions in all glass aquaria (92 x 46 x 46 cm) for about a fortnight prior to the initiation of the experiment. The fish were fed ad libitum on minced goat liver twice a week. However, the fish were not provided with any food during the exposure for 96 h, when the bioassays were conducted to determine the lethal concentrations of the electroplating factory effluent.

The electroplating factory effluent used in the present study was collected from M/s. Shivram and Sons, Wazir Singh Road, Ludhiana. The physico-chemical analysis of the undiluted (100%) and different sublethal concentrations (2.5%, 5.0% and 7.5% v/v) of the electroplating factory effluent was done in the Analytical Laboratory of the Punjab Water Pollution Control Board, Patiala (Table 1).

To determine $LC_{50}$, ten specimens were exposed for 96 h to different concentrations of the electroplating factory effluent. The mortality was observed at 24 h interval up to 96 h. $LC_{50}$ values for 24, 48, 72 and 96 h were determined by the methods of APHA [1].

Before exposing the fish to the sublethal concentrations of the effluent, five male and five female fish were autopsied and the livers were collected to determine DNA and RNA contents, and these served as the initial controls. Thereafter, the fish were exposed to three sublethal (2.5%, 5.0% and 7.5% v/v) concentrations of the untreated electroplating factory effluent for 120 days extending over the preparatory and prespawning phases of the annual reproductive cycle of this fish [2, 3]. Following exposure to the sublethal concentrations of the effluents, at least five females and five males were collected at 30-day intervals from each of the experimental and control aquaria and the livers were collected to estimate DNA and RNA levels.

The nucleic acids (DNA and RNA) were estimated by the procedure of Adams [4]. Two-way analysis of variance was used to compare the mean values in the experimental and control groups.

## RESULTS AND DISCUSSION

The present investigations deal with the effect of three sublethal concentrations, viz. 2.5%, 5.0% and 7.5% v/v of the electroplating factory effluent on the RNA, DNA levels and RNA/DNA ratio in the liver of both male and female fish. The RNA/DNA ratio has more relevance to the weight of tissue.

MALE FISH

Following 30 days of exposure, the liver RNA/DNA ratios at the three sublethal concentrations were higher ($p < 0.01$) than in the control. Among the treated groups, the RNA/DNA ratio in 7.5% effluent concentration was higher ($p < 0.01$) than in 2.5%. Thereafter, up to 120 days of exposure, the liver RNA/DNA ratios in the treated and control groups did not show significant variations (Table 2).

Further, the data subjected to the analysis of variance showed that only the duration of exposure had a significant effect on the RNA/DNA ratio in the liver of the male fish. This means that there was hardly any significant effect of the three sublethal concentrations of the effluent on RNA/DNA ratios throughout the period of exposure. Possibly, the sublethal concentrations of the effluent did not affect RNA biosynthesis. This is supported by the fact that the liver protein levels also did not show any significant alterations [5]. The initial significant alterations recorded following 30 days of exposure may be attributed to adaptability of the fish to the changed environment. In *Channa punctatus* also, no significant alterations was recorded in the liver RNA content following exposure to 1 mg/litre mercury and 2 mg/litre arsenic, lead, copper, cadmium and chromium [6].

**Table 1. Physico-chemical analysis of the electroplating industry effluent**

| Parameter | Values at different effluent concentrations | | | |
|---|---|---|---|---|
| | 2.5% | 5.0% | 7.5% | 10.0% |
| pH | 6.80 | 6.50 | 6.00 | 3.20 |
| Colour (Co-pt scale) | 150 units (light yellow) | 180 units (light yellow) | 200 units (light yellow) | 1800 units (dark yellow) |
| Total suspended solids | 20 | 24 | 27 | 60 |
| Total fixed solids | 378 | 456 | 513 | 2132 |
| Total volatile solids | 12 | 16 | 19 | 41 |
| Total dissolved solids | 390 | 472 | 532 | 2173 |
| Chloride | 50 | 60 | 70 | 250 |
| Sulphate | 42 | 61 | 94 | 411 |
| C.O.D. | 7.2 | 5.6 | 4.0 | N.D. |
| B.O.D. | N.D. | N.D. | N.D. | N.D. |
| Hexachrome | 2.0 | 3.7 | 4.9 | 6.0 |
| Total chrome | 3.0 | 3.7 | 4.9 | 75 |
| Nickel | 3.8 | 6.1 | 7.9 | 96 |
| Cyanide | 3.1 | 5.2 | 7.3 | 105 |
| Zinc | 0.162 | 0.3 | 0.44 | 0.99 |

N.D.—not detected..

**Table 2. Effect of sublethal concentrations of electroplating industry effluent on RNA/DNA ratio in the liver of male *H. fossilis***

| Duration of exposure (days) | RNA/DNA ratio under different effluent concentrations | | | |
|---|---|---|---|---|
| | 0 | 2.5% | 5.0% | 7.5% |
| 0 | $0.38 \pm 0.03$ | — | — | — |
| 30 | $2.01 \pm 0.12$ | $2.72 \pm 0.06^{**}$ | $3.09 \pm 0.20^{**}$ | $3.34 \pm 0.26^{**a'}$ |
| 60 | $1.77 \pm 0.06$ | $1.76 \pm 0.002$ | $1.63 \pm 0.04$ | $1.42 \pm 0.007$ |
| 90 | $1.09 \pm 0.01$ | $0.99 \pm 0.04$ | $0.84 \pm 0.04$ | $0.83 \pm 0.004$ |
| 120 | $1.07 \pm 0.01$ | $0.99 \pm 0.01$ | $0.99 \pm 0.01$ | $0.92 \pm 0.2$ |

C.D. ($p < 0.01$) = 0.59; C.D. ($p < 0.05$) = 0.47.

$^{*}P < 0.05$, $^{**}(P < 0.01)$ with respect to control.

$^{a}P < 0.05$, $^{a'}P < 0.01$—level of significance to 2.5% effluent concentration.

$^{b}P < 0.05$, $^{b'}P < 0.01$—level of significance to 5.0% effluent concentration.

FEMALE FISH

Following 30 days of exposure, the liver RNA/DNA ratio in 2.5% concentration was higher ($p < 0.01$) than in control. Among the treated groups, the liver RNA/DNA ratios in 5.0% and 7.5% were lower ($p < 0.01$) than in 2.5% concentration.

**Table 3. Effect of sublethal concentrations of electroplating industry effluent on the RNA/DNA ratio in the liver of female *H. fossilis***

| Duration of exposure (days) | RNA/DNA ratio under different effluent concentrations | | | |
|---|---|---|---|---|
| | 0 | 2.5% | 5.0% | 7.5% |
| 0 | 0.31 ± 0.00 | — | — | — |
| 30 | 2.39 ± 0.20 | 5.46 ± 0.33$^{**}$ | 3.49 ± 0.58$^{a'}$ | 3.41 ± 0.39$^{a'}$ |
| 60 | 7.92 ± 0.18 | 6.17 ± 0.16$^{*}$ | 8.44 ± 0.48$^{**a}$ | 2.89 ± 0.22$^{**a'b}$ |
| 90 | 5.91 ± 0.012 | 4.46 ± 0.12 | 2.52 ± 0.38$^{**a'}$ | 1.21 ± 0.04$^{**a'}$ |
| 120 | 1.51 ± 0.06 | 1.17 ± 0.04 | 0.71 ± 0.03 | 0.64 ± 0.06 |

C.D. ($P < 0.01$) = 1.93; C.D. ($P < 0.05$) = 1.53; S.E. 0.55.

$^{*}P < 0.05$, $^{**}(P < 0.01)$ with respect to control.

$^{a}P < 0.05$, $^{a'}P < 0.01$—level of significance to 5.0% effluent concentration.

$^{b}P < 0.05$, $^{b'}P < 0.01$—level of significance to 7.5% effluent concentration.

After 60 days of exposure, the RNA/DNA ratio was lower in 2.5% ($p < 0.05$) and 5.0 and 7.5% concentrations ($p < 0.01$) than in the control. Among the treated groups, the liver RNA/DNA ratio declined with increase in effluent concentrations.

After 90 days of exposure, the liver RNA/DNA ratios in 5.0 and 7.5% concentrations were lower ($p < 0.01$) than in 2.5% concentration as well as control. At 120 days of exposure, the liver RNA/DNA ratio in the liver of treated and control groups did not differ significantly.

These results show a significant decline in the liver RNA/DNA ratio in the female fish exposed to 5.0% ($p < 0.05$) and 7.5% ($p < 0.01$) concentrations of the effluent when compared with those exposed to 2.5% effluent and in control. This suggests a decline in the RNA/DNA ratio with increase in the concentration of the effluent. A significant effect of both the effluent concentration and duration of exposure on RNA/DNA ratio in the liver of female fish has been recorded, indicating that the effluent affected RNA synthesis possibly at the transcriptional level as is evident from the decline in the liver protein content in the effluent-exposed female fish [5].

In *Channa punctatus* too, a significant decline at higher and increase at lower concentration of cadmium was reported in RNA levels following 15-day exposure [7], and following exposure to 5 mg/litre mercury, arsenic, lead, copper, cadmium and chromium [6]. In Atlantic salmon (*Salmo solar*) also, a decline in liver RNA and DNA levels has been recorded following exposure to 71, 124 and 264 µg/litre of aluminium, and in liver RNA levels in relation to protein and RNA/DNA ratio in the fish exposed to 264 mg/litre of aluminium for 60 days [8].

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## REFERENCES

1. A. P. H. A., A. W. W. A. and W. P. C. F. 1981. Standard Methods for the Examination of Water and Waste Water, 15th edn. APHA, Washington DC: 845–874.

2. S. V. Goswami and B. I. Sundararaj. 1968. Compensatory hypertrophy of the remaining ovary after unilateral ovarioctomy at various phases of the reproductive cycle of the catfish *Heteropneustus fossilis* (Bloch.). Gen. Comp. Endocrinol., **11**(2): 401–413.

3. S. K. Nayyar and B. I. Sundararaj. 1970. Seasonal reproductive activity in the testes and seminal vesicles of the catfish, *Heteropneustus fossilis* (Bl.). J. Morph., **130**: 207-226.

4. R. L. P. Adams. 1980. Cell culture for biochemists. *In*: Laboratory Techniques in Biochemistry and Molecular Biology (eds. T. S. Work and R. H. Burdou). Elsevier/North Holland Biomedical Press, Amsterdam–New York–Oxford, vol. 8: 226–228.

5. P. Gupta. 1990. Effect of Electroplating Industry Effluent on Certain Tissues of Freshwater Teleost, *Heteropneustus fossilis* (Bloch.). Ph. D. Thesis. Punjab Agricultural University, Ludhiana.

6. S. R. Jana and N. Bandyopadhyaya. 1987. Effect of heavy metals on some biochemical parameters in freshwater fish. *Channa punctatus*. Environ. Ecol. **5**(3): 488–493.

7. M. S. Dubale and P. Shah. 1981. Biochemical alterations induced by cadmium in the liver of *Channa punctatus*. Environ. Res., **26**(1): 110–118.

8. J. M. Michael, C. O. Knowles and D. R. Buckler. 1989. Effects of aluminium on the biochemical composition of Atlantic salmon. Arch. Environ. Contam., **18**: 243–248.