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Relative Susceptibility of Different Life Stages of *Channa punctatus* and *Cyprinus carpio* to Nickel-Chrome Electroplating Effluent

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The heavy load of various industrial pollutants in the aquatic environment poses a serious threat to the biota living therein. For setting up standards for the safe disposal of such wastes, bioassay studies are used to determine their minimum concentration that kills fish in a particular period. Although toxicity of a pollutant depends upon the water characteristics and fish type, experimental standards are still useful in the conservation of fish populations in rivers. Furthermore the response of a species to a compound may be influenced by developmental stage and size of the test organism (Kendal et al. 1984; Kaur and Dhawan 1994).

The present paper is aimed at investigating the LC_{50}, acute toxicity ranges, safe concentrations, and relative susceptibility of three life stages (fry, fingerling and adult) of fresh water teleosts, *Channa punctatus* and *Cyprinus carpio* to nickel-chrome electroplating effluent.

MATERIALS AND METHODS

Fry,fingerlings and adult specimens of *Channa punctatus* were collected from the ponds situated in vicinity of Ludhiana city and those of *Cyprinus carpio* from ponds of Fisheries Research Complex, Punjab Agricultural University, Ludhiana. They were acclimated, in glass aquaria, to laboratory conditions for 2 wk prior to the initiation of the experiments. During experiments, *C. punctatus* and *C. carpio* were fed *ad libitum* on pig liver and mixture of rice bran, oil cake and fish meal respectively.

Treated and untreated nickel-chrome electroplating effluent was collected from the Hero Cycles Pvt.Ltd., Ludhiana. The physico-chemical analysis of the effluent

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Table 1. Physico-chemical analysis of untreated and treated nickel-chrome electroplating effluent

Parameter	Untreated	Treated
pH	3.0	8.80
Color	Light yellow	Colorless
Total suspended solids	78	62
Dissolved solids		
a) Fixed solids	1412	1530
b) Volatile solids	212	228
c) Total solids	1624	1758
COD	22.4	21.7
Chloride as Cl	228	310
Sulphate as SO_4	680	756
Ammonical nitrogen	2	5
Chromium total	34	3.2
Chromium Hexavalent	22	0.6
Nickel	40	4.0
Cyanides	1.0	0.1

Values except pH and color are given in mg L^{-1}

obtained from Punjab Pollution Control Board, Patiala is given in Table 1.

During twelve static bioassay experiments (three replicates each), ten specimens each of fry, fingerlings and adult of C. punctatus and C. carpio were exposed in glass aquaria (90 x 45 x 45 cm) containing 15 L, 50 Land 100 L of test solution, respectively. Dechlorinated tap water was used as diluent and control. The control and test concentrations were kept at temperatures ranging from 30±2.0°C. Mortality was observed at 24-hr intervals through 96-hr of exposure. Their physical responses were recorded. Dead fish were removed immediately to avoid asphyxiation by the remaining fish. The 96-hr LC_{50} values were calculated by subjecting the data to probit analysis (Finney 1971). The safe application rate was calculated by using the formula [$SAR=LC_{50}(LC_0 \div LC_{100})$] given by Basak and Konar (1977).

RESULTS AND DISCUSSION

Table 2 shows the concentrations of both untreated and treated electroplating effluent at which 100% survival and 100% mortality of various life stages of both C. punctatus and C. carpio was observed.

Data given in Table 3 show 96-hr LC values along with their fiducial limits, and safe application rates (SAR)

Table 2. Effect of nickel-chrome electroplating effluent on the survival of different life stages of *Channa punctatus* and *Cyprinus carpio*

Life stage	Length (cm) ($\bar{X} \pm$S.E.)	Weight (g) ($\bar{X} \pm$S.E.)	100% survival in effluent (% concentration) a*	100% survival b**	100% mortality a*	100% mortality b**
Channa punctatus						
Fry	3.40± 0.12	0.45± 0.01	5	90	40	NR
Fingerling	7.90± 0.45	5.30± 1.01	20	92	50	NR
Adult	12.50± 1.00	25.60± 5.80	30	99	65	NR
Cyprinus carpio						
Fry	4.50± 0.20	0.80± 0.18	10	80	36	100
Fingerling	8.20± 0.33	8.50± 2.00	20	94	42	NR
Adult	15.62± 1.55	36.70± 4.90	27	96	55	NR

a*-Untreated effluent, b**-Treated effluent.
NR-Not recorded even in pure effluent

for the three life stages (fry, fingerling and adult) of *C. punctatus* and *C. carpio* for untreated and treated electroplating effluent.

Dive and Philippo (1990) reported that wastes from electroplating industry contain a mixture of toxic metals (mainly Cu^{2+}, Zn^{2+}, Cr^{3+}, Fe^{3+}, Ni^{2+} and Hg^{2+}), acids, cyanides, alkalies and ammonia. So it is very difficult to pinpoint which particular factor was actually responsible for the mortality of the fish exposed to effluent. In the present study mortality of fish is caused by blockade of gills due to precipitation of mucus leading to a decrease in respiratory surface area as is clear from the studies of Trivedi and Dubey (1978) and Kondal et al (1984).

Acidic pH (3.0) of the untreated effluent and alkaline pH (8.8) of the treated effluent may also be responsible for the mortality of *C. punctatus* and *C. carpio*. Hogendoorn et al. (1978) reported that decrease in pH from 7.9 to 6.8 resulted in 50 to 200 fold increase in toxicity of hexavalent chromium to *Salmo*

Table 3. LC_{50} values with 95% fiducial limits and SAR (safe application rate 1 for different life stages of *Channa punctatus* and *Cyprinus carpio* exposed to untreated and treated electroplating effluent

Life stage	Fish	96-hr LC_{50}	95% Fiducial limits	SAR
		Untreated effluent		
Fry	*C. punctatus*	20.65	18.36-24.06	2.58
	C. carpio	25.05	21.95-28.56	2.78
Fingerling	*C. punctatus*	36.14	33.63-38.14	18.07
	C. carpio	33.59	32.41-34.81	16.78
Adult	*C. punctatus*	46.17	43.61-48.89	21.31
	C. carpio	36.91	34.29-39.73	19.99
		Treated effluent		
Fry	*C. punctatus*	96.71	86.35-108.31	*
	C. carpio	93.72	92.62-94.83	0.50
Fingerling	*C. punctatus*	**	-	-
	C. carpio	**	-	-
Adult	*C. punctatus*	**	-	-
	C. carpio	**	-	-

*SAR could not be calculated because of maximum 90% mortality in pure effluent

**96-hr LC_{50} values could not be calculated because in pure effluent, mortality was 30and 10% for fingerling and adult of *C. punctatus* and 50 and 20% for fingerling and adult of *C. carpio*

gairdneri. However, Klein (1957) stated that sodium hydroxide and other alkalies caused asphyxiation as a result of coagulation of gill secretion leading to fish mortality. Synergism of Ni^{2+} and Cr^{3+} present in the electroplating effluent may also be responsible for mortality of fish during present study. Khangarot and Ray (1990) reported that nickel and chromium had approximately the same acute toxicity to *Poecilia reticulata* but survival time in Ni-Cr mixture was much reduced, suggesting that metals potentiated each others toxicity and caused rapid death of fish.

High contents of suspended solids present in the electroplating effluent might have caused the mortality, by blocking the gills of the experimental fish as reported by Kondal et al. (1984). Significant concentration of ammonia in untreated (2.0 mg L^{-1}) effluent may also be another cause of fish mortality. The high concentration of chlorides(288 mg L^{-1}) In the untreated effluent may be another factor responsible for fish mortality as reported by Duodoroff and Katz (1950).

The median lethal concentration was observed to increase gradually with increase in size/developmental stage of fish, This may be attributed to enhanced resistance with increase in size as reported by Kondal et al. (1984).

Lower toxicity of the treated effluent as compared with untreated effluent may be because of neutralization of acids, reduction of hexavalent chromium to trivalent form (less toxic form of chromium) and precipitation of heavy metals as their sulphides or hydroxides (as indicated by 10 times reduction in their concentration in the treated effluent). Trivedi and Dubey (1978) also reported a decrease in toxicity of wastes from caustic and rayon industry after neutralization of acids and precipitation of heavy metals as their sulphides. However, the observed mortality in treated effluent may be attributed to alkaline pH (8.8) and high concentration of ammonia (5 mg L^{-1})and chlorides (310) mg L^{-1}). Henderson and Tarzwell (1957) pointed out that ammonia at a concentration of 2.5 mg L^{-1} and above is harmful to fish in an alkaline pH range of 7.4-8.5.

On exposure to various concentrations of either untreated and treated electroplating effluent, fish showed definite symptoms of restlessness reflected by erratic opercular movements, difficulty in respiration, convulsions and short jerky actions, and increase in surfacing intensity. This may be due to coagulation of film anoxia as observed by Mount and Stephan (1969). Some individuals dashed against the walls of the experimental containers indicating impairment of the sense of equilibrium. This abnormal behaviour may be due to failure of latero-acoustic or neuromast system and development of disorders in central nervous system as reported by Khangarot and Ray (1990) and Saksena and Pandey (1991).

Our observation is in confirmity with that of Verma et al. (1982) that C. carpio is more sensitive to electroplating effluent than C. punctatus. The greater resistance of C. punctatus may be attributed to the fact that it is an air breathing fish, so it can cope with the stress conditions in a better way and for a longer time than C. carpio, which is an aqueous breathing fish and solely depends on gill respiration.

On the basis of present observations made on different life stages of C. punctatus and C. carpio, safe concentrations (based on survival of most sensitive stage) may be suggested as 2.58 and 82.47% of untreated and treated nickel-chrome electroplating effluent respectively.

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