

***GENERAL SUMMARY
AND CONCLUSION***

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In India, fish culture ecosystems are frequently exposed to a variety of chemicals released by the way of industrial effluents into the receiving water body. These chemicals adversely affect various life stages of fish and their food species.

Pollution of natural waters with toxic effluents arising from industries is well known. The unused raw materials, process intermediates and derivatives and unrecovered products find their way into the effluents and reach the environment as chemopollutants. The effluents released by textile mill, electroplating industry and tannery are of great concern as far as water pollution is concerned. Because the effluent of textile mill contain starch, polyvinyl alcohol, suspended and dissolved solids, H_2SO_4 , NaOH, Na_2O_2 , sodium silicate, sodium bisulfite, alkaline hypochlorite etc. released during the processes such as sizing, desizing, scouring, mercerization, bleaching, dyeing, printing and finishing. Electroplating effluent contains NaOH, carbonates, silicates, benzene, petrol, ferrous sulphate, acids such as HCl, H_2SO_4 and HNO_3 , cyanides, phosphate, chlorides, sulfides etc. Apart from these, heavy metals like Cu, Ni, Ag, Au, Zn, Cd, Cr, Sn, Pb, Fe etc. These contaminants are released during processes such as surface cleaning, pickling or stripping, plating etc. Tannery effluent contains NaCl, dirt, alkali, sulphides, lime, $CaCO_3$, NH_4Cl , ammoniacal and organic nitrogen, ammonium salts,

H₂SO₄, chromium, dyes, oil and greases. These substances are released during the processes such as beam house processing (soaking, liming, deliming etc.), tan yard processing (chrome tanning, bating, pickling, tanning, dyeing, flat liquoring etc.).

After analysing the effluents for physico-chemical parameters such as temperature, turbidity, total solids, colour, pH, dissolved oxygen, free carbondioxide, hardness, chlorinity, alkalinity, acidity, phosphates and nitrates, it is reported that, the values exceeds the standard limits. Thus, it was found out that, the physico-chemical parameter of the effluents also affect toxicity of the effluents to the aquatic life of the receiving water body.

The effluents used for experimentation were analysed for quantitative estimation of some heavy metals like Cu, Ni, Cd, Zn, Pb, Cr, Al etc. which showed very high values as compared to the normal standard limits set by ISI. In textile mill effluent the maximum concentration was of Ni followed by Zn, Al, Cu whereas, Cd, Pb, and Cr was absent. In electroplating effluent the concentration of heavy metals was in the order of Cr > Zn > Cu > Cd > Al > Ni > Pb. In tannery effluent the concentration of heavy metals was in order of Cr > Ni > Zn > Cd > Cu > Al > Pb.

In acute toxicity experiment the fingerlings of freshwater fish *Labeo rohita* was exposed to tannery effluent at test concentrations of 10%, 15%, 20%, 25% and 30%. The LC₀ and LC₅₀ concentrations were 15% and 20% respectively. The test

concentrations for electroplating effluents were 2%, 3%, 4%, 5%, 6% and 8%. The LC_0 and LC_{50} concentrations were 3% and 6% respectively. The test concentrations for textile mill effluent were 16%, 18%, 20%, 22% and 24%. The LC_0 and LC_{50} concentrations were 18% and 22% respectively. It was found that, electroplating effluent was more toxic than that of tannery and textile mill waste. The behaviour disabilities of test fish also differed from one effluent to another. It was found that, in tannery effluent the fish showed erratic swimming, jerky movements, excess mucous secretion increased respiratory activity, gulping of atmospheric air, pale yellow coloured belly etc. In electroplating effluent the fish showed initial restricted movement, body torsion, loss of balance, heavy mucous secretion, shedding of scales, infection to snout and eye and bluish tinge on body after death. In textile mill effluent the fish showed erratic swimming, jerky movements, less mucous secretion, gulping of atmospheric air, loss of body coordination, decrease in opercular movement etc. In all the three effluents in later phase of experiment the fish became inverted (belly upward), floated near the surface for sometime and settled at the bottom of the container, indicates death of fish.

There were remarkable changes in biochemical composition in the fish tissues due to stress of the effluents. Metabolic activity of the fish showed utilization of biochemical energy to counteract the toxic stress. After acute exposure to the tannery, electroplating

and textile mill effluent, the fish showed remarkable changes in the biochemical composition i.e. total glycogen, protein and lipid content of various body tissues like gill, liver, muscle, kidney and brain. In general, there was significant decrease in glycogen level of various organs in both LC_0 and LC_{50} concentration, when compared to control, but it was more in LC_{50} than LC_0 concentration for all the three effluents. The protein content of all the organs in LC_0 concentration decreased as compared to control but, there was increased content in gill for tannery, whereas in kidney and brain for electroplating effluents at LC_{50} concentration. For textile mill effluent there was decrease in protein content in all the organs at LC_{50} concentration, whereas increase in the content in kidney and liver in LC_0 concentration. There was significant decrease in lipid content of various organs in both LC_0 and LC_{50} concentration when compared to control, but it was more in LC_{50} than LC_0 concentration for all the three effluents.

The present study revealed that, on the basis of physico-chemical characteristic of the effluents, they are highly toxic at very low concentrations, which degrades the water quality and aquatic habitats by changing the normal characteristic of the water. The heavy metal content of three effluents differed resulting into variation in their toxicity. Acute toxicity studies showed abnormal patterns of fish behaviour and rate of mortality which was specific for each effluent. The effluents at LC_0 and LC_{50} concentrations

altered the biochemical composition (glycogen, protein and lipid) of the various organs of fish, due to utilization of biochemical energy to counteract the toxic stress. Further studies need to be carried out encompassing various aspects of detail biochemistry, physiology and enzymology to understand the nature of damage and disfunctionings due to such industrial effluents.