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Impact of textile and composite industrial wastewater on fresh water fish, *channa gachua:* a comparative study

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Abstract

Pollution is the single largest contributory factor towards degradation of environment and the main source of pollution is industrial effluents, sewage, agricultural and domestic wastes including simple metal ions complex chemical compounds. The main threat to aquatic environment is by various industries which discharge their effluents in water bodies. In this context, the present investigation was done to know the effect and toxicity to the fish Channa gachua. The fish was exposed to sub-lethal doses of mixed and electroplating industrial effluent. Toxicity of mix effluent and electroplating effluent to the fish, Channa gachua is studied in relation to varying salinities i. e.1 to 5% The LC_{10}, LC_{50}, LC_{90}, LD and Safe concentration values of both mixed effluent and electroplating effluent obtained in high and low salinities showed that the mix effluent is highly toxic to Channa gachua at low salinities as result of osmotic stress as compare to mix effluent. The study strongly indicates that the essential for observing the concentration of effluent which should be treated and to be apply control methods to safeguard the safety of aquatic animal and the ecosystem at large.

Keywords: Fish, LC_{50}, Toxicity, Lethal Dose and Acute Toxicity.

Introduction

Effective green revolution has introduced a large variety of chemicals in to the environment these chemicals have been beneficial on one hand but exercise severe strength and environmental problems on other through food chain. The industrial effluent when it enters a terrestrial and aquatic ecosystem it impacts on animal and plant life. These toxic chemicals change the quality of water that affects the fish and other aquatic organisms. Many investigators have carried out their studies on fish and their toxicity well documented by the researcher[1-4].

In the recent years, residues of number of chemical compounds and industrial effluents from various industries has been reported both from Textile/Composite industrial effluent which affects different types of organisms[5-8]. The biological effects of these industrial effluents at various stages of the environmental adulteration, leads to their accumulation and bio-magnification through the food web are the most concerned ecological problem. On several occasions, industrial effluent is reported as highly toxic to freshwater fishes[9-12].

In the present investigation, two types of industrial effluents were selected *i.e.* Textile effluent and Composite industrial effluent because these effluents are commonly used in farming practices. Textile industries produce large quantity of contaminated effluents that are normally discharged to surface water bodies and. The wastewater pollutants severely damage the global ecological system. Effluent from Textile industries contains contaminants such as heavy metals, organic substances, cyanides, and suspended solids, at levels which are harmful to the environment and pose possible health risks to the public. Heavy metals are of great concern because of their toxicity to human and other biological life. Heavy metals typically present in Textile wastewater are Cadmium, Chromium, Copper, Lead, Nickel, Tin, and Zinc.

From the experimental results, we have observed that, these effluents were impact on aquatic food chain. To see the comparison of bioassay test *i.e.*LC_{10}, LC_{50}, LC_{90}, LD and Safe concentration values. We have studied the various concentrations of effluent which is impacting on to the targeted organisms.

Materials and methods

The healthy juveniles of the fish *Channa gachua* (wt. 12 $\pm$ 0.5 gms) were collected from Harsul Lake at Aurangabad (M.S.) India. The fish were brought to the laboratory within an hour. On arrival to the laboratory the animals were acclimated to the laboratory conditions in batches equal to environmental condition for a period of one week. The laboratory populations have attained zero mortality after the acclimatization period. Only healthy, active and nearly equal sized fishes were selected and separated for investigation.

They were not feed during acclimatization and experimentation. The effluent of Textile industry and Composite industrial effluent was brought to the laboratory. Physico-chemical analysis of both effluents was carried out to know the pollution load of the effluents by following standard procedure[13]. Appropriate amounts of concentration were done *i.e.* 1%, 2%, 3%, 4% and 5% by using dilution technique. The concentration of each effluent was diluted to the 2 liters of tap water. The toxicity tests were conducted employing renewal technique as recommended.

The fish *Channa gachua* in batches of 10 each were used for each concentration with each test and the experiments were repeated 7 times till the percentage of mortality in each of the tests is constant. Pilot experiments were conducted to selected concentration ranges which resulted in mortality. To maintain uniform conditions throughout, the volume of the test media was kept constant. In addition to 96h. LC_{50} values for 24, 48 and 72h and 96h were determined. A total of five concentrations (1%, 2%, 3% 4%and 5%) were used to assess the combined effect of concentration.

The experiments were conducted to know the range of concentrations of both effluents. The LC_{10}, LC_{50}, LC_{90}, lethal concentration, lethal dose and safe concentration was calculated by bioassay test value using the weighted regression method of probit analysis for heterogeneity for safe concentration[14,15]. The lethal dose and safe concentration was calculated by following formula given by Finney[14]:

Formula-1: Lethal Dose (LD) = LC_{50} Value X Exposure Time.

Formula-2: Safe Concentration = $\frac{48\ Hours\ LC^{50}\quad X\ 0.3}{S^2}$

Where: S=$\frac{24\ Hours\ LC^{50}}{48\ Hours\ LC^{50}}$

From the result of experimentation an overall impression is drawn that toxicity of any toxic chemical when it gets mixed with water is related to its concentration and duration of exposure[16,17]. The mortality of the fish is also related to the size of the fish and resistance of the body[18]. The findings of the toxic effluents *i.e.* mixed as well as electroplating effluent LC_{50} for 96h has shown considerable changes in several parameters such as pH, DO, free CO_2. In the past also several workers have reported variations in these characteristics due to toxic exposure, a few worth mentioning[19,20].

Results and discussion

Physico-chemical parameters of both electroplating and mixed effluents were analyzed and results are summarized in Table-1. Composite as well as Textile industrial effluent was used for the bioassays as a pollutant *i.e.* toxicity determination in *Channa gachua* fish. As per the observation the study shows that the effluents used for toxicity test seems to be toxic and hazardous. Exposure of specimens of *Channa gachua* to the effluent showed toxic nature. The toxicity tests were conducted for 24, 48, 72 and 96h. by the method described by Finney. Calculations of LC_{10}, LC_{50}, LC_{90}, LD and safe concentrations were determined for both effluents. The results are shown in Table-2. The graphical presentation is shown in Figure-1 to Figure-12.

The LC_{10}, LC_{50}, LC_{90}, LD and safe concentrations values of Textile effluents were found maximum and that of mix effluent has minimum. It is shown that the Composite effluent is more toxic than Textile effluent. The impact of exposure of the specimens in the effluent was also spectacular in respect to changes in oxygen in take capacity.

Table-1: Physico-Chemical Parameters of Composite and Textile Effluents.

Parameters	Composite Effluent	Textile Effluent
Temperature	37°C	35°C
pH	4.9	8.7
CO_2	968	88
Total Solids (TS)	20400	2800
Total Suspended Solids (TSS)	1400	1200
Total Dissolved Solids (TDS)	19000	1600
Chlorides	4970	285
Acidity	1412	175.8
Alkalinity	1072	538
Total Hardness	5500	250
BOD	254.59	88.75
COD	1060	980
Cadmium (Cd)	1.65	1.52
Copper (Cu)	1.07	0.91
Nickel (Ni)	4.55	2.36
Fluoride (F)	0.38	0.61

Note: all the values except, pH and temp is in ppm.

Table-2: LC_{10}, LC_{50}, LC_{90}, Lethal Dose (LD) and Safe concentration of Composite and Textile Effluent.

Salinity Concentration	Exposure Time (hrs.)	LC_{10} (ppb)	LC_{50} (ppb)	LC_{90} (ppb)	Lethal Dose (ppb)	Safe concentration (ppb)
Composite Effluent 1% to 5%	24	7.0794	10.7151	11.7489	257.162	1.2306
	48	4.6773	7.7803	11.7489	373.454	
	72	4.6773	5.902	9.3325	424.944	
	96	2.3442	3.3806	7.0794	324.537	
Textile Effluent 1% to 5%	24	8.9125	18.6208	22.3872	446.8992	1.6112
	48	9.1201	12.3026	22.3872	590.5248	
	72	4.4668	7.925	16.5958	570.6	
	96	4.4668	5.508	13.4896	528.768	

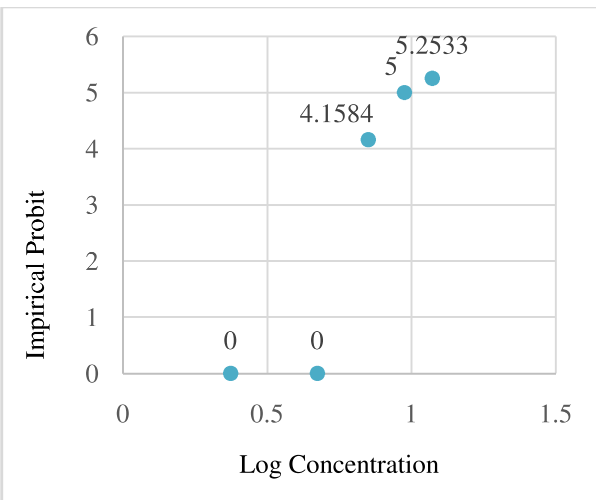

Figure-1: 24 Hours exposure of Composite Effluent.

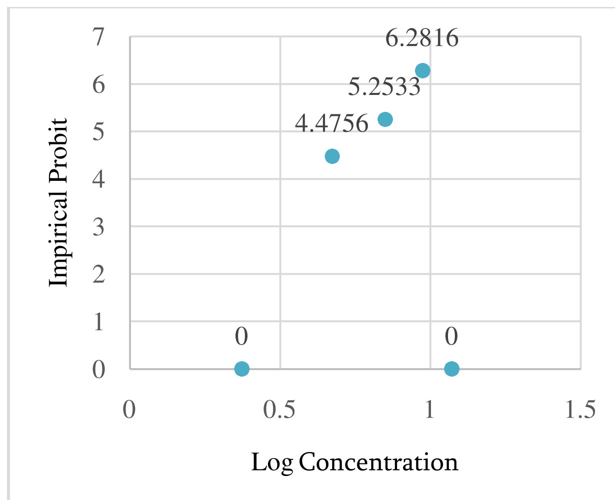

Figure-3: 72 Hours exposure of Composite Effluent.

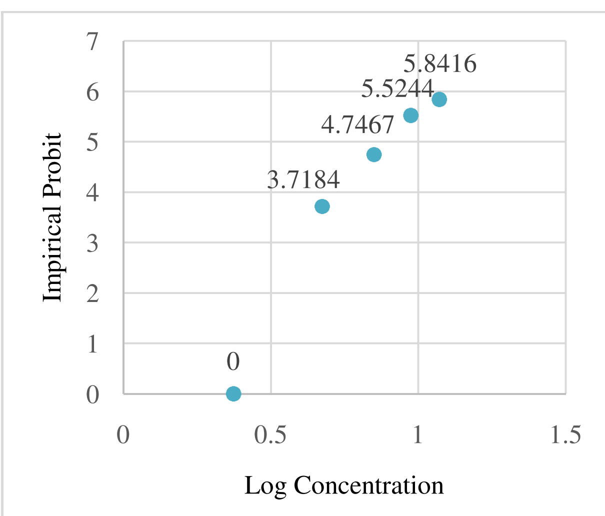

Figure-2: 48 Hours exposure of Composite Effluent.

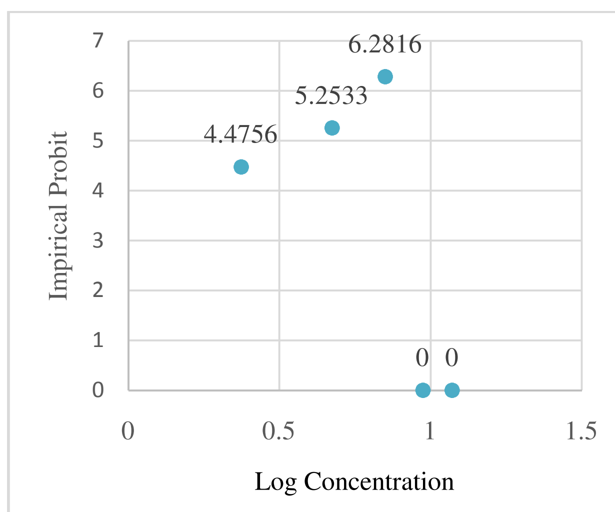

Figure-4: 96 Hours exposure of Composite Effluent.

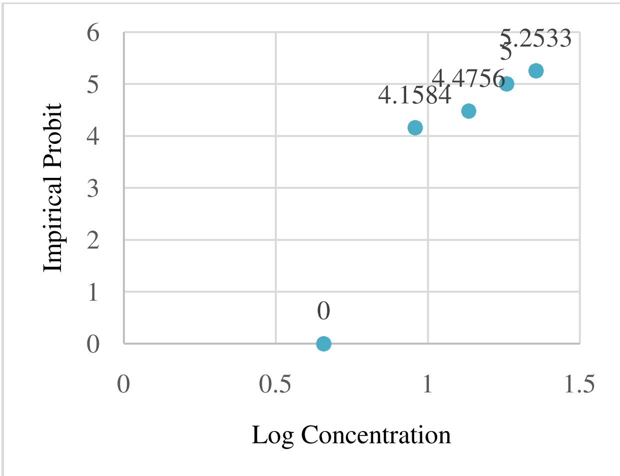

Figure-5: 24 Hours exposure of Textile Effluent.

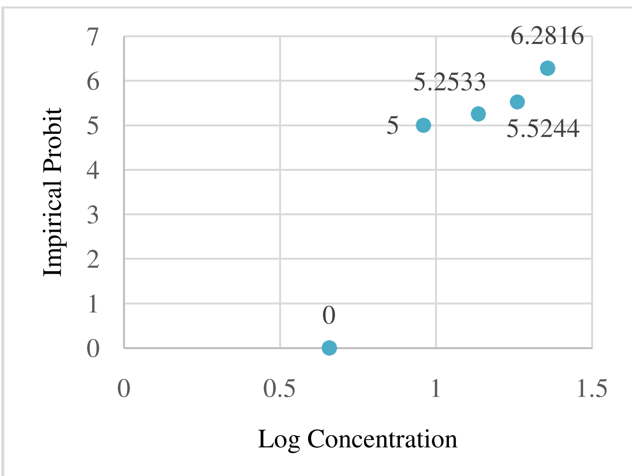

Figure-6: 48 Hours exposure of Textile Effluent.

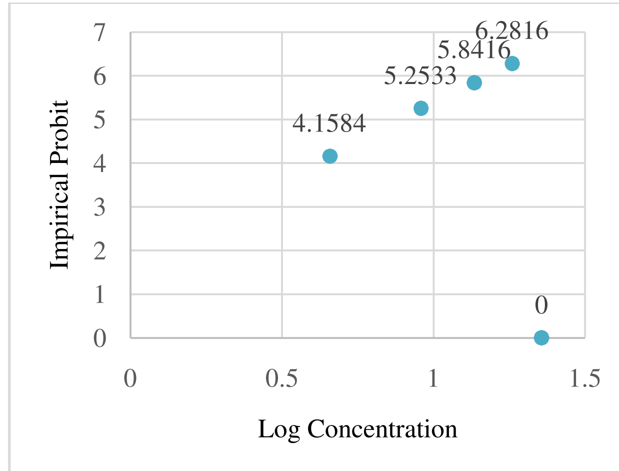

Figure-7: 72 Hours exposure of Textile Effluent.

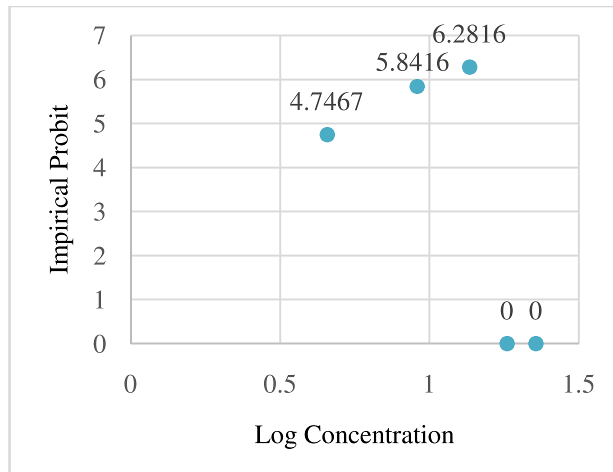

Figure-8: 96 Hours exposure of Textile Effluent.

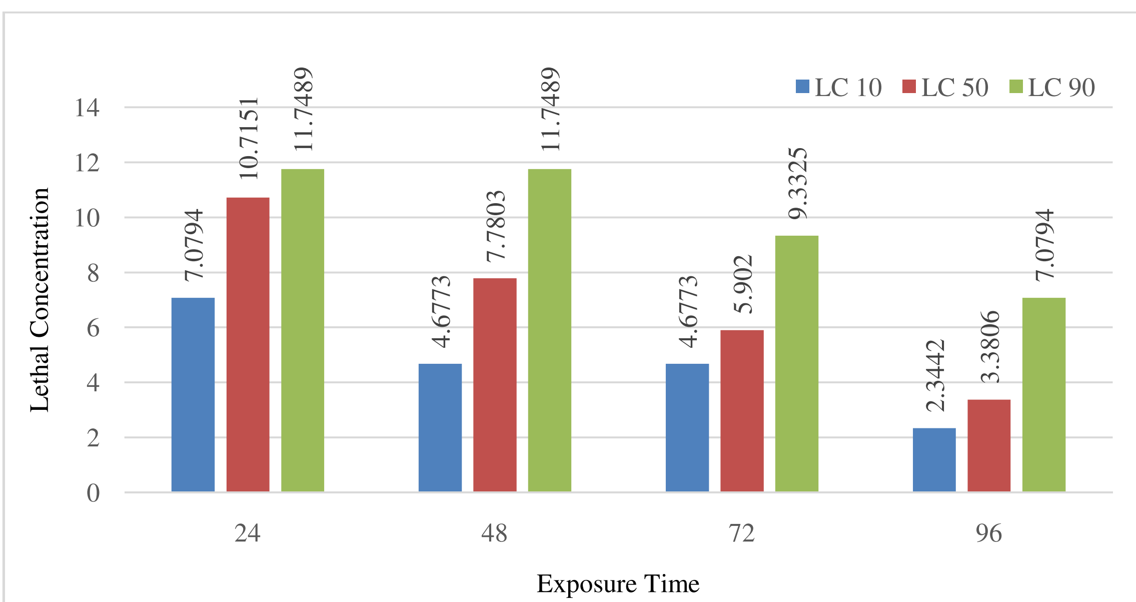

Figure-9: LC 10, 50 and 90 values of Composite Effluent.

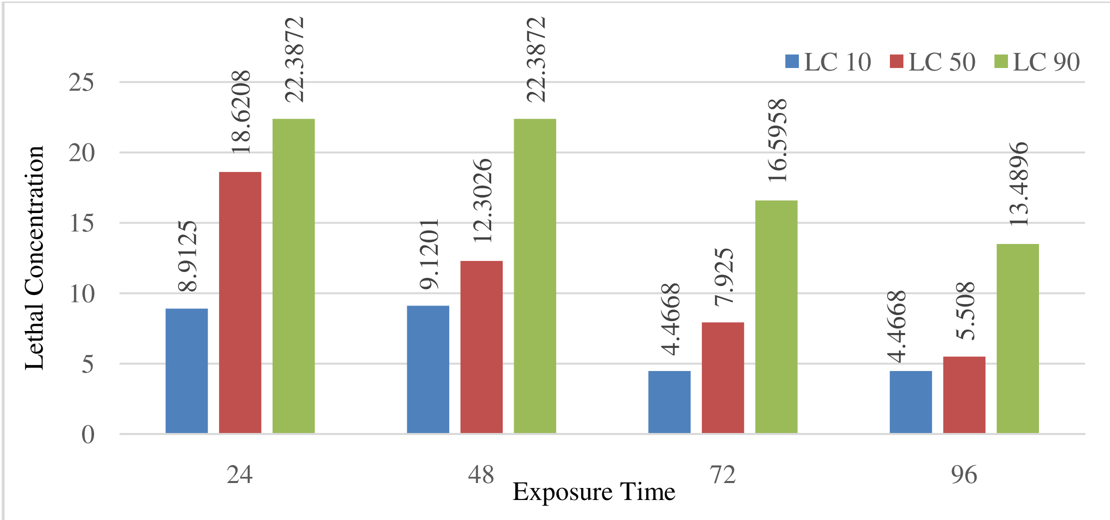

Figure 10: LC 10, 50 and 90 values of Textile Effluent.

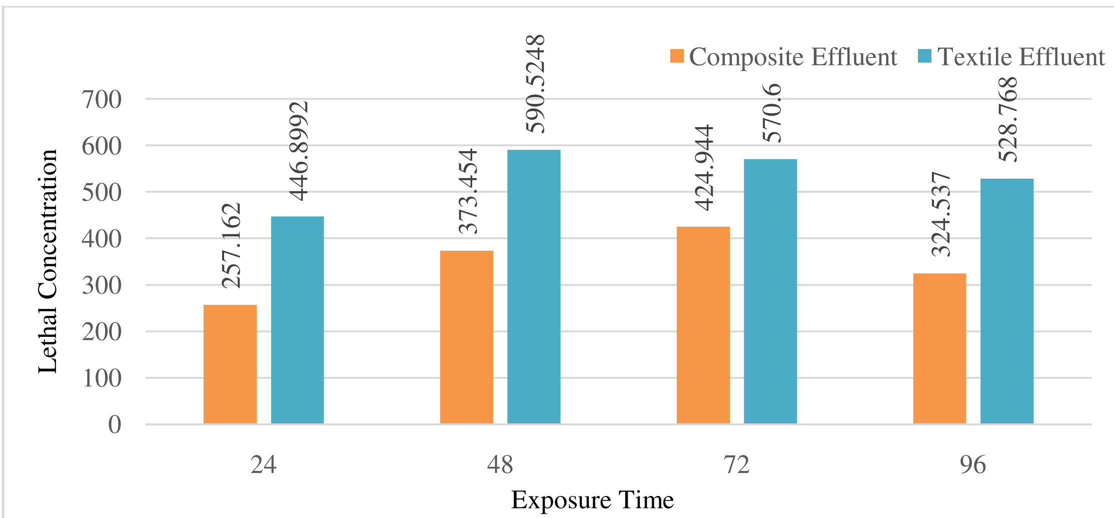

Figure-11: Lethal Dose(LD) values of Composite and Textile Effluent.

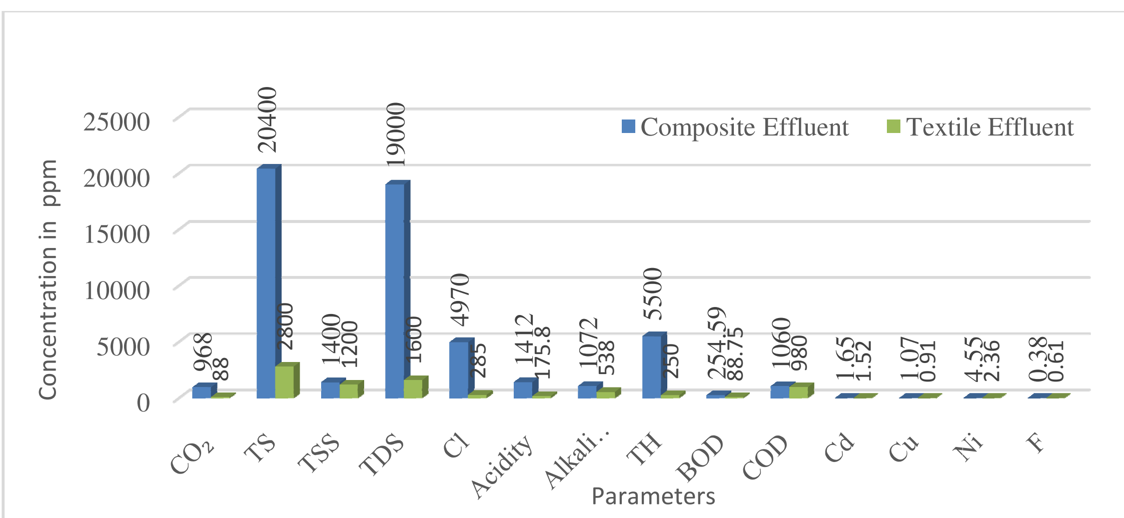

Figure-12: Physicochemical Parameters of Composite and Textile Effluent.

In the present investigation, the mortality of the fish was most probably attributable to several influences which resulted from association and recombination of the elements present in both effluents. From considering the aspects involved for change in ventilator movement, it seems that to survive with the abnormal toxic environment in the beginning specimens had to exert maximum to avoid distress but as the specimens lost resistance, there was as gradual decrease in the rate of ventilator travel towards the death end.

Conclusion

From the present study, it is concluded that both the effluents were found very much polluted. The analysis of physico-chemical parameters has shown that maximum parameters were found their concentration above standard limits and some are near the standard limits among these parameters. The BOD, COD, hardness, total solids, suspended solids, dissolved solids, chlorides, alkalinity, Cd, Cu, Ni and acidity are found above standard limits. Acute toxicity test conclude that both the effluents were found toxic to fishes and aquatic life. It is found that the Composite effluent is more toxic than Textile effluent. in view of the present findings, it is suggestive to treat the effluent when release to the nallas or in to the river with the adjoining water areas and to keep the permissible limit for the release of effluent and should be restricted as per the prescribed central pollution control boards guideline to save water wealth of the area.

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