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Toxicity Determination Of Distillery Effluents On Freshwater Fish Labeo Rohita: An Experimental Approach

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Abstract:

Distillery effluent poses a serious environmental threat; especially pollute the water bodies which adversely affect the aquatic organisms. The present study is to determine the mortality rate of freshwater fish Labeo Rohita (Rohu) in spent wash, PTDE (Primary treated distillery effluent) and PTDE diluted with 50% of water, PTDE diluted with 75% of water. The mortality rate of Labeo Rohita was observed at different days i.e. 1st day to 10th day, and it was found that the mortality rate of Labeo Rohita increased with time and dilution. This shows that the toxicity of distillery effluent was very high for aquatic organism. The higher concentration and longer exposure of species show higher mortality rate. In normal condition (fresh water) fish showed normal behaviour and swimming, in contrast to the effluent exposed fish which showed abnormal swimming and behaviour. The fresh water organisms particularly freshwater fishes are more affected to these effluents.

Keywords: Distillery effluent, Mortality, Labeo Rohita, Toxicity, physico-chemical parameters.

Introduction

Distillery industries play a major role in the environmental pollution. The organic effluent discharged by such industries is one of the most complex, troublesome and strongest organic effluent having extremely high B.O.D. and C.O.D. which discharge directly or indirectly into land or small channel leading to the nearby river, due to which water quality of rivers and streams gets degraded. There are number of chemicals in the environment, some of them are toxic chemicals which are discharged by industries into water bodies and they enter into food chain. Once they enter our biological system and disturb the biological process, leading in some cases to fatal results, depending on the composition and concentration of industrial effluent, rate of feeding and digestion process of fishes¹.

The freshwater environment is going to be polluted by various pollutants which have adverse effects on aquatic organisms. The fresh water organisms particularly fishes are more susceptible to these pollutants. The effects of pollutants are generally characterized on survival, reproduction or growth due to physiological alteration in animal. The physical and biological components of the environment play an important role in manifestation of biological response to pollutants. The toxicity of particular pollutants depends upon many factors such as animal weight² and developmental stages³ also. Toxicity tests are used to evaluate the concentrations of the chemical and the duration of exposure required to produce the criterion effect. Apparently aquatic toxicity tests are used in detecting and evaluating the potential toxicological effects of chemicals on aquatic organisms^{4, 5}. Toxicity tests become desirable in chemical quality evaluations as a consequence of the inability of the physical and chemical tests alone to sufficiently access the potential effect on aquatic biota⁶.

The effect of any substance is dependent on a number of factors. The most important factor is the dose time relationship. Dose is the quantity of a substance that a surface, plant or animal is exposed to. Time means how often the exposure occurs. Thus the dose time relationship is how much of the substance is involved and how often the exposure to substance occurs⁷. The present study deals with the toxicity of distillery effluent on freshwater fish *Labeo Rohita* at different concentration/dilution and dose time.

Materials And Methods

The effluent samples were collected from Lord's distillery Ltd., Nandgaj, Ghazipur, U.P., India, for toxicity test, samples were stored in dark place and the physicochemical analysis of spent wash, primary treated distillery effluent (PTDE) and its dilution with 50% and 75% of water were carried out as per as standard methods⁸.

A number of experimental fish *Labeo Rohita* commonly known as Rohu were caught from Ganga River. After disinfecting them with 0.1% KMnO_4 and acclimatizing them to laboratory conditions for 10 days at room temperature in glass tank in which air (oxygen) was continuously bubbled through an aerator, the fishes were fed with standard fish meal. The average length of fishes was 8-12 cm, used for experiment. Fishes were caught with a hand net from acclimatization tanks and carefully transferred into the test jars. The fishes were not touched with hand during the selection so as to avoid stress due to handling. Only healthy and active test fish were selected.

The mortality tests were performed in 20 liter glass jars, containing 10 fishes in each with concentrations of the distillery effluent ranging from spent wash, PTDE (Primary treated distillery effluent), and its dilution with 50% and 75% of water. Fish mortality rate was observed on (every 24 hrs.) 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th and 10th day exposure. A batch of 10 fishes was maintained along with experimental fishes as control group (fresh water).

Results And Discussion

The physicochemical properties of spent wash, PTDE (Primary Treated Distillery Effluent), PTDE diluted with 50% with water and PTDE diluted with 75% of water was studied. Chemical composition such as colour, odour, Total Solids (TS), Total dissolved solids (TDS), Total Suspended Solids (TSS), pH, Electrical Conductivity (EC), Total hardness, Calcium(Ca), Magnesium (Mg), Alkalinity, Chloride (Cl), Dissolved Oxygen (D.O), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonical Nitrogen, Total Phosphorus, and Total Potassium were analysed and tabulated (Table 1). The data revealed that the great variation at different dilution level of effluent. The spent wash and PTDE (Primary Treated Distillery Effluent) shows that the higher values at all physicochemical parameters. All the values decreased with increasing dilution, whereas the properties of fresh water were under limit.

The toxicity of distillery effluent on freshwater fish *Labeo Rohita* shows that the fish exposed to lethal concentration of distillery effluent for a short term exposure were studied in terms of rate of survival and mortality. The results of the fish test indicate that the toxicity of distillery effluent varies considerably (Fig. 1). The mortality rate of freshwater fish *Labeo Rohita* exposed for 1st day, 2nd day 3rd day, 4th day, 5th day, 6th day, 7th day, 8th day, 9th day and 10th day have been observed at different dilution of distillery effluent (Table 2).

The mortality rate of fishes in spent wash was 100% on 1st day (after 24 hrs.). They show that the toxicity of distillery effluent was very high for freshwater fish. In this dilution fish's shows abnormal behaviour, it is noticed that the fishes do erratic swimming, convulsion, jerky movement and rapid opercula movement. Similar report was observed in paper mill effluent^{9, 10}. This is due to high toxicity of distillery effluent. The levels of D.O. in effluent were nil, B.O.D. & C.O.D. was too high, and the solids were also very high due to huge amount of organic matter in effluent. High TSS levels may be partially responsible for the toxicity observed at high concentrations of effluent, due to the fish gills being blocked by particulate matter. Similar result was observed that the suspended solids can have toxic effects by clogging gills of fishes¹¹. The concentration of chlorides was also very high in distillery effluent which may be toxic for fish. The chlorides can be fatal to fish in concentration above 400 mg/l¹².

The primary treated distillery effluent (PTDE) also show the toxic effect on fresh water fish. In this dilution fish also shows the similar action as found in spent wash i.e. abnormal behaviour, it is noticed that the fishes do erratic swimming, convulsion, jerky movement and rapid opercula movement. The mortality rate of fish on 1st day (after 24 hrs.) in PTDE was 80% and reached to 100% on 4th day. Whereas the mortality rate of fishes was decreased with increasing dilution. When the PTDE diluted with 50% of water, the mortality rate of fishes was 20% on 1st to 3rd day, which increased to 40% on 4th to 6th day then again increased to 50% on 7th to 8th day and finally reached 60% on 9th & 10th day. It shows the mortality rate of fishes was also dependent on exposure of time. The lowest mortality rate of fishes was observed on PTDE diluted with 75% of water. No mortality was found on 1st day to 3rd day but with increased exposure, 10% mortality was observed on 4th & 5th day which increased to 20% on 6th to 8th day, finally increased to 30% on 9th to 10th day (fig.1). It shows that the low dilution of distillery effluent was not more toxic for fishes. While the mortality rate of fishes in fresh water was nil.

PARAMETERS	Spent Wash	PTDE (Primary treated distillery effluent)	PTDE diluted with 50% of water	PTDE diluted with 75% of water
Colour	Dark brown	Reddish brown	Brown	Light brown
Odour	Offensive	Offensive	Offensive	Minute smell
Total solids	76500 ±2.3	28060 ±2.0	16120 ±3.0	10432 ±5.4
Total Dissolve solids	49040 ±4.5	22616 ±2.0	12354 ±2.0	8010 ±6.6
Total suspended solids	18460 ±0.0	5444 ±0.0	3766 ±0.0	2422 ±0.0
pH	3.9 ±0.2	6.4 ±0.8	7.6 ±0.6	7.7 ±1.4
EC (µS)	30456 ±4.9	14800 ±2.4	8380 ±4.8	3476 ±2.4
Total Hardness	4876 ±4.2	2060 ±3.6	1354 ±2.3	940 ±6.2
Calcium	2050 ±1.2	872 ±2.2	610 ±2.0	422 ±4.2
Magnesium	3715 ±2.8	1742 ±3.0	992 ±4.3	684 ±6.8
Alkalinity	7850 ±1.4	3680 ±5.0	1880 ±3.0	1260 ±2.1
Chloride	7238 ±4.5	5352 ±3.0	2362 ±6.0	1464 ±1.4
Dissolve Oxygen	Nil	Nil	2.6 ±0.4	4.6 ±1.3
Biological Oxygen Demand	36100 ±2.0	14824 ±2.0	6890 ±2.2	3240 ±4.2
Chemical oxygen Demand	84050 ±8.6	32030 ±6.2	11448 ±4.2	4254 ±4.5
Ammonical Nitrogen	1660 ±0.8	714.2 ±2.2	412.3 ±2.0	286.6 ±3.0
Total Phosphorus	125 ±0.6	32.08 ±1.5	22.4 ±2.3	12.8 ±1.3
Total Potassium	9600 ±1.8	5360 ±4.0	2854 ±2.2	1482 ±3.0

(*All values are in mg/l unless otherwise stated)

Table 1: Physicochemical characteristics of PTDE and its dilution in 50% and 75% of water

Mean of triplicate samples (Mean ± Std. error of mean); (Values are in mg/l unless otherwise stated).

Dilution of distillery effluent	No. of fish exposed	Mortality rate (%) of fishes at different Days										
		1 st day	2 nd day	3 rd day	4 th day	5 th day	6 th day	7 th day	8 th day	9 th day	10 th day	
Spent Wash	10	100%	-	-	-	-	-	-	-	-	-	-
PTDE (Primary treated distillery effluent)	10	80%	80%	80%	100%	-	-	-	-	-	-	-
PTDE diluted with 50% of water	10	20%	20%	20%	40%	40%	40%	50%	50%	60%	60%	60%
PTDE diluted with 75% of water	10	0%	0%	0%	10%	10%	20%	20%	20%	30%	30%	30%
Fresh water	10	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 2: Mortality rate (%) of freshwater fish *Labeo rohita* in different dilution of distillery effluent on different day

Conclusion

In present study the mortality of fishes was calculated at different dilution of distillery effluent. The data indicates that the mortality rate was associated with time of exposure and dilution. Survival rate of *Labeo Rohita* decreased with increasing time and dilution of distillery effluent. Thus it was calculated that the higher concentration of distillery effluent is more toxic to aquatic organisms like freshwater fishes. It also shows that the freshwater fish *Labeo Rohita* is very sensitive. The physicochemical constituents of the receiving environment also played a major role in determining the mortality rate of the aquatic organisms.

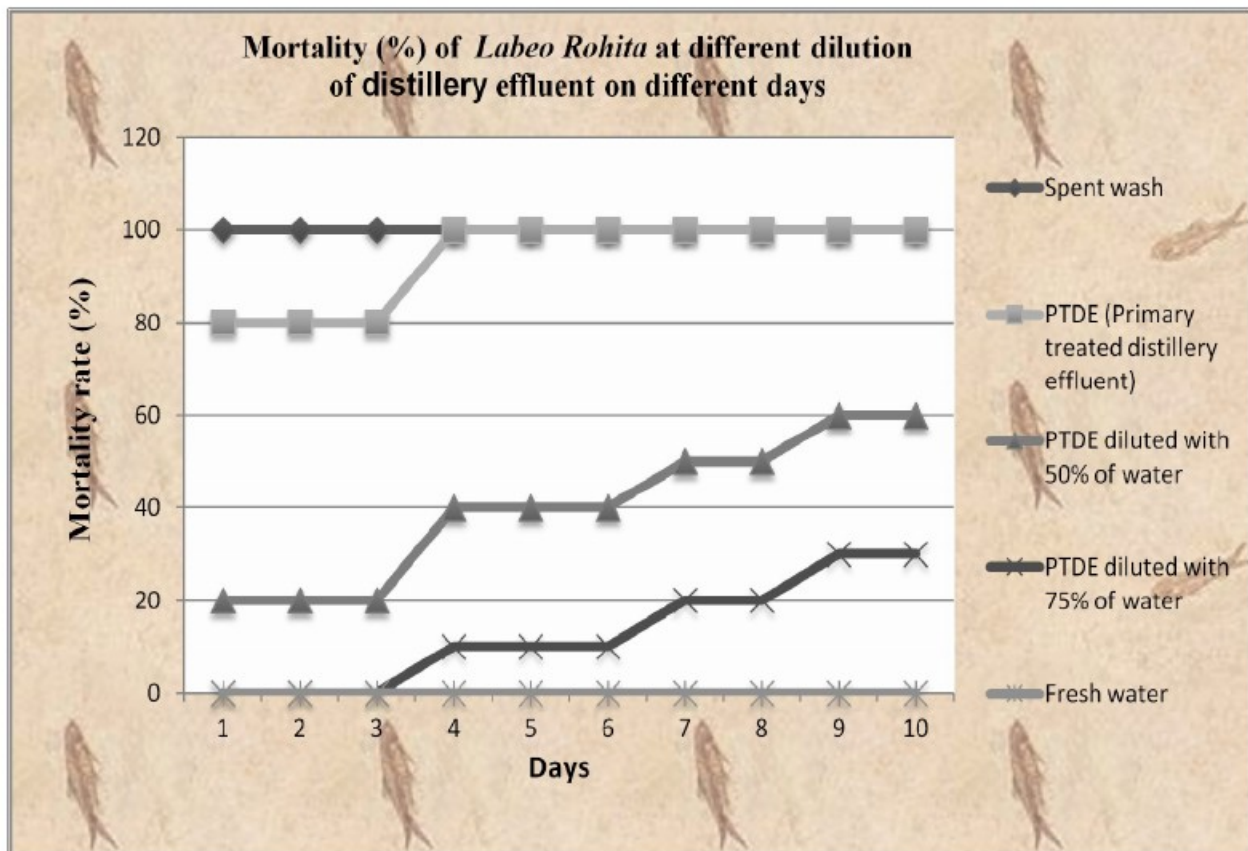


Figure 1: Mortality rate (%) of freshwater fish *Labeo rohita* in different dilution of distillery effluent at different days

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