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ORIGINAL ARTICLE

Analysis of Paper Mill Effluent (Waste Water) and its Phytoremediation of Free Floating Macrophytes (Lemna minor)

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ABSTRACT
The physico-chemical characteristics of paper mill effluent and phytoremediation results of the industrial effluents are presented, paper mill industrial effluents show high level of pollution load with relation to their physico-chemical characteristic which were beyond standard recommended permissible limits. The aquatic macrophytes were found to alter the pH from alkaline to neutral pH of each industrial effluent. Changes in pH were dependent mainly upon the duration of treatment. I have shown better performance of alterations in pH (neutral). In the study TDS, BOD and COD value of each industrial effluent was significantly reduced. The data demonstrated reduction of TDS BOD and COD parameter dependent of concentration and duration. The result is obtained by phytoremedation experiment COD is 58.48%, TDS is 62.22% and BOD is 59.70%. The lemna minor plant is most effective for the reduction of Paper mill effluent. Data indicate that Lemna minor plants were significant ($p<0.001$) in reducing the physico-chemical characteristic of the effluents concentration at various exposure duration.
Key Words *: Pulp and paper mills effluent, Phytoremediation, BOD, bioremediation, COD*

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INTRODUCTION

India is rich in water resources, being endowed with a network of rivers and vast alluvial basins to held ground water. The rapid increase in the pollution of the country and the need to meet water resources in many parts of the country are getting depleted and the water quality has deteriorated. Industrial waste has been a major cause in reducing soil fertility and causing great damage because effluent are being added to he neighboring soil and water (Frequently used for irrigation) continuously [1]. Water is a vital resource for agriculture. Most of the industrial wastewater creating the alkalinity and salinity problems in irrigation water poses as great challenge to the sustainability of irrigation agriculture. Industrial effluents contaminate the land by its high salt and metal contents. Industrial effluents when discharged into the sewage canals, rivers and irrigation water cause serious pollution and health hazards. Industrial effluents have been a major cause in reducing soil fertility and causing great damage because effluents are being continuously added to the neighboring soil and water. Today about million people in India do not have access to safe drinking water. Most of the country's water is used for agriculture purposed (84%), then to industrial section (12%) and rest for domestic use (4%).

In this study, the growth of duckweed was associated in laboratory scale experiments. They were fed with municipal and industrial waste water at constant temperature, COD, Total Nitrogen, Total phosphate removal efficiencies of the reactors were monitored by sampling influent and effluent of the system. Removal efficiency in this study reflects optimal results: 73-84 % COD removal, 83-87% TN removal, 70-85% TP removal and 83-95% OP removal. The result shows that the duckweed-based waste water treatment is capable of treating the laboratory wastewater [3].

MATERIAL AND METHODS

To the study the bioremediation of Paper Mill Waste water (industrial effluents) and Free-floating aquatic Macrophyte *Lemna minor* (Duckweed) were undertaken. Lemna minor is a small floating fresh water plant with much reduced and has adventitious roots with red coloured beneath. Duckweed collected from natural fresh water ponds and effluent sample were collected from as pre-treatment and post treatment.

The settled and filtered industrial effluents (100%) were diluted to 75%, 50% and 25% of original effluent concentration using deionized water as diluents. The different effluent concentration on varying length of exposure durations (7, 14, 21 and 28 days). The Physico- chemical analysis of paper mill effluent is analysis i.e, Temperature, pH, COD, BOD, TDS etc [2].

RESULTS AND DISCUSSION

A brief description of physico-chemical characteristic (Table I, Figure I) of paper mill industrial is analyses. The pre treated (Untreated) Effluent of Pulp and Paper mill was recorded as dark reddish brown in colour with offensive smell, temperature 50°C and pH 9.42. The TDS, BOD, COD were 2045, 1506, 3245 respectively.

While post-treatment (Treatment by Effluent Treatment plant of industry) effluent was recorded as reddish in colour with slight offensive smell, temperature 25.2° C, pH 8.25, TDS 465, BOD 610, COD 875.

Table II and Figure II showed the changes in pH of industrial effluents are exposure of aquatic macrophytes. The changes in pH of industrial effluents and exposure duration of macrophytes and the initial pH values recorded as 8.25, 8.20, 8.12 and 8.07 in 100,75,50 and 25% effluent concentrations, respectively. The lowest pH values were observed in 25% effluent concentration after 28 days exposure of aquatic macrophytes then other days (7, 14, 21 days) of exposure. The results were recorded 7.35. It is more effective plant for the reduction of the pH level of Paper Mill effluent towards neutral pH.

Table III and Figure III indicate the reduction in TDS content of industrial effluent exposure of aquatic macrophyte. The reduction in TDS content of industrial effluents exposure of aquatic macrophytes. The initial value of TDS were recorded as 465, 395, 280 and 225 mg/l in 100, 75, 50 and 25% effluent concentrations, respectively. The minimum reduction in TDS was recorded 25% effluent concentration after 28 days exposure of aquatic macrophytes than other days (7, 14, 21 days) of exposure. The results were recorded 62.22% and most effective for the reduction of TDS content of Paper mill effluent.

Table IV and Figure IV indicate the reduction in BOD of Industrial Effluents and exposure duration of aquatic macrophyte. The reduction in BOD content of industrial effluents exposure of aquatic macrophytes. The initial value of BOD were recorded as 610, 550, 420 and 235 mg/l in 100, 75, 50 and 25% effluent concentrations, respectively. The minimum reduction in TDS was recorded 25% effluent concentration after 28 days exposure of aquatic macrophytes than other days (7, 14, 21 days) of exposure. The results were recorded 59.70% and most effective for the reduction of BOD content of Paper mill effluent.

Table V and Figure V indicate the reduction in COD of Waste water effluent and exposure of aquatic macrophyte. The reduction in COD content of industrial effluents exposure of aquatic macrophytes. The initial value of COD were observed as 875, 830, 680 and 565 mg/l in 100, 75, 50 and 25% effluent concentrations, respectively. The minimum reduction in COD was recorded 25% effluent concentration after 28 days exposure of aquatic macrophytes than other days (7, 14, 21 days) of exposure. The results were recorded 58.48% and most effective for the reduction of COD content of Paper mill effluent.

Data indicate that *Lemna minor* plants were significant ($p<0.001$) in reducing the physico-chemical characteristic of the effluents concentration at various exposure duration.

Table I: Physico-Chemical Analysis of Paper Mill Effluents

Parameter	Paper Mill Industry	
	Effluent Treatment	
	Pre Treatment (Untreated Industrial Effluent)	Post Treatment(Treated Effluent after ETP)
Colour	Dark Reddish Brown	Reddish
Odour	Offensive	Offensive
Temperature	50	25.6
pH	9.42	8.25
TDS	2045	465
BOD	1506	610
COD	3245	875

~Values are the mean of three replicates

^Except temperature and pH, all the measurement's is mg/l

Table II: Changes in pH at different Concentration of effluent after exposure of Free-Floating aquatic macrophytes at various durations.

Name of Macrophytes	Effluent's Concentration (%)	Exposure Duration (Day)				
		0	7	14	21	28
Lemna minor	100	8.25	8.08	7.90	7.69	7.51
	75	8.20	8.02	7.83	7.60	7.45
	50	8.12	7.96	7.78	7.52	7.40
	25	8.07	7.91	7.72	7.44	7.35

Table III: Reduction in TDS (mg/l) at different Concentration of effluent after exposure of Free-Floating aquatic macrophytes at various durations.

Name of Macrophytes	Effluent's Concentration (%)	Exposure Duration (Day)				
		0	7	14	21	28
Lemna minor	100	465 (0.00)	290 (37.63)	250 (46.24)	240 (48.39)	230 (50.54)
	75	395 (0.00)	240 (38.99)	200 (49.37)	190 (51.90)	185 (53.16)
	50	280 (0.00)	155 (44.64)	125 (55.36)	120 (57.14)	115 (58.93)
	25	225 (0.00)	115 (48.44)	95 (57.78)	90 (60.00)	85 (62.22)

Values in parentheses percent reduction of TDS.

Table IV: Reduction in BOD (mg/l) at different Concentration of effluent after exposure of Free-Floating aquatic macrophytes at various durations.

Name of Macrophytes	Effluent's Concentration (%)	Exposure Duration (Day)				
		0	7	14	21	28
Lemna minor	100	610 (0.00)	395 (35.25)	330 (45.95)	315 (48.36)	310 (49.18)
	75	550 (0.00)	335 (39.09)	275 (50.00)	265 (51.82)	260 (52.53)
	50	420 (0.00)	240 (42.86)	195 (53.57)	182 (55.95)	180 (57.14)
	25	335 (0.00)	175 (47.76)	145 (56.72)	140 (58.21)	135 (59.70)

Values in parentheses percent reduction of BOD

Table V: Reduction in COD (mg/l) at different Concentration of effluent after exposure of Free-Floating aquatic macrophytes at various durations.

Name of Macrophytes	Effluent's Concentration (%)	Exposure Duration (Day)				
		0	7	14	21	28
Lemna minor	100	875 (0.00)	625 (28.57)	550 (37.41)	535 (38.86)	520 (40.57)
	75	830 (0.00)	570 (31.33)	490 (40.96)	475 (42.77)	465 (43.98)
	50	680 (0.00)	425 (37.50)	340 (50.00)	330 (51.47)	320 (52.94)
	25	565 (0.00)	335 (40.71)	260 (53.98)	250 (55.75)	235 (58.48)

Values in parentheses percent reduction of COD.

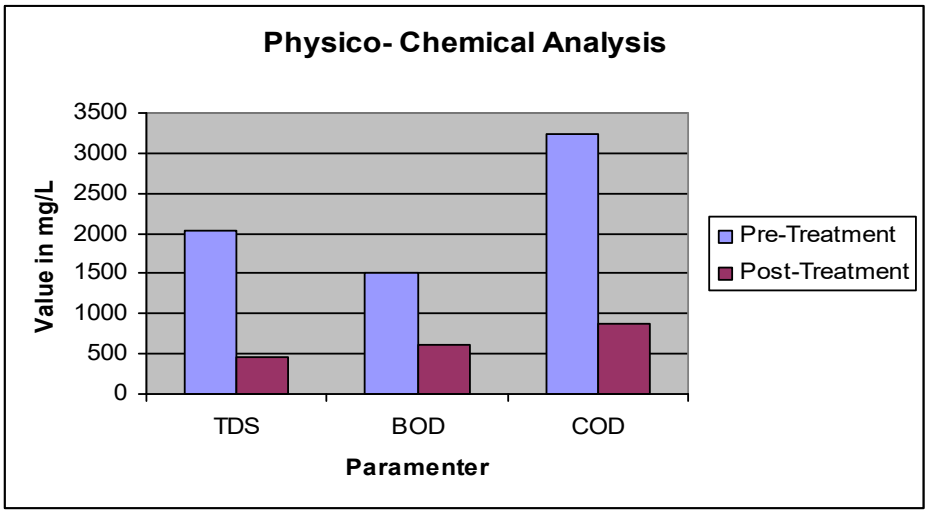

Fig. I: Physico-Chemical Analysis of Paper Mill Effluents Pre-Treatment and Post-Treatment

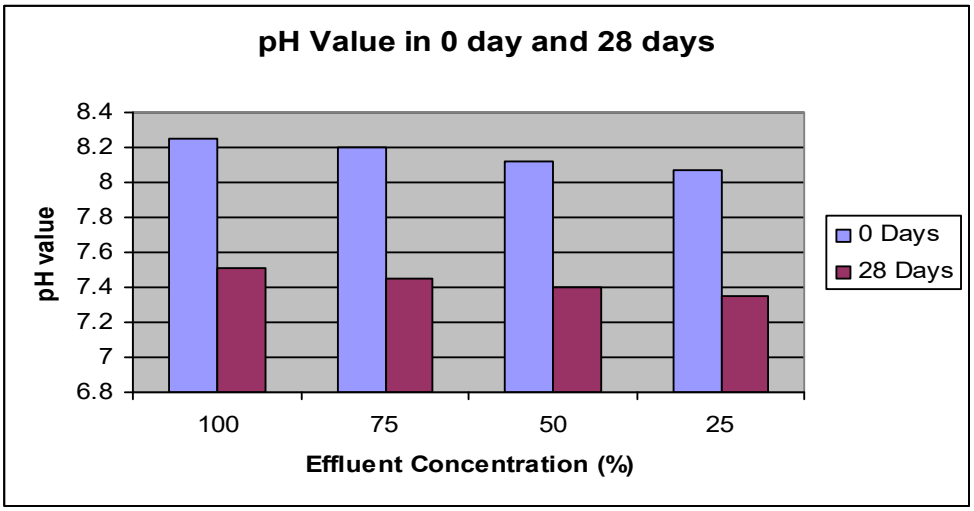

Fig. II: Percent Reduction & Change in pH different concentration of Paper Mill Effluents (Initial (0 days) & Final (28 days))

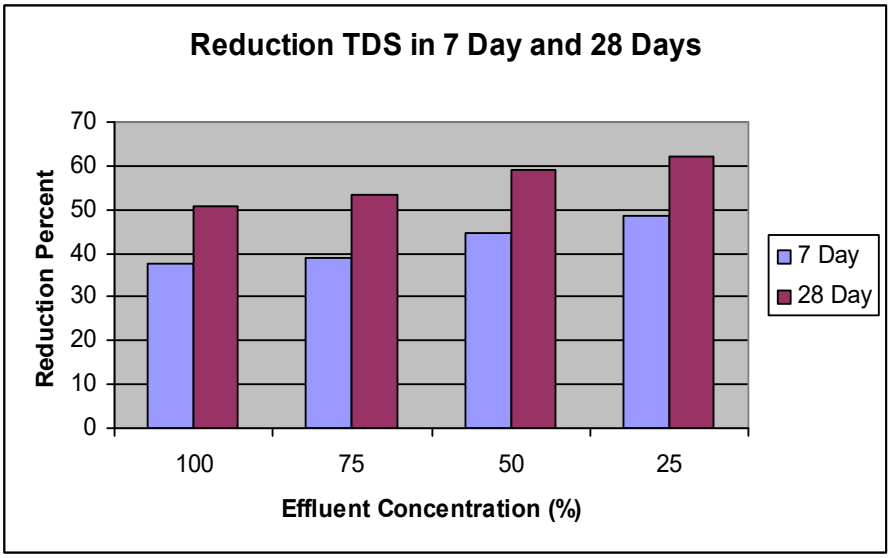

Fig. III: Percent Reduction & Change in Total Dissolved Solids (TDS) different concentration of Paper Mill Effluents (Initial (7 days) & Final (28 days))

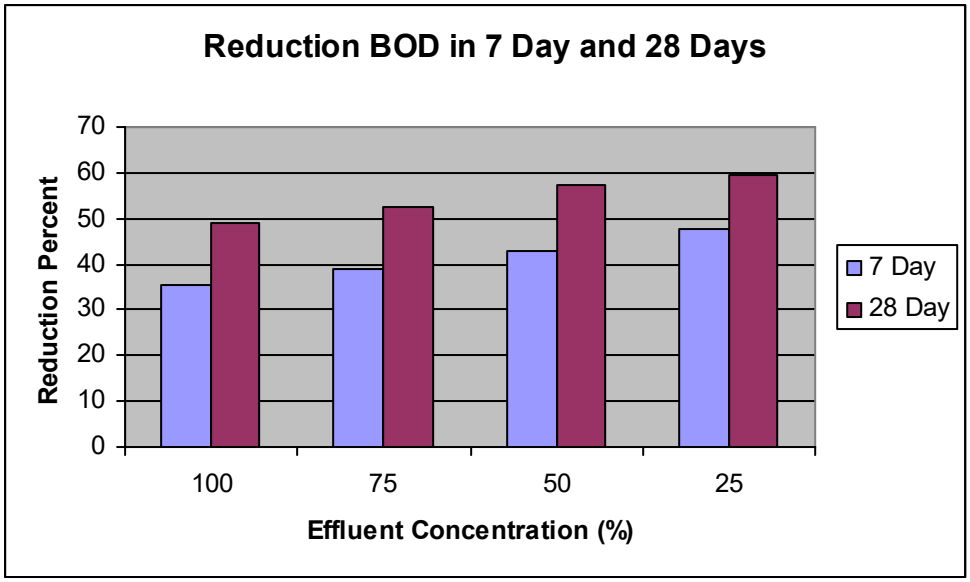

Fig. IV: Percent Reduction & Change in Biological Oxygen Demand (BOD) different concentration of Paper Mill Effluents (Initial (7 days) & Final (28 days))

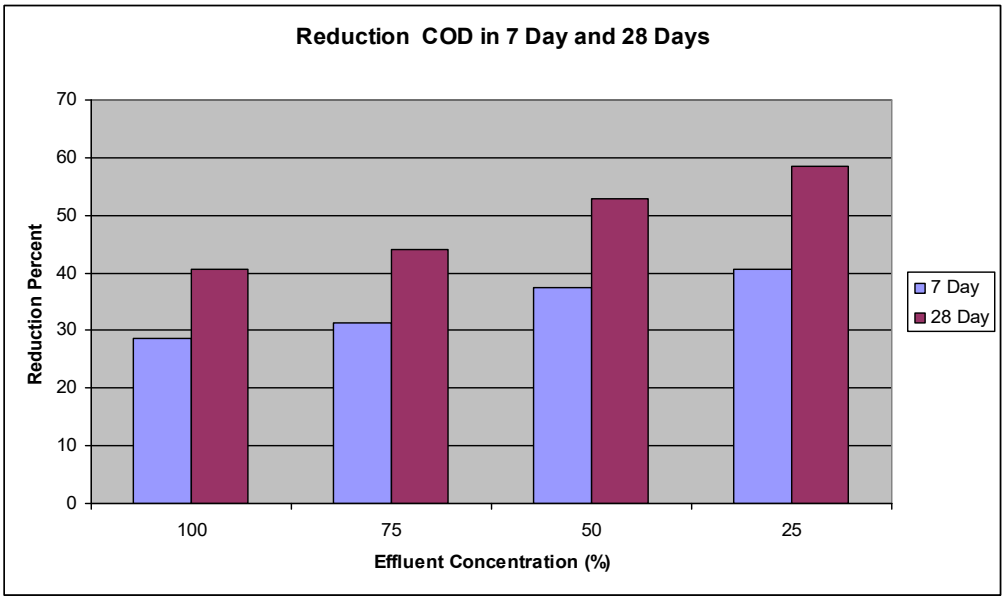

Fig. V: Percent Reduction & Change in Chemical Oxygen Demand (COD) different concentration of Paper Mill Effluents (Initial (7 days) & Final (28 days))

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