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Role of Fungi Species in Colour Removal from Textile Industry Wastewater

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Abstract: The present study focused to isolate the different fungi species from contaminated soil samples of textile industry wastewater, located in Kanchipuram. The experiments were conducted against the effect of pH, fungi biomass and different concentration (different dilution ratio) to know the effectiveness of fungi for removing colour from textile industry wastewater. The results showed that the order of maximum removal of colour by the fungi at an optimum pH of 5, an optimum fungi biomass of 10 g and an optimum dilution ratio of 5 was *Aspergillus niger* (96.72 %) followed by *Aspergillus flavus* (94.44 %). Also, the experimental data on removal of colour in a textile industry wastewater is validated with the aqueous solutions of same colour concentration and the results of validated experiments showed that the experimental investigation done for this study may be reproduced for removing any coloured wastewater from any industrial wastewater environment.
Keywords: Fungi Species, Process Parameters, Textile Industry Wastewater .

Introduction

Textile industries consume a large volume of water and chemicals for making various textile goods and as a result, large volume of wastewater discharged on land with or without treatments. The quantities and characteristics of wastewater discharged vary from mill to mill, which depends on the water consumption and the average daily product[1]. The wastewater generated from the various processing units in a textile industries are desizing, scouring, bleaching, mercerizing, dyeing, printing, and packing required huge amount of organic chemicals of complex structure[2]. The main parameters identified in the textile industry are pH, electrical conductivity, chloride, sulphate, phenols, total dissolved solids, biochemical oxygen demand and chemical oxygen demand and other solution substances [3]. Therefore, wastewaters from the textile industry have to be treated before being discharged to the environment.

Various methods like coagulation, oxidation, reduction, precipitation, filtration, flotation, electro-chemical treatment, reverse osmosis, membrane separation, adsorption[3,4,5], constructed wetland[6] and ozonation techniques etc. can be employed to remove various pollutant forms the textile industry wastewater. However their costs are high and most of them are difficult to use under field conditions, hence such a condition there is an urgent need to study the simplest and cost-effective techniques for controlling pollution from industrial wastewaters and treating such wastewater, such as bioremediation. Bacteria, fungi, yeast and algae are abundantly available in nature are a potential alternative to conventional methods that are used to decontaminate liquid wastes. The greater advantages of using fungi species is that the fungi species have wall material, which shows excellent metal-binding properties [7]. Similarly, it can adapt and grow under various

extreme conditions of pH, temperature, nutrient availability and high metal concentrations. Thus, the present study focuses to isolate the different fungi species from textile industry wastewater contaminated site, located in Kanchipuram District. The isolated different fungi species from textile industry wastewater were used to remove the colour in a textile industry wastewater. Also, the experimental data on removal of colour in a textile industry wastewater by all isolated fungi speciesisvalidated with theexperimental data on removal of colour in an aqueous solution.

Materials and Methods

Collection of Textile Industry Wastewater

For the present study, textile industry effluent sampleswere collected from the final clarifier of textile industrial effluent treatment plant of Kanchipuram, Tamil Nadu, India with the help of airtight sterilized bottles. Then, took the effluent samples to the Environmental Laboratory and then they were stored in the refrigerator at a temperature of 278 K for analyzing colourin later stages.

Soil Sample Collection

Soil samples were collected by randomly at 5 places around the textile industrial wastewater contaminated site and composite soil sample was prepared from mixing of soil samples from 5 sites and it was taken for laboratory and stored at 4°C to ensure minimal biological activity. The isolation of fungi was carried out within 24 hours of sample collection for further investigation.

Sterilization of Apparatus

Petri plates, media bottles, distilled water, McCartney bottles and syringes weresterilized in an autoclave for 60 min. at 120°C. After autoclaving all sterilized material dried in oven at 100°C.

Media Preparation

Potato Dextrose Agar (PDA) media were used for the isolation of fungi. For the preparation of PDA, potatoes (200g) were peeled, sliced and boiled, and then sieved through a clean muslin cloth to get a broth in which agar (10g) and dextrose sugar (10g) was added. The media was then autoclaved for 30 min. at 120°C.

Isolation of Fungi

Fungi were isolated on Potato Dextrose Agar (PDA) by the soil dilution method. Poured the media in Petri-dishes and allowed to solidify for 48 hours. To suppress the bacterial growth, 25 mg/L of streptomycin was added to the medium. After solidification, the plates were filled with diluted soil solution (different proportion). The plates were incubated at 28°C for 72 hours. After incubating at 28°C for 72 hours, the prominent colonies were picked and inoculated individually in other PDA plates for further purification.

Identification of Fungi

After incubation, the distinct colonies were counted and identified. The fungal cultures were identified on the basis of macroscopic (colonial morphology, colour, texture, shape, diameter and appearance of the colony) and microscopic (septation in mycelium, presence of specific reproductive structures, shape and structure of conidia, and presence of sterile mycelium) characteristics (Table- 1).

Table 1: Isolated Fungi from Textile Industry Wastewater Contaminated Soil Samples

Fungus Code	Isolated Fungi	Sample Code
F1	*Aspergillus niger*	S1, S2, S3, S5, S8, S10
F2	*Aspergillus flavus*	S4, S6, S7, S9

Absorption Experiments

This method consists of batch experiments involving effect of pH, fungi biomass and different initial concentration (different dilution ratio) to know the effectiveness of fungi for removing colour from textile industry wastewater. The colour of textile industry wastewater is due the presence of Acid Orange 10 dye, whose initial concentration in a textile industry wastewater is 45 mg/L. The concentrations of colour in a textile industry wastewater before and after equilibrium were determined as per standard procedure given by APHA, 2005 [8]. Triplicate of each experimental setup was maintained. In order to reduce colour in a textile industry effluent, the experimental setup were examined for different pH (2, 3, 4, 5, 6, and 7), different fungi biomass (2, 4, 6, 8, 10, and 12 g) and different dilution ratio (0, 1, 2, 3, 4, and 5). The absorption removal percentage of various parameters by fungi species was calculated by using the following formula:

$$\text{Percentage Removal} = \frac{(C_1 - C_2)}{C_1} \text{X } 100 \qquad (1)$$

in which C_1 is the concentration of colour (mg/L) before treatment with fungi species and C_2 is the concentration of colour (mg/L) after treatment with fungi species.

Results and Discussion

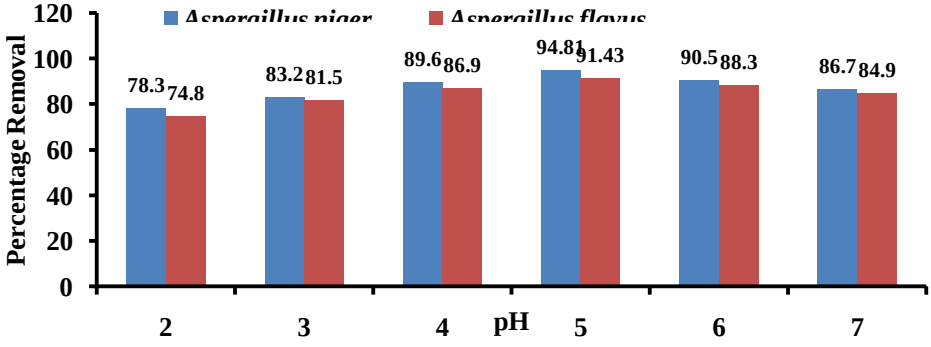
In this study, fungi isolated from textile industry wastewater contaminated soil were used to remove the colour of Acid Orange 10 dye from the textile industry wastewater collected from Kanchipuram. The reduction of colour in a textile industry wastewater using isolated fungi species was done against different pH, fungi biomass and dilution ratio.

Effect of pH

Table 2: The Maximum Removal Percentage of Colour in a Textile Industry Wastewater by an Isolated Fungi with an Optimum pH of 5, Optimum Incubation Time of 5 days, Fungus Biomass of 2 g, and an Initial Colour Concentration of 45 mg/L

Sample Code	Isolated Fungi	Percentage Removal
S1	*Aspergillus niger*	94.81
S2	*Aspergillus niger*	93.17
S3	*Aspergillus niger*	89.48
S4	*Aspergillus flavus*	91.43
S5	*Aspergillus niger*	86.51
S6	*Aspergillus flavus*	87.07
S7	*Aspergillus flavus*	84.31
S8	*Aspergillus niger*	83.25
S9	*Aspergillus flavus*	82.36
S10	*Aspergillus niger*	80.77

Figure1: The Maximum Removal Percentage of Colour in a Textile Industry Wastewater by the Group of an Isolated Fungi with an Optimum pH of 5, Optimum Incubation Time of 5 days, Fungus Biomass of 2 g, and an Initial Colour Concentration of 45 mg/L



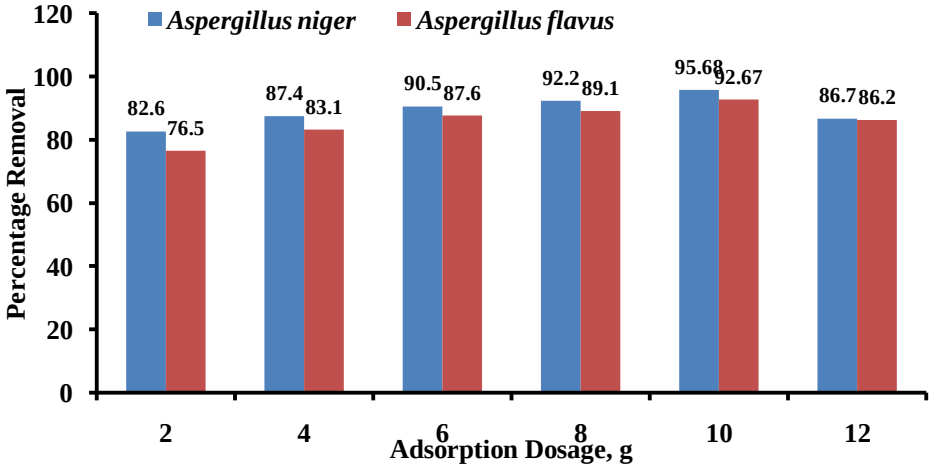
(Table- 2) shows the removal of colourfor the incubation period of 5 days, 2g of each fungal biomass, initial concentration of Acid Orange 10 dye 45 mg/L (dilution ratio 1part of wastewater : 0 part of deionized water) against pH of 2, 3, 4, 5, 6 and 7. The colour removal was found to be varied for two fungi species and for incubation time. It can be observed from (Table- 2), the reduction of colour increases upto the pH of 5 and decreases with increase pH values of 6 and 7. The colour reduction by two fungi have shown similar trend and the optimum pH found from this study is 5 and the decrease in sorption capacity to increase in pH may be attributed to the changes in other metal speciation and the dissociation of functional groups on the fungi. From (Table- 2), it may be noted that the order of removal of colour by the fungi at an optimum pH of 5was S1 > S2 > S4 > S3 > S6 > S5 > S7 > S8 > S9 > S10. Furthermore, the maximum removal of removal by the group of an isolated fungi species (Figure- 1) at an optimum pH of 5was found in the order of *Aspergillus niger* (S1) > *Aspergillus flavus* (S4) and the maximum percentage removal was 94.81 %, and 91.43 % respectively for the fungi species *Aspergillus niger* (S1) and *Aspergillus flavus* (S4).

Effect of Fungus Biomass

Table 3: The Maximum Removal Percentage of Colour in a Textile Industry Wastewater by an Isolated Fungi with an Optimum pH of 5, Optimum Incubation Time of 5 days, Optimum Fungus Biomass of 10 g, and an Initial Colour Concentration of 45 mg/L

Sample Code	Isolated Fungi	Percentage Removal
S1	*Aspergillus niger*	95.68
S2	*Aspergillus niger*	93.23
S3	*Aspergillus niger*	90.21
S4	*Aspergillus flavus*	92.67
S5	*Aspergillus niger*	87.37
S6	*Aspergillus flavus*	89.18
S7	*Aspergillus flavus*	85.51
S8	*Aspergillus niger*	84.46
S9	*Aspergillus flavus*	83.88
S10	*Aspergillus niger*	81.43

Figure 2: The Maximum Removal Percentage of Colour in a Textile Industry Wastewater by the Group of an Isolated Fungi with an Optimum pH of 5, Optimum Incubation Time of 5 days, Optimum Fungus Biomass of 10 g, and an Initial Colour Concentration of 45 mg/L



(Table- 3) shows the removal of colour for the incubation period of 5 days, initial concentration of Acid Orange 10 dye 45 mg/L (dilution ratio 1part of wastewater : 0 part of deionized water), Optimum pH of 5 against the fungi biomass of 2, 4, 6, 8, 10, and 12 g. It can be observed from (Table- 3), the reduction of colour increases upto the biomass of 10 g and decreases with increase biomass values of 12 g. The optimum biomass for which, maximum removal of colour occurred at 10 g. Higher the removal is due to more binding sites in the fungi biomass. The colour removal by two fungi species have shown similar trend as that of effect of pH.

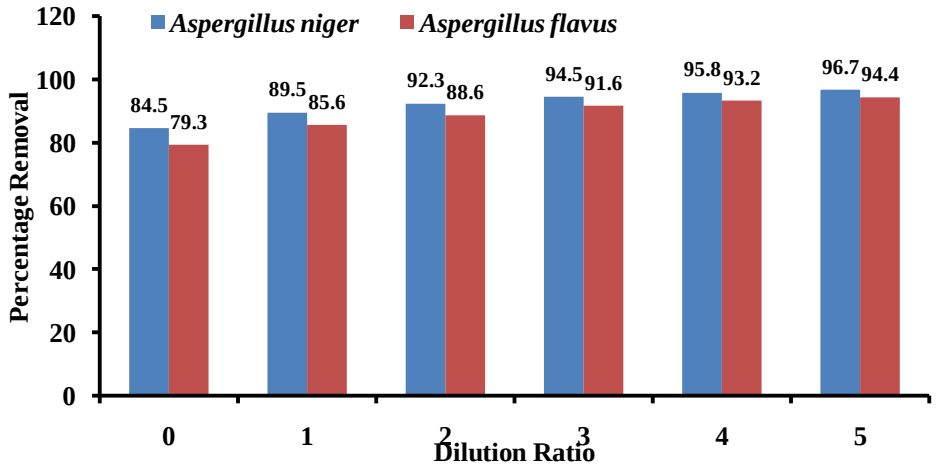
From (Table- 3), it may be observed that the order of removal of colour by the fungi at an optimum biomass of 10 gwas S1 > S2 > S4 > S3 > S6 > S5 > S7 > S8 > S9 > S10. Furthermore, the maximum removal of colour by the group of an isolated fungi species (Figure- 2) at an optimum biomass of 10 g was found in the order of *Aspergillus niger* (S1) > *Aspergillus flavus* (S4) and the maximum percentage removal was 95.68 %, and 92.67 % respectively for the fungi species *Aspergillus niger* (S1) and *Aspergillus flavus* (S4).

Effect of Initial Concentration

Table 4: The Maximum Removal Percentage of Colour in a Textile Industry Wastewater by an Isolated Fungi with an Optimum pH of 5, Optimum Incubation Time of 5 days, Optimum Fungus Biomass of 10 g, and Optimum Initial Colour Concentration of 1.41 mg/L

Sample Code	Isolated Fungi	Percentage Removal
S1	*Aspergillus niger*	96.72
S2	*Aspergillus niger*	95.86
S3	*Aspergillus niger*	91.94
S4	*Aspergillus flavus*	94.44
S5	*Aspergillus niger*	89.23
S6	*Aspergillus flavus*	90.28
S7	*Aspergillus flavus*	88.48
S8	*Aspergillus niger*	86.49
S9	*Aspergillus flavus*	84.72
S10	*Aspergillus niger*	82.52

Fig.3 The Maximum Removal Percentage of Colour in a Textile Industry Wastewater by the Group of an Isolated Fungi with an Optimum pH of 5, Optimum Incubation Time of 5 days, Optimum Fungus Biomass of 10 g, and Optimum Initial Colour Concentration of 1.41 mg/L

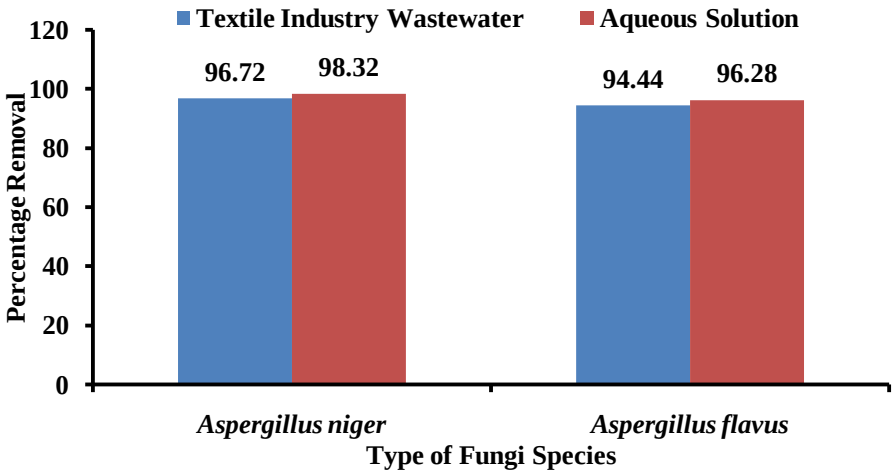


(Table- 4) shows the removal of colourfor the incubation period of 5 days, optimum pH of 5, optimum fungi biomass of 10 g against the dilution ratio of 0, 1, 2, 3, 4 and 5. It can be observed from (Table- 4), the reduction of colour increases upto the dilution ratio of 5. Higher the removal is due to more binding sites in the fungi biomass, which able to adsorb and absorb the colour intensity in the textile industry wastewater. The colour removal by two fungi species have shown similar trend as that of effect of pH and fungi biomass and the optimum dilution ratio found from this study is 5. From (Table- 4), it may be observed that the order of removal of colour by the fungi at an optimum dilution ratio of 5was S1 > S2 > S4 > S3 > S6 > S5 > S7 > S8 > S9 > S10. Furthermore, the maximum removal of removal by the group of an isolated fungi species (Figure- 3) at an optimum dilution ratio of 5 was found in the order of *Aspergillus niger* (S1) > *Aspergillus flavus* (S4) and the maximum percentage removal was 96.72 %, and 94.44 % respectively for the fungi species *Aspergillus niger* (S1) and *Aspergillus flavus* (S4).

Validation of Experiment

Validation of experiment is required to verify the finding of similarities against the observed values of an experimental investigation. This study is used to check the degree of similarity between the experiments at optimum values of pH, biomass and concentration on removal of colour in a textile industry wastewater using different fungi species with the new experiments (separate experiments) conducted against the optimum values of pH, biomass and concentration on removal of colour in an aqueous solution.The maximum removal of colour in a textile industry wastewater and an aqueous solution by an isolated fungi species at the optimum values of selected parameters is shown in (Figure- 4). The results (Figure- 4) showed that the maximum removal percentage of colour in an aqueous solution by an isolated fungi species at the optimum conditions is greater than the results of colour removal in a textile industry wastewater by an isolated fungi species. From (Figure- 4), it may be noted that the colour removal from aqueous solution is higher than the colour removal from textile industry wastewater, is due to there are no competitive ions present in aqueous solution than in a textile industry wastewater, where the competitive ions impurities are presented. The order of maximum removal of colour in an aqueous solution by the group of an isolated fungi species at an optimum condition is *Aspergillus niger* followed by *Aspergillus flavus*, which is similar to the observation made for removal of colour in a textile industry wastewater.

Figure 4: The Maximum Removal Percentage of Colour in a Textile Industry Wastewater, Colour in an Aqueous Solution by an Isolated Fungi Species with an Optimum pH of 5, Optimum Incubation Time of 5 days, Optimum Fungus Biomass of 10 g, and Optimum Initial Colour Concentration of 1.41 mg/L



Conclusion

Fungi species isolated from textileindustry wastewater contaminated soil were used to remove the colour from textile industry wastewater of Kanchipuram. The maximum removal percentage of colour in textile industry wastewater by isolated fungi is found at an optimum pH of 5, optimum incubation time of 5 days, optimum fungus biomass of 10 g, and an initial colour concentration of 45 mg/L. The maximum removal of colour from textile industry wastewater was achieved by *Aspergillus niger* than *Apergillus flavus*. Further, the findings of observed values of an experimental investigation with the observed values of an experimental investigation on removal of colour in aqueous solutions were validated by an isolated fungi species.The results of these studies (both regular and validate study) concluded that the isolated fungi species *Aspergillus niger* and *Aspergillus flavus* from textile industry wastewater contaminated soil are very viable and useful for bioremediation of any contaminated water and wastewater.

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