International Journal of Engineering &Technology, 7 (3.12) (2018) 180-184

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper



Dye Degradation using Saccharomyces Cerevisiae

Mahalakshmi Mathivanan[1*], Prabinth V[2], Selvin Chinnaiah S[3], Shanmuga Sundaram RS[4]

[1]School of Civil Engineering, SASTRA Deemed University, Thanjavur, India
**Corresponding Author Email: [1]mahalakshmi@civil.sastra.edu*

Abstract

Disposal of dyes into the environment causes serious damage and they may be toxic to some aquatic organisms due to their breakdown products. The colouring pigments present in the effluent may give aesthetic look and it affects the photosynthetic in plants. The chemical and physical methods have many disadvantages which can overcome by biological method because it is cost saving and environmentally benign. In biological methods, absorbents like Bacteria, fungus, cellular membrane etc. can be used. Since yeast is cheap and more effective it is preferred. In the present study an attempt was made to examine the potential of Saccharomyces Cerevisiae in decolorization of Congo red dye. The influence of different condition in variation of concentration, time and pH in that Study was made to find the optimum condition in which the maximum decolorization was occur. The UV Spectrum shows the maximum wavelength was observed in 496.93. At room temperature, the maximum decolorization of 90.7% was observed in the concentration of 40 ppm(0.004g/100ml) and it took place after 18hrs. In the next experiment, maximum decolorization of 96.88% was obtained in the concentration of 40ppm(0.004g/100ml) and pH of 4 at a time of 17hrs with a dosage of 0.1g in room temperature which is considering to be the optimum condition. The above results show the potential of this *Saccharomyces Cerevisiae* to be used in the biological treatment of textile effluent under optimum condition.

Keywords: *Saccharomyces Cerevisiae, Congo red dye, UV Spectrum,Yeast. Dye Degradation.*

1. Introduction

Environmental impact has become a major crisis in this world especially in developing countries. In India, water pollution is a big thread. In future many cities in India will be deprived of water. This matter has to be taken into consideration to reduce the damage caused by humans. Now days many industries dispose waste into natural wealth, these industries are more in number in rural area where the agriculture, humans, cattle and natural resources gets affected. Untreated water may cause huge impact in all the nature's creation. Deadly disease to humans, plants, animals and soil become unfertile. To avoid this water should be treated before disposing [1]. The usage of water in cities is very high than that of the village where people in village use water for agriculture where as in cities the water is wasted in car washing, swimming pools etc. To overcome this difficulty. We can use the treated water to this kind of activities like car washing, gardening and it can be again used for agricultural purpose. [2]
The water can be treated in ways such as physical, chemical and biological method. In physical method it is difficult to make membrane to capture the chemical pollutants present in the water and high pressure is required in this process. In case of chemical method, the treated water may contain some chemical impurities. [3] So Biological method is one of the best ways to treat water and it is economical when compared to other methods. In biological method, absorbent like Bacteria, Fungus can be used. [4].

2. Methodology

2.1 Cultivation of Yeast

In order to prepare yeast (Saccharomyces cerevisiae) some quantities of glucose, peptone, NaCl, yeast extractor should be added for the sterilization process i.e., food for yeast. These materials are kept in autoclave for sterilizing process. Then some amount of yeast is added after cooling it to room temperature. Then the yeast is kept at the Mechanical shaker for culturing process to make it grow for a period of time. [5]

2.2 Preparation of Media

The collected powder dye should be diluted to required proportions. Calibration process should be carried out to find the linearity of the collected dye sample. Yeast and dye solution are mixed together to make up media solution. For different parameters and concentration, the same process has to be carried out. Media can be prepared both in dead and living conditions. [6]
The media is prepared by mixing the following ingredients at the proportion mentioned glucose (0.4g/100ml), peptone (0.5g/100ml), NaCl (0.3g/100ml), yeast extract of (0.1mg/100ml) and dye (40ppm). The ingredients are mixed in a conical flask and kept in an auto clave for an hour for the purpose of sterilization. Auto clave is an instrument which is used for the sterilization purpose and the auto clave. The conical flasks are kept in a cooker for about an hour. Then it is cooled and the yeast (0.1g/100ml) is added. pH of the samples are noted down.

Copyright © 2018 Authors. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Then the media prepared is kept in a mechanical shaker. Mechanical shaker is an instrument which rotates at differential speed and it allows the particles to settle down which is kept over it. In this experiment we have set a rate of 100rpm to the shaker. Then 5ml of sample from each flask is pippeted out and kept in a centrifuge motor for about 10 minutes at a rate of 3000 rpm. This instrument is also used settle the particles down. It allows the minute small particles to settle down so the treated water stays up.

The treated water at the top is kept in a calorimeter to check the amount of absorbance. Calorimeter is an instrument which is used to check the absorbance of particles which is kept over it with accordance to the reference which is calibrated before the sample is placed. The corresponding OD value is noted for each sample and tabulated.

2.3 Treatment of Dye Solution

When partial yeast particles are formed between adsorbed species or when the absorbate got into the channels of the solids, we call it absorption. The yeast layer acts as a spongy media and it also acts as the absorbing layer. The coloring substance present in dye solution settled at the surface by the yeast.

2.4 Varying the Conditions

The yeast which is cultured has an optimum point at which the rate of absorption is maximum. Parameters like time, concentration of dye, concentration of yeast and inoculum are varied in the media to get the efficient result.

2.5 Reuse of Treated Water

After the treatment process, the water can be reused for industrial purpose, agriculture, gardening, car wash etc. The treated water may contain little amount of pigment elements and so it can be consumed by civilians. Compared to modern day chemical treatment methods, biological methods which we use for treating the water is more efficient for irrigation purpose. Even though the water has been treated, it can be used only for irrigation and domestic purpose and not as potable water. [7]

3. Results and Discussion

3.1 Varying Concentration

In this process, the concentration of dye is varied from 10 ppm to 40 ppm. Same procedure is carried out and optical density value for every one-hour interval is observed. The percentage colour removal graph and absorption capacity chat are plotted.

Table 1: OD Value for Varying Concentration

TIME (in hrs)	Concentration in ppm			
	10	20	30	40
Initial	0.148	0.235	0.722	0.901
5	0.056	0.060	0.269	0.394
16	0.026	0.035	0.091	0.086
17	0.026	0.034	0.088	0.085
18	0.025	0.032	0.087	0.084

Table 2: Percentage Colour Removal For Varying Concentration

TIME (in hrs)	Concentration in ppm			
	10	20	30	40
Initial	0	0	0	0
5	62.16	74.76	62.74	56.27
16	82.43	85.1	87.39	90.45
17	82.43	85.53	87.81	90.56
18	83.1	86.38	87.95	90.67

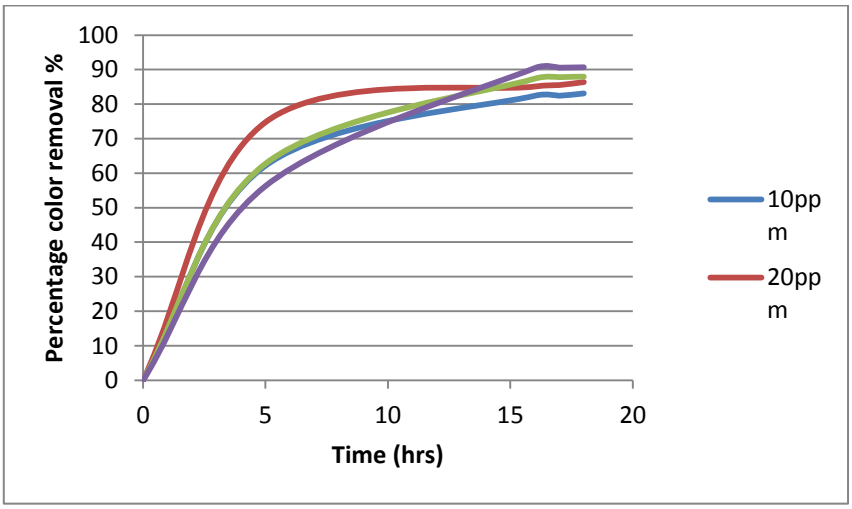

Fig. 1: Percentage Colour Removal For Varying Concentration

3.2 Varying pH

The media is prepared by mixing the following ingredients at the proportion mentioned glucose (0.4g/100ml), peptone (0.5g/100ml), NaCl (0.3g/100ml), yeast extract of (0.1mg/100ml) and dye (40ppm). The ingredients are mixed in a conical flask and kept in an auto clave for an hour for the purpose of sterilization.

Auto clave is an instrument which is used for the sterilization purpose and the auto clave which we use here is pressure cooker [8]. The conical flasks are kept in a cooker for about an hour. Then it is cooled and the yeast (0.1g/100ml) is added. pH of the samples are noted down. Then the samples are made to desired pH by adding acidic and basic solutions to it. To make a solution acidic, acidic solution prepared is added and for basic, add basic solution.

Then the media prepared is kept in a mechanical shaker. Mechanical shaker is an instrument which rotates at differential speed and it allows the particles to settle down which is kept over it. In this experiment we have set a rate of 100rpm to the shaker.

Then 5ml of sample from each flask is pippeted out and kept in a centrifuge motor for about 10 minutes at a rate of 3000 rpm. This instrument is also used settle the particles down. It allows the minute small particles to settle down so the treated water stays up. The treated water at the top is kept in a calorimeter to check the amount of absorbance [9]. Calorimeter is an instrument which is used to check the absorbance of particles which is kept over it with accordance to the reference which is calibrated before the sample is placed. The corresponding OD value is noted for each sample and tabulated.

Table 3: pH Value

TIME (in hrs)	CF					
	1	2	3	4	5	6
Initial	4	5	6	7	8	9
13	5.30	6.00	6.20	6.80	7.00	7.20
14	5.70	6.21	6.55	6.80	7.04	7.33
15	5.80	6.44	6.75	6.93	7.10	7.30
16	5.70	6.49	6.80	7.01	7.19	7.39
17	5.70	6.55	6.87	7.02	7.18	7.40

Table 4: Percentage Colour Removal For Varying pH

TIME (in hrs)	CF					
	1	2	3	4	5	6
13	91.94	83.33	60.36	89.35	92.51	70.84
14	92.73	84.33	73.07	89.75	92.53	71.54
15	94.89	89.45	87.38	90.44	92.83	83.56
16	95.08	89.85	87.78	90.54	92.93	84.26
17	95.08	90.06	88.08	90.54	93.43	84.36

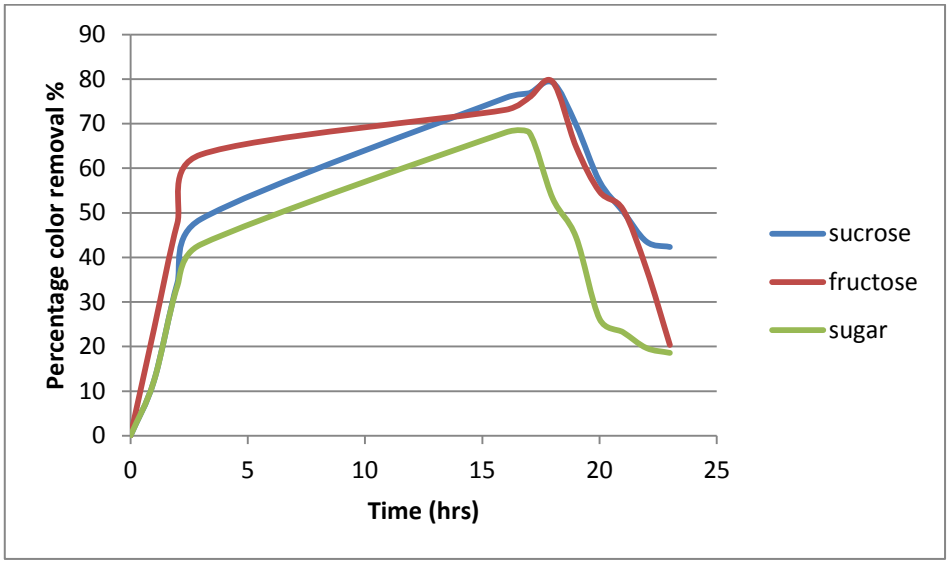

Fig. 2: Percentage Colour Removal for Varying pH

3.3 Varying Size of Inoculum

The various concentration of inoculums create impacts on the absorption capacity [10]. Microorganisms namely yeast and fungal cells were widely adopted in the absorption of dye due to their biomass [11]. In this condition inoculum added to the yeast is varied that is the food provided for the yeast (glucose, fructose and sugar) without changing the other parameter like quantity of yeast(0.1g/100ml) and concentration of dye (40ppm). And the same procedure is carried out optical density for every one hour is noted and percentage absorption value, Absorption capacity values are calculated and the graph is plotted.

Table 5: Percentage Colour Removal for Varying Inoculum

INC / TIME(hrs)	FRU	SUC	SUGAR
0	0	0	0
1	12.29	23.86	12.29
2	34.27	47.62	33.6
3	48.58	60.2	42.89
16	75.8	75.8	68.03
17	76.81	77.98	68.03
18	79.23	79.39	53.27
19	69.75	64.82	44.53
20	57.05	54.77	26.22
21	50.3	50.75	23.22
22	43.54	37.43	19.67
23	42.33	20.35	18.57

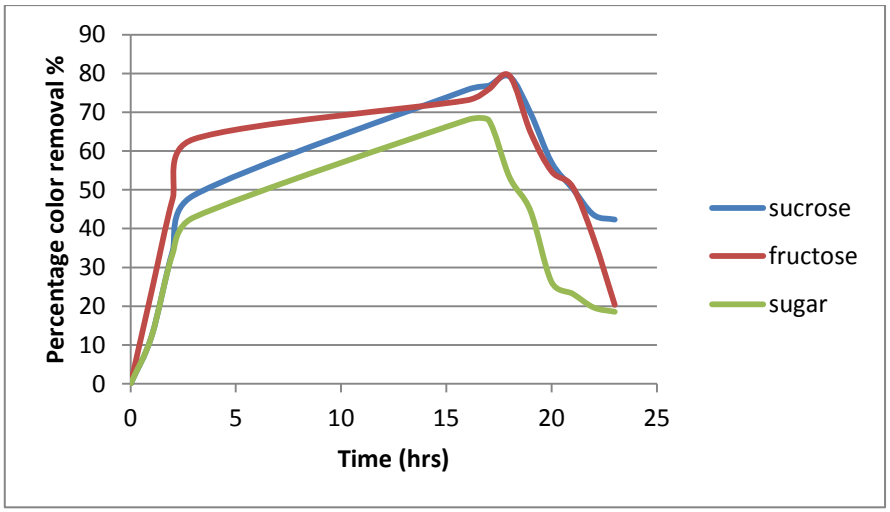

Fig. 3: Percentage Colour Removal for Varying Inoculum

3. 4 Varying Amount of Yeast

The yeast concentration variations show the changes in absorption capacity. In this condition yeast of quantities 0.1-0.4g is varied without changing the other parameter like inoculum (glucose 0.4g/100ml) and concentration of dye (40ppm). And the same procedure is carried out optical density for every one hour is noted and percentage absorption value, Absorption capacity values are calculated and the graph plotted.

Table 6: Percentage Colour Removal For Varying Yeast

Yeast conc(g) / Time(hrs)	0.1	0.2	0.3	0.4
0	0	0	0	0
1	1.15	1.37	0.9	0.55
2	1.9	1.65	0.98	0.85
3	2.51	1.79	1	0.88
4	2.75	1.81	1.01	0.89
5	3.43	2.37	1.25	0.93
16	3.54	2.39	1.33	0.95
17	3.51	2.35	1.32	0.91
18	3.63	2.49	1.36	0.97
19	3.53	2.39	1.27	0.86
20	3.47	2.36	1.23	0.82
21	3.29	2.25	1.14	0.72
22	3.26	2.22	1.13	0.71
23	0.59	1.28	0.73	0.52

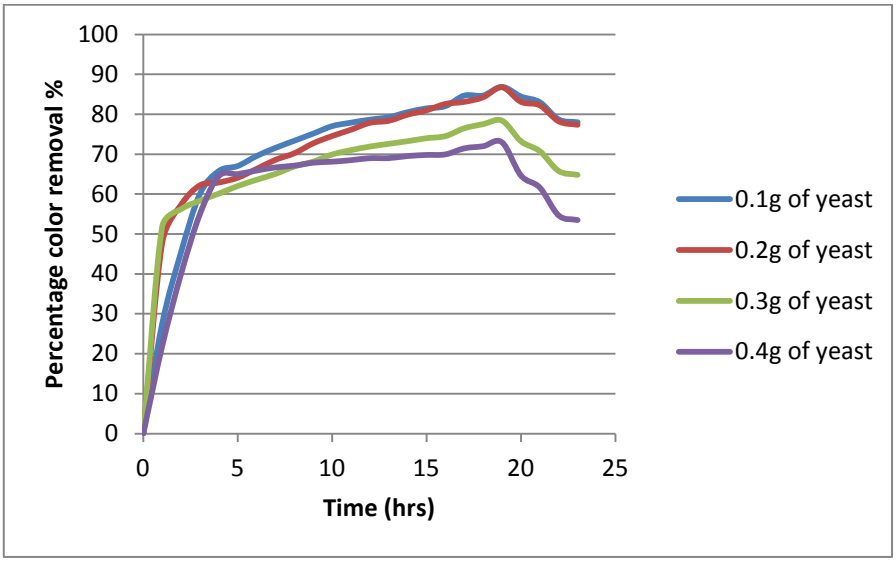

Fig. 4: Percentage Colour Removal for Varying Yeast

4. Conclusion

The decolorization of dyes was studied under stationary conditions like concentration and time. Encouraging results were obtained after two days but maximum decolorization of the dyes was obtained by varying pH. In this study we have observed higher decolorization under shaking condition by ***Saccharomyces cerevisiae,*** which could be due to better oxygenation of fungus, moreover agitation also helps the yeast to grow better [11].Disappearance of dye color may be due to biodegradation of chromophore in dye molecule because of extra cellular enzyme production by yeast along with absorption. Due to the environmental friendly techniques it utilize, bioremediation has been characterized as soft technology. It's cost effectiveness and more absorbing nature of this method is very attractive and an alternate method of choice. By varying the concentration and time, the pigmented elements on the Congo red dye gets absorbed by ***Saccharomyces cerevisiae*** and the percentage absorption are obtained. For the various concentration and linear absorption with increment of time. The results are obtained in the range of 80 to 90 percentages and maximum absorption took place a day after adding the absorbent. By varying pH and time for a concentration of 40 ppm which is the maximum value that we used in the previous experiment, the percentage absorption is obtained and they are in the range of approximately 85 to 95 percentage. In the experiment the results are obtained a day after. The optimum results are chosen from the above experiments and the conditions where the maximum percentage of absorption are identified and can be used for further treatment process.

From the experiment of variation in concentration and time we found out the maximum percentage of absorption took place under the concentration of 30 ppm and maximum absorption took place after 18 hours of adding the yeast to the media solution. The maximum percentage of absorption was 87.9%. From the experiment of variation in pH and time we found out the maximum percentage of absorption took place under 4 pH and 17 hours after adding the yeast to the media solution. The maximum concentration of 40 ppm was used in this experiment and the maximum percentage of absorption was 98.66%.The maximum degradation in varying the dosage occurs at a concentration of 0.1g of yeast which is 86.84%. The maximum degradation occurs at a time of 19hours after adding the yeast to the media solution. From the process of varying the inoculum in which the ingredients such as Glucose, Sucrose, Fructose and Sugar are varied and the maximum degradation obtained in Glucose after a period of 18 hours after adding the yeast to the media solution. The maximum percentage of decolourization is 90.7% at 40ppm.

From the above process, we conclude that the optimum results obtained are acidic pH of 4, maximum absorption at a time period of 17 hours, the yeast added is 0.1g to the media solution, the inoculum added is glucose and the concentration is 40 ppm.

References

[1] P.Kaushik and A.Malik, "Microbial decolourization of textile dyes through isolates obtained from contaminated sites", Journal of Scientific and Industrial Research 68, 325-331 (2009).

[2] HA.Mohammed, Biodeclorization of Congo red Dye by using two species of Fungi, Mesopotamia Environmental Journal 1(4), 50-56(2015).

[3] R.Kabbout and S.Taha, Biodecolorization of Textile Dye Effluent by Biosorption on Fungal Biomass Materials, International Conference on Material Sciences, CSM8-ISM5.

[4] H.Forootanfar, A.Moezzi, MarziehA.Khozani, Y. Mahmoudjanlou, A.Ameri, F.Niknejad andM.A.Faramarzi, Synthetic dye decolorization by three sources of fungal laccase, Iranian Journal of Environmental Health Science & Engineering 9(1), 1-10(2012).

[5] S. Kannan, K. Dhandayuthapani and M.Sultana, Decolorization and degradation of Azo dye - Remazol Black B by newly isolated Pseudomonas putida, International Journal of Current Microbiology and applied Science 2(4), 108-116(2013).

[6] N.Rajamohan andM.Rajasimman, Kinetic Modeling of Dye Effluent Biodegradation by Pseudomonas Stutzeri, ETASR-Engineering, Technology & Applied Science Research 3(2),387-390(2013).

[7] B.Rani, V.Kumar, J.Singh, S.Bisht, P.Teotia, S.Sharma andR.Kela, Bioremediation of dyes by fungi isolated from contaminated dye effluent sites for bio-usability, Brazilian Journal of Microbiology 45(3), 1055-1063 (2014).

[8] N.Das and D.Charumathi, Remediation of synthetic dyes from wastewater using yeast—An overview, Indian Journal of Biotechnology 11, 369-380 (2012).

[9] N.Jafari, M.R.Soudi and R.K.Kermanshahi, Biodegradation perspectives of azo dyes by yeasts, Microbiology 83(5), 484-497 (2014).

[10] M.S. Mahmoud, Decolorization of certain reactive dye from aqueous solution using Baker's Yeast (*Saccharomyces cerevisiae*) strain, HBRC Journal 12, 88-98 (2016).

[11] Yuzhu Fu and T. Viraraghavan, Fungal decolorization of dye wastewaters: a review, Bioresource Technology 79, 251-262 (2001).