Bionatura
Latin American Journal of Biotechnology and Life Sciences

Bionatura Issue 4 Vol 8 No 1 2023

Article

Removal of two Textile Dyes using *Aspergillus niger*

Anas M. Almamoori[1], Hadeel A. Kadhum[2], Israa H. Ibrahim[3]
[1]Department of Anesthesia, Hilla University College, Iraq.
[2]Ministry of Education, Iraq.
[3]Department of Biomedical Engineering, University of Warith Al-Anbyaa, Iraq.
* *Correspondence: Corresponding Author: anas.almamoori@gmail.com*
Available from: http://dx.doi.org/10.21931/RB/CSS/2023.08.04.15

Abstract
The current study included studying the possibility of fungi in removing two types of dyes used in textile factories (red and yellow). Three concentrations of dyes (500, 100 and 300) ppm were treated with fungi and measured. Removal efficiency was measured after 72 hours, and the fungus was more efficient in removing the red dye. The removal efficiency was (99.77, 96.02 and 92.19) % for the red dye and (94.11, 93.65, and 88.9) % for the yellow dye. Results indicated that the degradation rate of the low concentrations was higher than that of high concentrations of both dyes. The results recorded decreased pH values for both dyes and all concentrations. It decreased from (7.33, 7.27 and 7.27) to (4.83, 4.83 and 4.87) after 72 hours of red dye treatment and from (7.23, 7.23 and 7.27) to (4.83, 4.83 and 4.8) for the yellow dye. The electrical conductivity also decreased for dyes and all concentrations, from (1509, 1466 and 1501.33) microsiemens/cm to (968, 975 and 972.33) microsiemens/cm for the red dye. At the same time, it decreased from (1472.67, 1481 and 1487) microsiemens/cm to (988.33, 997 and 999.33) Microsiemens/cm for yellow dye. Total dissolved solids values also decreased for both dyes, and all concentrations decreased from (1011, 982 and 1005)mg/l to (648, 653 and 651) mg/l from the red dye. At the same time, the yellow dye decreased from (986, 992 and 996) mg/l to (662, 667 and 669) mg/l.
Keywords: Textile Dyes, Aspergillus niger, pollution

INTRODUCTION

Humans have used textile dyes, and the first evidence of using them belongs to Pre-Neanderthals about 1080,000 years ago [1].

Approximately (10 – 15) % of the total pigments used are lost during the textile industry, and many dyes and other substances found in the effluents of factories cause environmental pollution [28]. Pigment removal from industrial wastewater is an important step. Industrial wastewater must be treated before discharge [2].

Direct disposal of textile wastewater to natural waters resulted in many environmental problems. This industry needs high quantities of water, so many countries need to treat this water to consume and reduce water requirements [3].

Disposing of effluents from textile industries has become very interesting, as this liquid waste alters the physical properties of water and increases the Chemical and biological oxygen demand because they are organic compounds, some of which are complex. Some of them contain nitrogen in their composition. Additionally, the products of anaerobic decomposition of some pigments are carcinogenic or DNA mutagenic [4].

These dyes are toxic to aquatic biota because of their salts and heavy metals. Their toxicity to mammals is low, but their extensive use can produce wastewater with salt levels much higher than normal [5, 6].

In the last years, many Chemical and physical color removal methods have been used, but few were accepted [7]. Both physical and chemical treatment methods are not widely used due to their cost and disposal problems. Hence, there is a need for new green techniques to solve the problem, including the adsorption of dyes on algae, bacteria, fungi and plants ((or) low-cost non-traditional adsorbents [8, 9].

Research interest in the biological treatment of fungi has increased in the past decades because of the high biomass compared to bacteria to remove color by degrading synthetic dyes [10]. So, the cell wall of fungi is made of glycoprotein, glucan, and chitin, multiple binding sites for the interaction of the bio-sorbents with the dye. The fungi was recorded as a suitable microorganism for wastewater treatment and removal of dyes [11]. The fungal cell has an additional advantage over other unicellular microorganisms by dissolving insoluble substances by enzyme production outside the cell because of the increased cell ratio to the surface [12]. Aspergillus niger is a dark-colored fungus; it is a saprophytic fungus used to degrade dyes and heavy metals [13]. Aspergillus niger is rapidly growing on a set variety of substances that produce colonies consisting of yellow or white basal hyphae covered with a dense layer of conical heads of dark brown to black color, and their fungal hyphae are divided and obvious [14].

The pH has a significant effect on the ability to remove pigment; the pH value of a solution of the dye affects the chemical structure of both the dye molecule and the biomass of fungi [15]. [16] also recorded that the optimum pH value of Coriolus versicolor growth was at 45. The highest dye removal efficiency (99%) was also obtained at pH 4.5 while decreased to (50%) at pH= 6 or 7 [17].

METHODS

Preparation of dye concentrations:

Three dye concentrations were prepared (50, 150, 300) ppm with their replicates and control groups.

Inoculation build-up:

Aspergillus niger was taken from the Biology Department at the University of Babylon; the fungus was cultured on a PDA medium and incubated at 25 C for 7 days. Aspergillus niger spores were harvested from the petri dish after adding 2 ml of distilled water to the petri dish, then filtered, and the filtrate was taken to use as an inoculum [29].

Absorbance Measurement:

Absorbance was measured by using a spectrophotometer at 487 nm. Measurements were taken each 24 hrs.

$$D\ (\%) = \frac{Dye\ (i) - Dye\ (I)}{Dye\ (i)} \times 100$$

Where D%= removal ratio, i = first absorbance, I = last absorbance.

Measurement of pH, Ec and TDS:

Measurements of pH, Ec and TDS were taken by portable electronic multi-measurement meter (HANNA).

RESULTS

The results showed that the rates of red dye removal when measured after (24, 48, and 72) hours were (62.85, 83 52 and 99.77) % for the concentration 50 ppm, while for the concentration 100 ppm were (50.96, 77.87 and 96.02) %, and the concentration 300 ppm were (38.87, 60.55 and 92.19)%, as shown in Figure (1-1). The yellow dye removal results revealed that for the concentration (62.09, 80.94 and 94.11) %, while the concentrations of 100 ppm were (48.31, 76.88 and 93.65)%, and for the concentration of 300 ppm were (38.68, 58.01 and 88.9) % when measured after (24, 8, and 72) hours as shown in Figure (1-2)

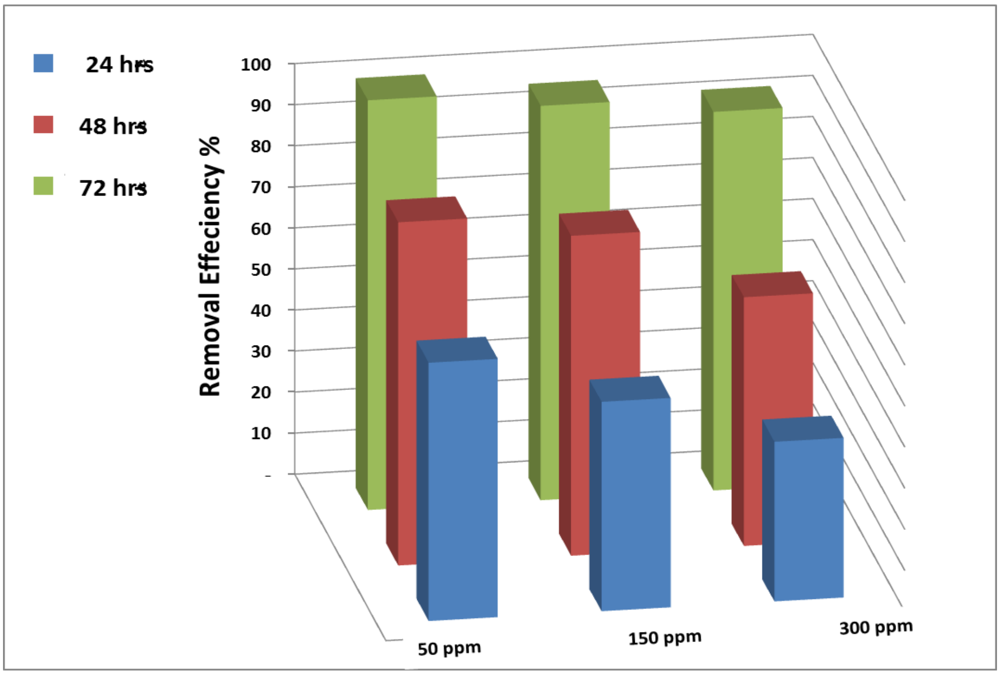

Figure 1. Removal efficiency% of *Aspergillus niger* of the red dye

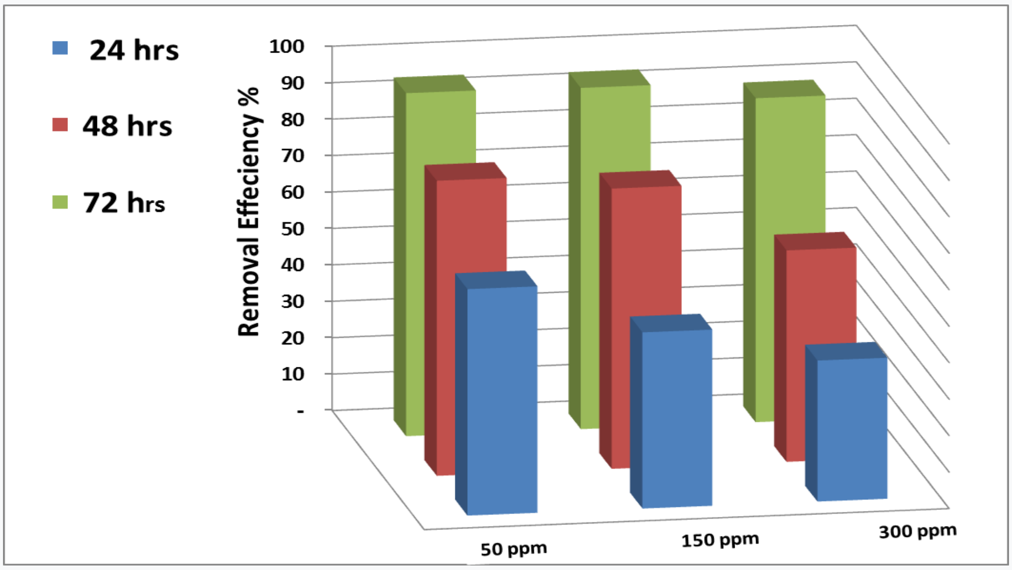

Figure 2. Removal efficiency% of *Aspergillus niger* of the yellow dye

The efficiency of the fungus in removing the dyes was higher at the low concentrations for both, while the fungus was less efficient in removing high concentrations of dyes. Dye adsorption with a range of concentrations determines the organism's ability to remove; the higher concentrations of the dye need more time for decomposition and remove the color, so it has been recorded that the rate of decolorization decreased with increased concentrations of the dye; this is related to the inhibition effects of the high concentrations of dye on potency and activeness of the fungus [18].

The results also revealed a decrease in the values of Ph, the electrical conductivity and TDS of the solutions of both dyes and for all concentrations after 72 hours of treatment, as shown in Figures (1-3, 1-4, 1-5, 1-6, 1-7 and 1-8).

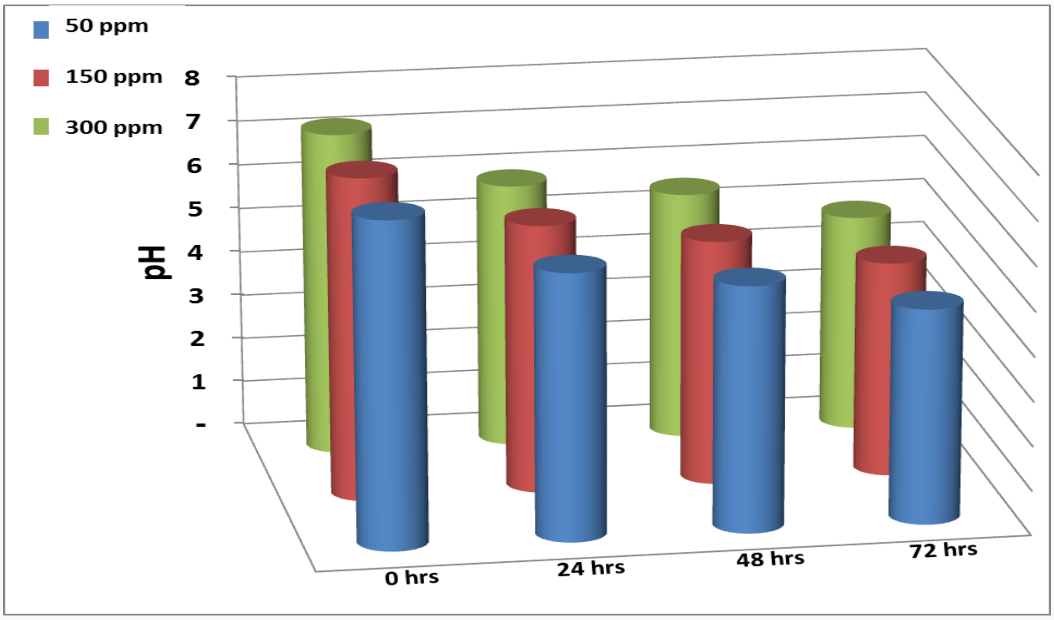

Figure 3. pH values for red dye concentrations during 72 hours

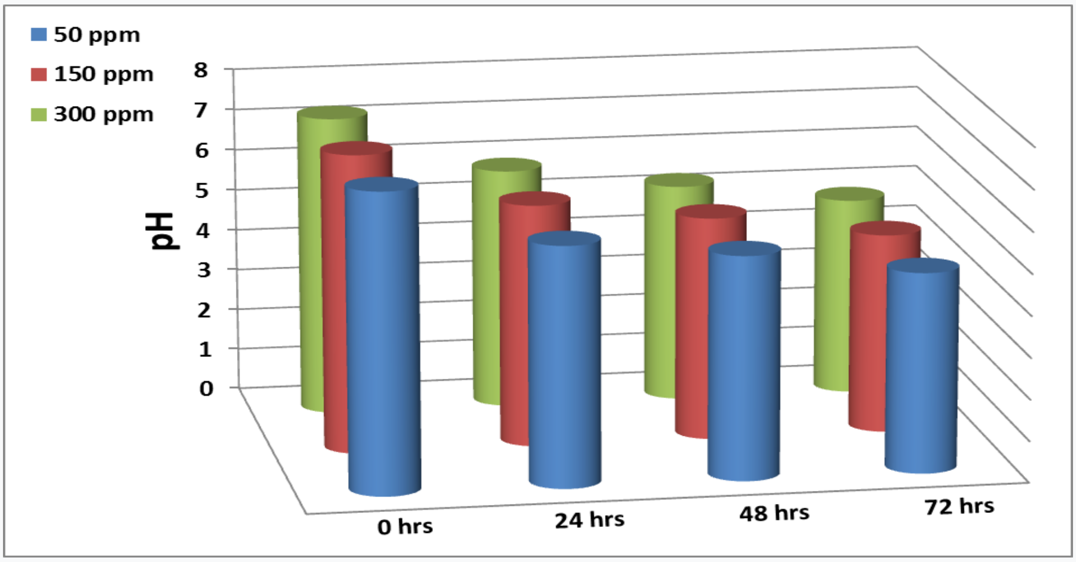

Figure 4. pH values for yellow dye concentrations during 72 hours

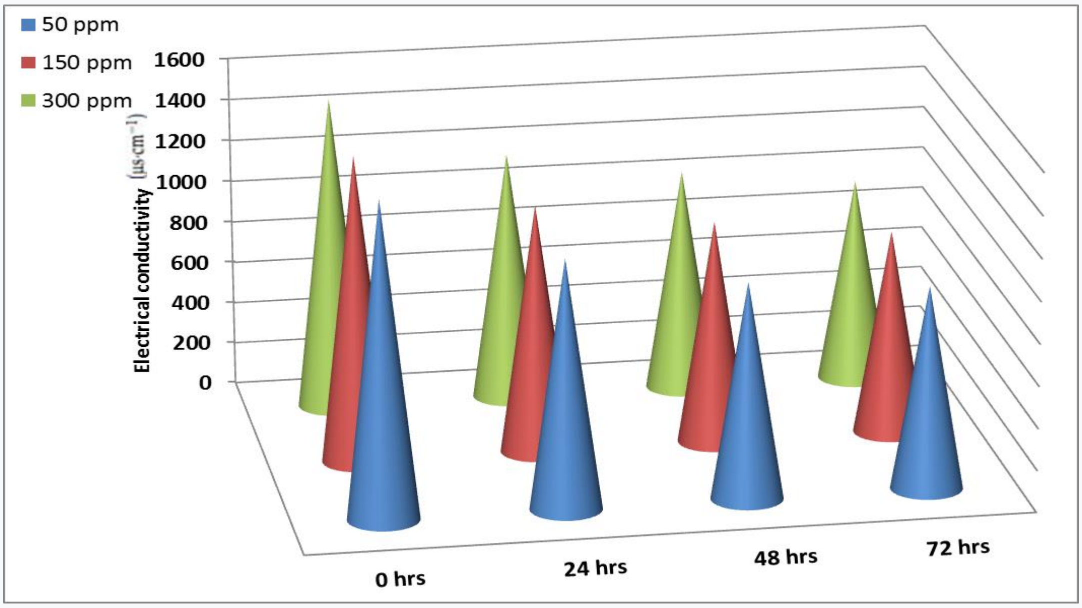

Figure 5. Electrical conductivity values for red dye concentrations during 72 hours

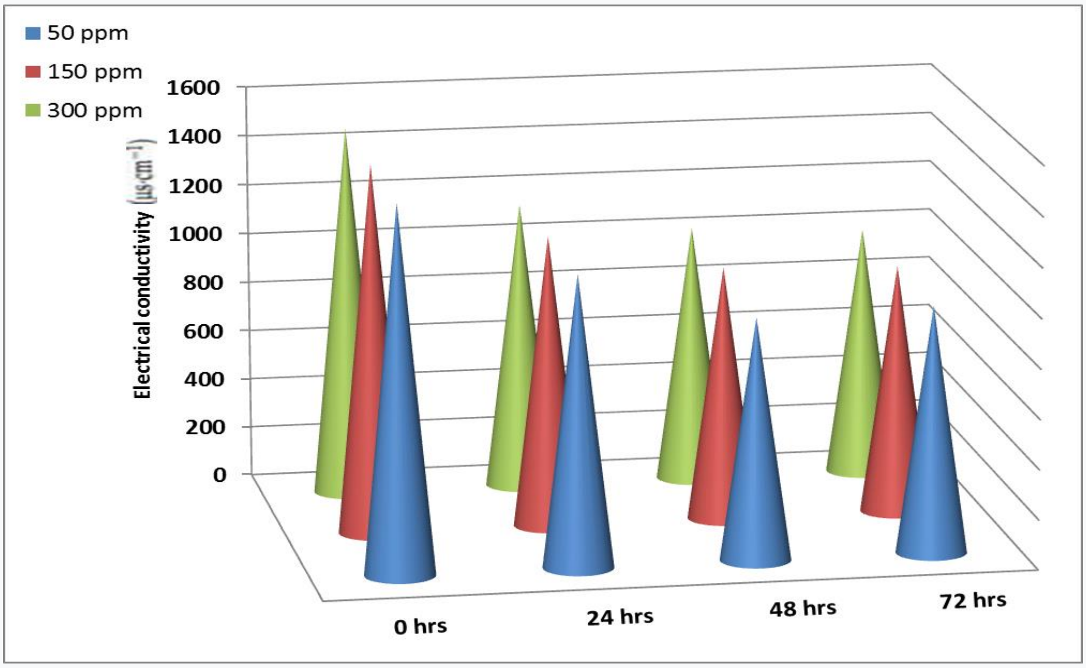

Figure 6. Electrical conductivity values for yellow dye concentrations during 72 hours

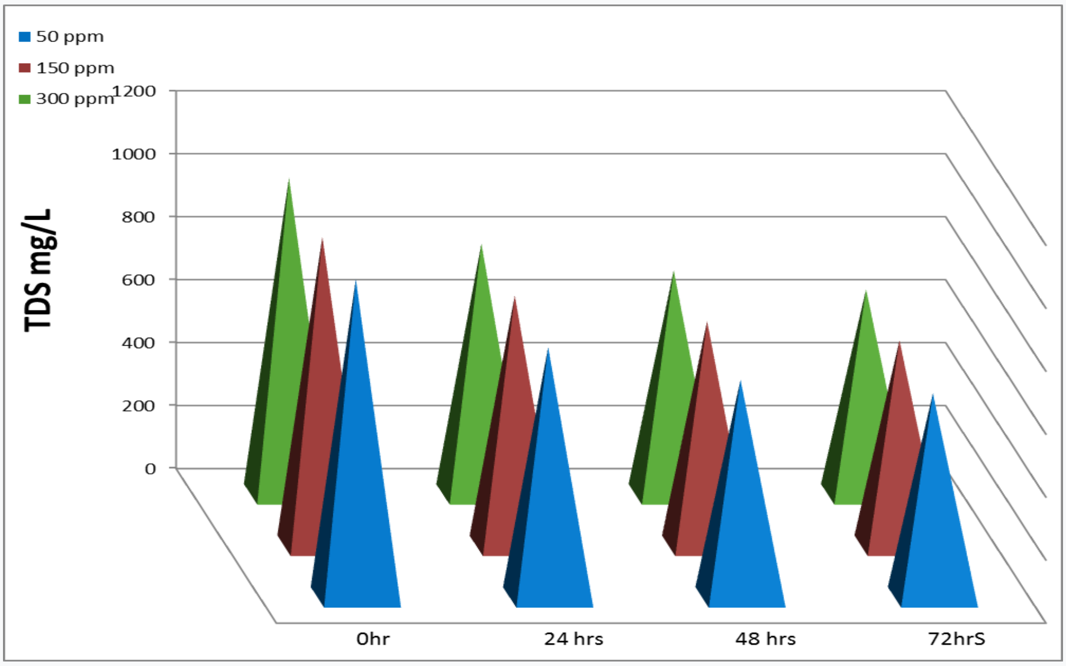

Figure 7. TDS values for red dye concentrations during 72 hours

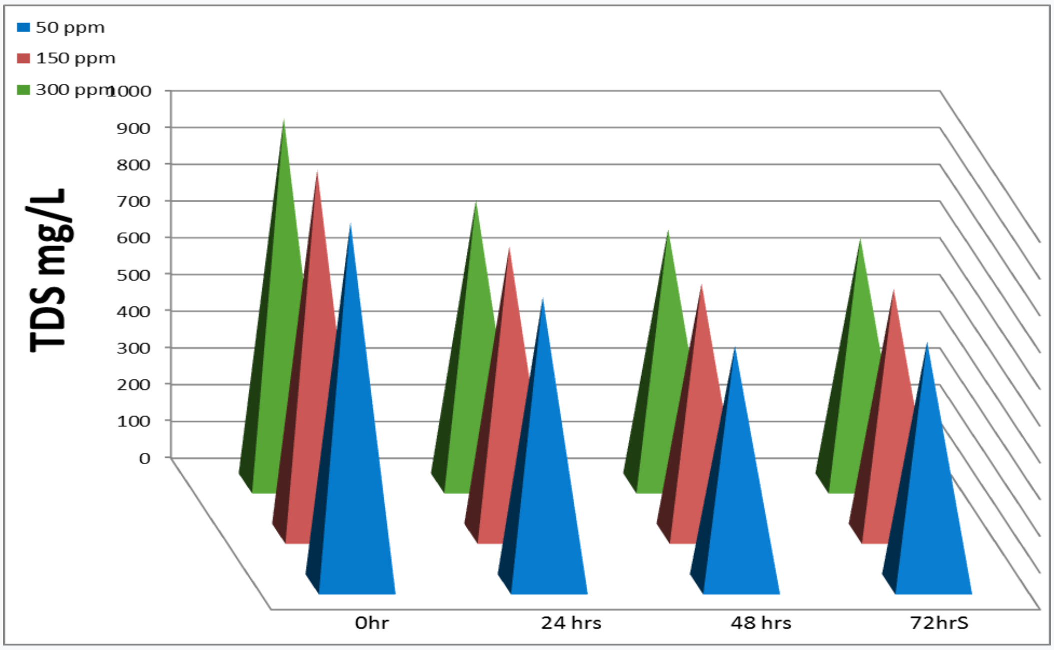

Figure 8. TDS values for yellow dye concentrations during 72 hours

DISCUSSION

These results agree with the results of [19] and [20], which recorded a significant decrease in BOD, COD, TSS, and TDS values after textile wastewater treatment by using Aspergillus niger. The lower values were due to the decomposition of the chemicals in the samples. PH decrease results from the decomposition of dyes into simple low molecular weight compounds, such as the formation of Organic acids [21].

[22] indicated a decrease in pH after fungal biological treatment in both static without shaking samples and with shake-led pH decrease due to the accumulation

of organic acids, vanillic acid, and formic acid that is formed as a result of fungal biomass activity.

Different pH values have an important role in the decolorization because it detects the surface charge of the bio-sorbent and the ionization of the dye solution, and it has achieved decolorization by more than 97 % using Aspergillus niger at pH = 5 [23]. Furthermore, [24] recorded that the acid values of pH are predominant in general and maintain the good growth of microorganisms to remove color optimally. It is possible to control the biomass surface charge and dyes ionic forms pH value of the solution [25]. The decreased value of total dissolved solids of the treated solution may result from ion consumption by fungal cells for growth [26, 27].

CONCLUSIONS

Results indicated that the degradation rate of the low concentrations was higher than that of high concentrations of both dyes. The results recorded decreased pH values for both dyes and all concentrations.

References

1. Christie. RM (**2007**). Environmental aspects of textile dyeing. Elsevier.
2. Yagub, M. T., Sen, T. K., Afroze, S., & Ang, H. M.. Dye and its removal from aqueous solution by adsorption: a review. Advances in colloid and interface science, **2014**, 209, 172-184.
3. Hmd, R. F. K. (**2011**). Degradation of Some Textile Dyes using Biological and Physical Treatments. Master thesis, Faculty of Science, Ain-Shams University.
4. Shin and Dirk. (**2002**). 'Degradation of dye-containing textile effluent by the agaric white-rot fungus Clitocybula dusenii', Journal of Biotechnology, pp. 989–993.
5. Egyptian Environmental Affairs Agency report (EEAA). (**2003**). Summary of sectional reports of Environmental Agency. Sustained Environmental Management (SEAM) project "Clean Production" (CP), prepared by Central Unit for Water Quality, Ministry of Water Resources and Irrigation, Cairo- Egypt.
6. Camarero S., Ibarra D., Martínez M.J. and Angel T.M., (**2005**). Lignin derived compounds as efficient laccase mediators for decolourization of different types of recalcitrant dyes, Appl Environ Microbiol, 71(4), 1775-1784.
7. Zhang, S.J.; Yang, M.; Yang, Q.X.; Zhang, Y.; Xin, B.P. and Pan, F. (**2003**). Biosorption of reactive dyes by mycelium pellets of a new isolate of Penicillium oxalicum. Biotechnology Letters, 25, 1479-1488.
8. Crini G., (2006). Non-conventional low-cost adsorbents for dye removal: a review, Bioresource Technol, 97(9), 1061-85.
9. Priyadarshani, I.; Sahu, D. and Rath, B. (**2011**). Microalgal bioremediation: Current practices and perspectives. J of Biochem Techn, 3 (3): 299-304.
10. Dhanjal N.I.K., Mittu B., Chauhan A. and Gupta S., (**2013**). Biodegradation of textile dyes using fungal isolates, J Env Sci Technol, 6(2), 99-105.
11. Banat, IM; Nigam, P.; Singh, D. and Marchant, R. (**1996**). Microbial decolorization of textile-dye-containing effluents. A review. Bioresource Technol., 58, 217-227.
12. Kaushik, P. and Malik, A. (**2009**). Fungal dye decolorization: recent advances and future potential. Environment. International, 35, 127-141.
13. Rangabhashiyam, S., Suganya, E., Selvaraju, N., & Varghese, L. A. (**2014**). Significance of exploiting non-living biomaterials for the biosorption of wastewater pollutants. World Journal of Microbiology and Biotechnology, 30(6), 1669-1689. 873.
14. Frisvad, J.C.; Hawksworth, D.L; Kozakiewicz, Z.; Pitt, J.I.; Samson, R.A. and Stolk, A.C. (**1990**). Proposals to conserve important species names in Aspergillus and Penicillium. In Samson, R.A. and Pitt, J.I., (Eds.), Modern Concepts in Penicillium and Aspergillus Classification. Plenum press, NY. (1). Pp 83- 89.
15. Fu, Y. and Viraraghavan, T. (2002). Removal of congo red from an aqueous solution by fungus Aspergillus niger. Adv. Environ. Res., 7, 239- 247.
16. Kapdan, I.K.; Kargi, F.; McMullan, G. and Marchant, R. (**2000**). Effect of environmental conditions on biological decolorization of textile dyestuff by C. versicolor. Enzyme and Microbial Technology, 26, 381-387.

17. O'Mahony, T.; Guibal, E. and Tobin, J.M. (**2002**). Reactive dye biosorption by Rhizopus arrhizus biomass. Enzyme and Microbial Technology, 31,456-463.
18. Anjaneyulu.Y., Sreedhara Chary.N., Samuel SumanRaj.D. (**2005**). Decolourization of industrial effluents – available methods and emerging technologies – a review. Reviews in Environmental Science and Bio/Technology. 4:245–273.
19. Salem S. Salem1, Asem A. Mohamed2, Mamdouh S. Gl-Gamal1, Mohamed Talat1, Amr Fouda1 (**2019**). Biological Decolorization and Degradation of Azo Dyes from Textile Wastewater Effluent by Aspergillus niger. Egypt.J.Chem. Vol. 62, No.10. pp.1799- 1813.
20. Selim, M.T.; Salem, S.S.; Mohamed, A.A.; El-Gamal, M.S.; Awad, M.F.; Fouda, A. (**2021**). Biological Treatment of Real Textile Effluent Using Aspergillus flavus and Fusarium oxysporium and Their Consortium along with the Evaluation of Their Phytotoxicity. J. Fungi, 7, 193.
21. Mohamed,W.S.E.-D. (**2016**). Isolation and screening of reactive dye decolorizing bacterial isolates from textile industry effluent. Int. J. Microbiol. Res., 7, 1–8.
22. Fouda, A.H.; Hassan, S.E.-D.; Eid, A.M.; Ewais, E.E.-D. Biotechnological applications of fungal endophytes associated with medicinal plant Asclepias sinaica (Bioss.). Ann. Agric. Sci. **2015**, 60, 95–104.
23. Verma A., Agarwal M·, Bhati D., and Garg H. 2019. Investigation on the Removal of Direct Red Dye using Aspergillus Niger.
24. Amin, N. K. (**2008**) .Removal of reactive dye from aqueous solutions by adsorption onto activated carbons prepared from sugarcane bagasse pith, Desalination. 223: 152–161.
25. Mostafa, M.H., Elsawy, M.A., Darwish, M.S., Hussein, L.I., and Abdaleem, A.H. (**2020**). Microwave-Assisted preparation of Chitosan/ZnO nanocomposite and its application in dye removal, Materials Chemistry and Physics.
26. ALKDSAWY ERM **2013**. Fungal treatment for wastewater leather tanning in Nahrwan – Iraq. MSc Thesis. University of Babylon pp. 129. [In Arabic].
27. VENOSA A.D., ZHU X. **2003**. Biodegradation of crude oil contaminating marine shorelines and freshwater wetlands. Spill Science and Technology Bulletin. Vol. 8. Iss. 2 p. 163–178. DOI 10.1016/S1353-2561(03)00019-7.
28. Murugalatha, N., Mohankumar, A., Sankaravadivoo, A. and Rajesh, C. (**2010**). 'Textile effluent treatment by Bacillus species isolated from processed food', African Journal of Microbiology Research ISSN 1996-0808, Vol. 4(20), pp. 2122-2126.
29. Sarhan, A. R. T. (**2012**). Practical Mycology. First Edition.

Received: May 15, 2023/ Accepted: June 10, 2023 / Published: June 15, 2023
Citation: Almamoori, A.M.; Kadhum, H.A.; Ibrahim, I.H. Removal of two Textile Dyes using *Aspergillus niger*. Revista Bionatura 2023;8 (2) 63. http://dx.doi.org/10.21931/RB/CSS/2023.08.04.15