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# Decolorization of Textile Dyes in Two Different Medium

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**ABSTRACT:** In this study, the decolorization of textile dyes, taken from textile factory, (Doracryl Blue (DB), Astrozon Red (AR) and Maxillon Red (MR)), were determined by pure bacterial culture which isolated from waste water. Bioaccumulation rate were determined in two different media (Nutrient Broth and Molasses medium) as a function of initial pH (5-8), dye concentration (100-500 $mgL^{-1}$), and temperature (25-35ºC). High rates of decolorization at pH 7 and 8 have been found in both nutrient and molasses medium at incubation period. The bacterial culture decolorized MR and DB colors at high concentrations and all temperatures almost 95% decolorization yield, besides AR decolorized at 200 $mgL^{-1}$ dye concentrations and 40% rate and couldn't be decolorized at higher concentrations. The results were showed that the bacterium was able to decolorize the DB and MR high ratio in both nutrient and molasses media at high concentrations and all temperatures, although the AR weren't decolorized at high ratio by bacterium. Because of this, although the bacterial culture could be used highly for decolorization for DB and MR, it has got limited usage for AR.

**Keywords:** Bacterial culture, decolorization, textile dyes

# İki Farklı Besiyerinde Tekstil Boyalarının Renk Giderimi

**ÖZET:** Bu çalışmada tekstil fabrikasından alınan üç farklı tekstil boyasının (Doracryl Blue (DB), Astrozon Red (AR) and Maxillon Red (MR)) atık sudan izole edilen bakteriyel kültür ile renk giderimi tespit edilmiştir. Biyoakümülasyon oranı, iki farklı besiyerinde (Nutrient Broth ve Melaslı Besiyeri) başlangıç pH (5-8), boya konsantrasyonu (100-500 $mgL^{-1}$) ve sıcaklığa (25-35ºC) karşılık tespit edilmiştir. Her iki besiyerinde de inkübasyon periyodu boyunca pH 7 ve 8'de yüksek oranlarda giderim tespit edilmiştir. Bakteriyel kültür MR ve DB boyalarını tüm yüksek konsantrasyonlar ve sıcaklıklarda %95 oranında gidermiştir. Bunun yanında AR ise 200 $mgL^{-1}$ konsantrasyonda %40 oranında giderilmiş ve daha yüksek konsantrasyonlarda giderilememiştir. Çalışmada elde edilen sonuçlar bakteriyel kültürün MR ve DB boyalarını tüm konsantrasyon ve sıcaklıklarda yüksek oranda gidermesine karşın AR'nin yüksek oranda dekolorize edilmediğini ortaya koymuştur. Bundan dolayı bakteriyel kültür DB ve MR boyalarının dekolorizasyonu için kullanılabilecekken AR için sınırlı kullanım alanına sahiptir.

**Anahtar Kelimeler**: Bakteriyel kültür, dekolorizasyon, tekstil boyaları

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## INTRODUCTION

Synthetic dyes are produced as resistant to sweat, light, water, chemical agents and also fading. Synthetic dyes are widely used in textile industry and high amount of water used in dying process that is the major cause of water pollution. The pH, amount of dissolved oxygen and inorganic substances of the waste water is varied according to the chemical composition of dyes. The removal of the dye into the water is very hard and it is blocked the photosynthesis by entrance of the sunlight to water or diminish the concentration of dissolved oxygen (Kaputska and Reporter, 1993; Banat et al., 1996; Vandevivere et al., 1998; Robinson et al, 2001; Rai et al, 2005; Kestioğlu and Yalılı, 2006; Pandey et al., 2007; Ghodake et al., 2009).

Many physical and chemical methods are used for dye remove, but they have disadvantages such as high costs and creating secondary waste. Biosorption, bioaccumulation, enzymatic techniques are mostly used and very important for dye removal from the environment (Chen et al., 2002; Forgacs et al., 2004; Khehra et al., 2005; Han et al., 2011). Bioaccumulation, is the uptake and accumulation the chemicals by organisms' body surface. In a bioaccumulation process the initial pH, medium components, initial dye concentration, dye structure and culture conditions affect the microbial growth and bioaccumulation of dyes (Gönen and Aksu, 2009; Yabanlı, 2010).

In this study, the decolorization of textile dyes, taken from textile factory of (Doracryl Blue (DB), Astrozon Red (AR) and Maxillon Red (MR)), were determined by pure bacterial culture which isolated from waste water. Bioaccumulation rate were determined in two different media as a function of initial pH dye concentration and temperature.

## MATERIAL AND METHODS

In the study, the dyes such as Doracryl Blue (DB), Astrozon Red (AR), Maxillon Red (MR) were used and obtained from textile factory. Bacterial culture was isolated from waste water. The nutrient broth and molasses medium were used (80 $mlL^{-1}$ stock molasses, 1.0 $gL^{-1}$ $(NH_4)_2SO_4$, 0.5 $gL^{-1}$ $KH_2PO_4$) for the determination of decolorization capacity of the bacterial culture (Aksu and Dönmez 2000; Dönmez, 2001).

The dye concentration was measured by spectrophotometer (600 nm for Doracryl Blue, 530 nm for Maxillon Red, and 490 nm for Astrozon Red). Decolorization experiments were determined as a function of initial pH (5-8), initial dye concentration (100-500 $mgL^{-1}$) and temperature effect (25-35°C), and the dye samples were taken at 12, 18, 24, 48 hours of incubation period. Initial dye concentrations were settled as 100-500 $mgL^{-1}$ in nutrient broth and molasses media. All of the experiments were made at 100 mL medium in 250 mL Erlenmeyer's flasks, the samples were taken 2 mL and centrifuged to separate the bacterium from the medium, at 5000 rpm for 10 minutes. Decolorization yield of dyes were calculated by the following formula. $C_o$ represents the initial dye concentration and $C_f$ represents the final dye concentration.

$$Decol\% = ((C_o-C_f)/C_o)*100$$

## RESULTS

In this work the bioaccumulation of textile dyes (Doracryl Blue (DB), Astrozon Red (AR), Maxilon Red (MR)) were determined and there is a few study about bioaccumulation of the dyes, besides there is biosorption study with the dyes (Artan Onat et al., 2013). The bacterial culture which used in this study was Gram (+) cocci and has smooth colonies on nutrient agar.

### Effect of pH

At first the effect of pH has been investigated on the removal of dye and the pH was selected which demonstrated the highest removal values for following studies. In this study, molasses broth and nutrient broth medium were prepared at different pH values (5, 6, 7, 8), and the medium initial dye concentration adjusted at 100 $mgL^{-1}$ for each dye and bacterial culture was inoculated at 1/100 v/v ratio. The decolorization yields of the dyes were showed at Fig. 1, and results were obtained at 18. hour of incubation period, at 24. hour of incubation period the dyes were provided decolorization at maximum yields.

As shown that Fig. 1 high rates of decolorization at pH 7 and 8 have been found in both nutrient and molasses media at incubation period. The dye removal was established as 76.90%, 58.80% and 75.48% for MR, DB and AR respectively at 18. hours of incubation period in molasses medium at pH 8. Moreover, the decolorization rate was determined almost 95% at 24. hour of incubation period for all dyes. However, the pH 6 was selected for DB due to the removal rate

was 89.93% and the pH 8 was selected for MR and AR with the removal rate were 96.89% and 82.88% consequently at 24 h incubation period in nutrient broth medium. The dye decolorization ability of bacterium was proximately at same pH values and also the rates of decolorization yield were very high for all dyes.

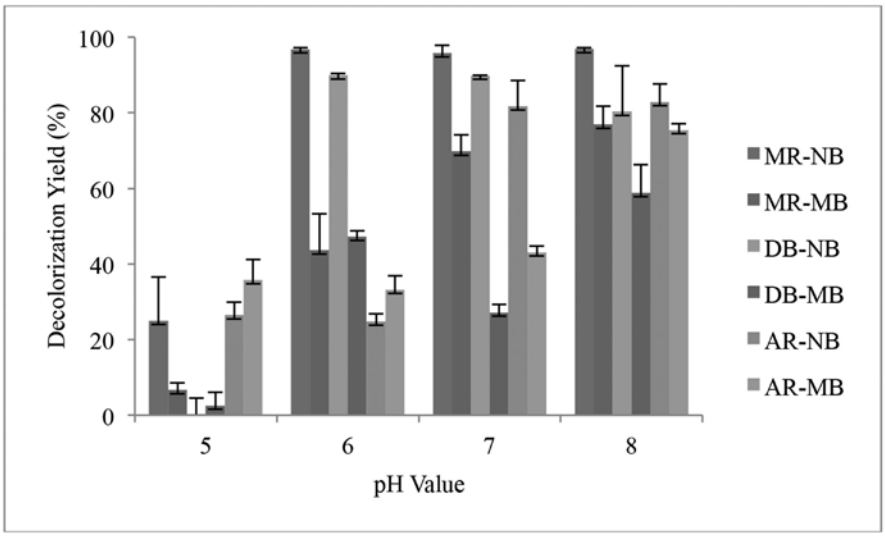


**Figure 1.** The effect of pH on decolorization of textile dyes in nutrient broth and molasses media at 100 $mgL^{-1}$ initial dye concentration at 30°C at 18 h. (MR-NB: Maxillon Red-Nutrient Broth, MR-MB: Maxillon Red-Molasses Medium, DB-NB: Doracryl Blue-Nutrient Broth, DB-MB: Doracryl Blue-Molasses Medium, AR-NB: Astrozon Red-Nutrient Broth, AR-MB: Astrozon Red-Molasses Medium)

**Effect of dye concentration**

The effect of increasing concentration of dyes was studied on the dye removal capacity of bacterium, initial dye concentrations were settled to 100 – 500 $mgL^{-1}$ for each medium and incubated for 48 hours and the data were shown at Fig. 2.

The removal of MR was determined almost 97 – 99% for all dye concentrations at nutrient broth medium. However, the dye removal was decreased with increasing of dye concentration in molasses medium. The removal was determined as 89.93%, 91.51%, 81.47%, 80.84% and 74.62% for 100 – 500 $mgL^{-1}$ initial dye concentration sequentially.

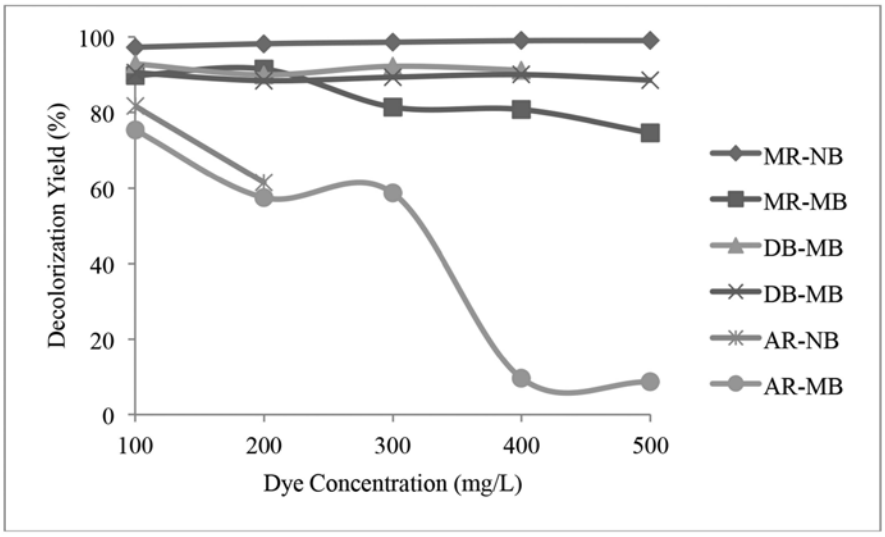


**Figure 2.** The effect of dye concentration on decolorization of textile dyes in nutrient broth and molasses media at 30°C at 48 h. (MR-NB: Maxillon Red-Nutrient Broth, MR-MB: Maxillon Red-Molasses Medium, DB-NB: Doracryl Blue-Nutrient Broth, DB-MB: Doracryl Blue-Molasses Medium, AR-NB: Astrozon Red-Nutrient Broth, AR-MB: Astrozon Red-Molasses Medium)

DB was decolorized almost 90% for 100 – 400 $mgL^{-1}$ dye concentration at nutrient broth, besides 500 $mgL^{-1}$ dye concentration reduced bacterial growth and decolorization did not determine at that concentration. Moreover, dye decolorization was obtained as 90% for all dye concentrations in molasses media.

The bacterial growth was determined only 100 and 200 $mgL^{-1}$ AR concentrations at nutrient broth and the removal ratios were 80% and 60% respectively. On the other hand, molasses medium increased the tolerance of bacterium to AR and removal ratio were determined as 75.48%, 57.47%, 58.66% for 100 – 300 $mgL^{-1}$ dye concentration and also 10% decolorization yield was obtained for 400 and 500 $mgL^{-1}$ dye concentrations.

As a consequence, it was clear that the bacterium decolorizes DB and MR at elevated concentrations in 48 hours' incubation period. Therefore, AR was affected the bacterial growth and reduced dye removal.

**Effect of temperature**

In the study the effect of temperature was also studied on dye removal with bacterium, 25 – 35ºC and 100 $mgL^{-1}$ dye concentration at 24 hours' incubation period (Fig. 3). The MR was decolorized in nutrient broth and molasses media almost 90% and 80% sequentially at all temperatures. In addition to this, the DB was showed same decolorization yield with MR, on the other hand AR was decolorized almost 40% yield. The results were showed that the bacterium was able to decolorize the DB and MR high ratio in both nutrient and molasses media at high concentrations and all temperatures, although the AR did not decolorize at high ratio by bacterium.

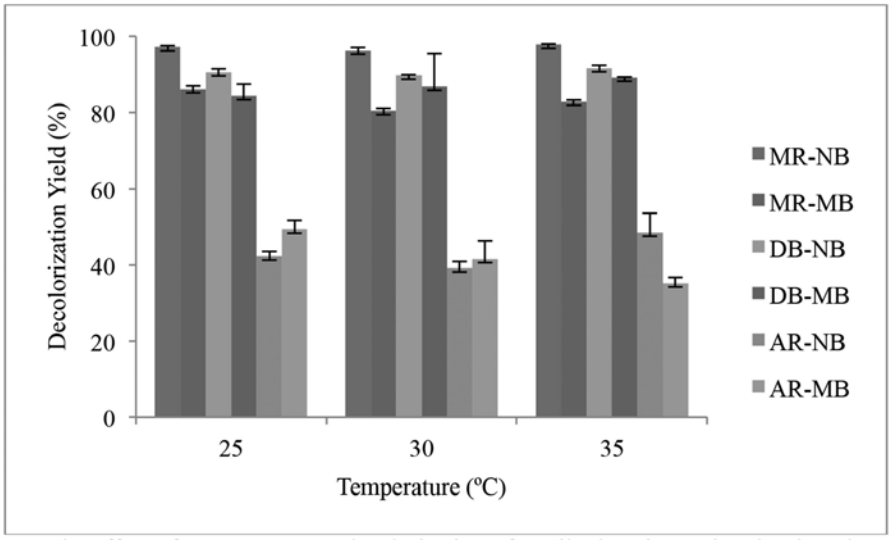


**Figure 3.** The effect of temperature on decolorization of textile dyes in nutrient broth and molasses media at 100 $mgL^{-1}$ dye concentration at 24 h. (MR-NB: Maxillon Red-Nutrient Broth, MR-MB: Maxillon Red-Molasses Medium, DB-NB: Doracryl Blue-Nutrient Broth, DB-MB: Doracryl Blue-Molasses Medium, AR-NB: Astrozon Red-Nutrient Broth, AR-MB: Astrozon Red-Molasses Medium)

## DISCUSSION

The dye decolorization ability of bacterium, that isolated from waste water, was detected for three textile dyes in two different media. The dye decolorization ratio were determined as almost 95% for all dyes at pH 7 and 8 in 30°C at 24 h incubation period. Bacterial consortium or pure cultures decolorize different textile dyes similar pH values and temperature degrees. Therefore, the bacterial culture that used in this work reduces the dye concentration at 18h incubation period and this is the shortest decolorization time for this textile dyes. Moreover, initial dye concentrations were higher than literature (Feng vd., 2014; Khouni vd., 2012; Moosvi vd., 2006; Vijayalakshmidevi vd., 2015; Silveria vd., 2009; Sirianuntapiboon vd., 2007).

Doğan et al., (2009) was decolorized the MR by adsorption with kaolinite and decolorized 20 moles $g^{-1}$ dye at maximum ratio at pH 4.8. There is no work about

the decolorization of DB and AR by bioaccumulation method. However, the biosorption yield of DB and AR were determined almost 95% (Artan Onat et al., 2013).

In this work the decolorization yields were determined at maximum ratio (95%) for DB and MR for high concentrations (100-500 $mgL^{-1}$) also for AR in nominal degrees. In literature there were many studies about decolorization of different textile dyes by bacterial consortium or pure bacterial cultures Therefore, in this study the incubation period was shorter and the initial dye concentrations were higher. In addition, the data those taken from this work were coherent with the literature, on the other hand there was little work about the dyes that were used in this study (Yeşilada et al, 2002; Moosvi et al., 2006; Sirianuntapiboon et al., 2007; Sedighi et al, 2009; Silverda et al, 2009; Almeida et al., 2010; Khouni et al., 2012; Feng et al., 2014; Vijayalakshmidevi et al., 2015).

## CONCLUSION

The dye decolorization ability of bacterium was approximately at same pH (7 and 8) values and also the rates of decolorization yield were approximately 95% for all dyes at 100 $mgL^{-1}$ dye concentration and 24 hours' incubation period. The bacterium decolorizes DB and MR at elevated concentrations in 48 hours' incubation period. Therefore, AR affected the bacterial growth and reduced dye removal. The decolorization yields were determined at maximum ratio for DB and MR for high concentrations also for AR in nominal degrees. The temperature did not affect dye decolorization significantly. Moreover, the bacterial culture could be used highly for decolorization for DB and MR at different temperature and high dye concentrations, and has got limited usage for AR because of limited bacterial growth.

## REFERENCES


Aksu Z, Dönmez, G 2000. "The use of molasses in copper(II) containing wastewaters: effect on growth and copper(II) bioaccumulation properties of Kluyveromyces marxianus", Process Biochemistry 36, 451-458.

Almeida CAP, Santos A, Jaerger S, Debacher NA, Hankins NP, 2010. "Mineral waste from coal mining for removal of astrazon red dye from aqueous solutions", Desalination, 264, 181-187.

Artan Onat T, Çakırgoz M, Kara R, 2013. "Decolorization of doracryl blue and astrozon red by Chiloscyphus polyanthos", Current Opinion in Biotechnology 24S S28–S47.

Banat IM, Nigam P, Singh D, Marchant R, 1996. "Microbial decolorization of textile dye containing effluents: A review", Bioresource Technology 56, 217-227.

Chen BY, 2002. "Understanding decolorization characteristies of reactive azo dye by Pseudomonas luteola: Toxicity and kineties", Process Biochemistry 38(3),437-446.

Doğan M, Karaoğlu MH, Alkan M, 2009. "Adsorption kinetics of maxillon yellow 4GL and maxillon red GRL dyes on kaolinite", Journal of Hazardous Meterials, 165, 1142-1151.

Feng C, Fang-yan C, Yu-bin T, 2014. "Isolation, identification of a halotolerant acid red B degrading strain and its decolorization performance", Apcbee Procedia, 9, 131-139.

Forgacs E, Serhati T, Oros G, 2004. "Removal of synthetic dyes from wastewaters: a review", Environment International, 30(7), 953-971.

Ghodeke GS, Telke AA, Jadhav JP, Govindwar SP, 2009. "Potential of Brassica juneau in order to treat textile effluent contaminated sites", İnternational Journal Of Phytoremediation, 11(4).

Gönen F, Aksu Z, 2009. "Singal and binary dye and heavy metal bioaccumulation properties of Candida tropicalis: use of response surface metodology (RSM) for the estimation of removal yields", Journal of Hazardous Materials, 172, 1512-1519.

Dönmez G, 2001. "Bioaccumulation of the reactive textile dyes by Candida tropicalis growing in molasses medium ", Enzym and Microbial Technology, 30, 363-366.

Han JL, N I S, Wang Y, Zheng X, Chen WM, Hsueh CC, 2011." Exploring new strains of dye-decolorizing bacteria.", Journal of Bioscience And Bioengineering, 113(4),508-514.

Kapustka LA, Reporter M, 1999. "Terrestrial primary producers", Handbook of Exotoxicology,

Kestioğlu K, Yalılı M, 2006. "Yüksek KOI içerikli tekstil atık sularının kimyasal çökeltim ve adsorpsiyon yöntemleriyle arıtılabilirliği", Ekoloji, 59: 27-31.

Khehra MS, Saini SH, Sharma DK, Chadha BS, Chimni SS, 2005." Comparative studies on patential of consortium and constituent pure bacterial, isolates to decolorize azo dyes" Water Research, 39, 5135-5141.

Khouni I, Marrot, B, Amar, RB, 2012. "Treatment of reconstituted textile wastewater containing a reactive dye in an aerobic sequencing batch reactor using a novel bacterial consortium", Separation and Purification technology, 87, 110-119.

Moosvi S, Kher X, Madamwar D, 2007. "Isolation, characterization and decolorization of textile dyes by a mixed bacterial consortium JW-2", Dyes and Pigments, 74, 723-729.

Pandey A, Singh D, Lyengar L, 2007. "Bacterial decolorization and degradation azo dyes", International Deterioration and Biodegradation, 59-73.

Rai H, Bhattacharya M, Singh J, Bansal TK, Vats P, Banerjee RC, 2005. "Removal of dyes from the effluent of textile and dye stuff manufacturing industry: a review", Critical Reviews in Environmental Science and Technology, 33(3).

Robinson T, Mcmullan G, Marchant R,Nigam P, 2001. "Remediation of dyes in textile effluent a critical review on current treatment Technologies with a proposed alternative", Bioresource Technology, 77, 247-255.

Sedighi M, Karimi A, Vahabzadeh F, 2009. "Involvement of ligninolytic enzymes of Phanerochaete chrysosporium in treating the textile effluent containing astrozon red FBL in a packed-bed bioreactor", Journal of Hazardous Meterials, 169, 88-93.

Silveria E, Marques PP, Silva SS, Lima-Filho, JL, Porto ALF, Tambourgi EB, 2009. "Selection of Pseudomonas for industrial textile dyes decolourization", International Biodeterioration & Biodegradation, 63, 230-235.

Sirianuntapiboon S, Srisornsak P, 2007. "Removal of disperse dyes from textile wastewater using bio-sludge", Bioresource Technology, 98, 1057-1066.

Vandevivere PC, Bianchi R, Verstraete W, 1998. "Treatment and reuse of wastewater from the textile wet-processing industry: Review of Emerging Technologies", Journal of Chemistry Technology and Biotechnology, 72, 289.

Vijayalakshmidevi SR, Muthukumar K, 2015. "Improved biodegradation of textile dye effluent by coculture", Ecotoxicology and Environmental Safety, 114, 23-30.

Yabanlı M, 2010."Deniz yosunlarında arsenik bioakümülasyonu", Türk Bilimsel Derlemeler Dergisi, 3(1).

Yesilada O., Cing, S., Asma, D., (2002). "Decolourisation of the textile dye astrazon red FBL by Funalia trogii pellets", Bioresource Technology, 81, 155-157.