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Cleanup Textile Azo Dye Pollution by Using Silver Nanoparticles of Bacteria Isolated From Shrimp Shell Contaminated Soil in Thoothukudi Coast

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ABSTRACT

Cryogenic silver nanoparticles (AgNPs) synthesized by using bacteria (*Acinetobacter sp.* and *Bacillus sp.*) isolated from shrimp shell contaminated soil in Tuticorin coast and it was confirmed by UV–visible spectroscopy. AgNPs show a peak around 540nm (*Acinetobacter sp.*) and 510nm (*Bacillus sp.*). Further the efficiency of synthesized AgNPs was assessed for the decolorization of azo dyes such as Congo red, Acid Orange 5 and Black 7984. Decolourization assay was measured in the terms of percentage decolorization using UV-Spectrophotometer. The results revealed that bio-synthesized silver nanoparticles using the selected bacteria were found to be negligible in degrading the selected dyes.

Keywords : AgNPs, Azo dye, Acinetobacter sp, Bacillus sp, decolourization, congo red, acid orange 5, black 7984.

I. INTRODUCTION

Nanotechnology is an important field of research in modern science. The size of the nanoparticles ranges from 1-100nm within this size they exhibit improved physical, chemical and biological properties compared to their bulk ones [1, 2]. Nanoparticles show various diverse applications in areas such as biomedical science, optics, mechanics, magnetics catalysts, bio-sensors and energy science [3-5]. There are various routes accessible for the synthesis of silver nanoparticles, such as thermal decomposition, electrochemical, microwave assisted process etc. However, most these techniques employed involve huge inputs in terms of capital and energy. Therefore, biological synthesis mediated by plants, bacteria, fungi and algae is gaining more acceptance because of its cost effectiveness and eco-friendly nature [6-8].

The diversity of microorganisms is being used as ecofriendly nanofactories for bio-synthesis of nanoparticles [9-11] such as silver, cadmium sulfide, gold, tin and Ni [12-14]. The bio-synthesis of microbial metal nanoparticles shows several applications including the fields of bio-remediation, bio-mineralization, bio-leaching and microbial corrosion [15]. Because of these applications the current investigation was carried to synthesize silver nanoparticles, they were characterized by UV-Visible spectrophotometer and it can be used for bio-remediation of textile dye, as it is useful important in the polluted water treatment.

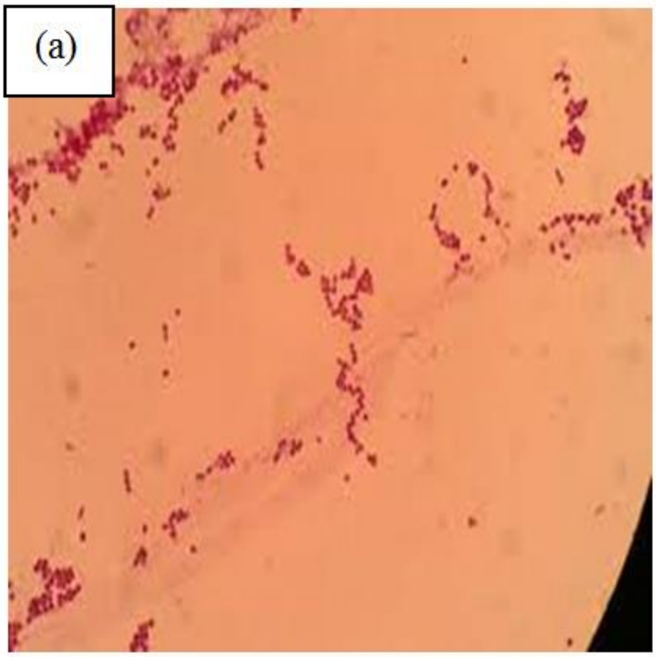
II. METHODS AND MATERIAL

DYES

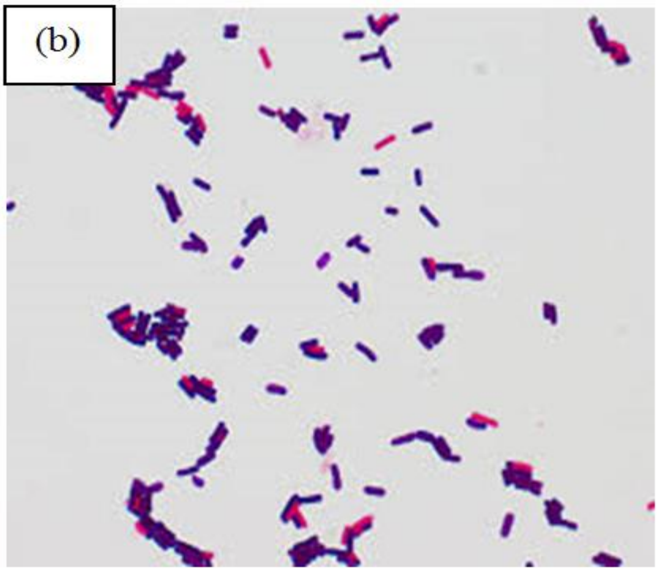
The textile azo dyes viz. Congo Red, Acid Orange and Black 7984 were bought from the small textile industry in Erode.

MICROORGANISMS

Two bacterial species namely *Acinetobacter sp.* and *Bacillus sp.* (Plate 1) were isolated and identified using standard procedures from shrimp shell waste contaminated soil in Tuticorin coast. The stock culture of both bacterial strains were maintained at 4°C on Muller Hinton agar slants.



(a) *Acinetobacter sp*



(b) *Bacillus sp*

Plate 1: Bacterial isolates from shrimp shell waste contaminated soil.

SYNTHESIS AND CHARACTERIZATION OF SILVER NANOPARTICLES:

The isolated bacterial strains were cultured, to produce the biomass for bio-synthesis in liquid broth namely Muller Hinton broth medium. The culture flasks were incubated for 24 h at 37°C. The cultures were centrifuged at 6000rpm and the supernatants were filtered by Whatmann No.1 filter paper. The filtrates were mixed with $AgNO_3$ to a concentration of 1 mm. The reduction of silver ions was analyzed visually by colour change (Plate 2) and was also monitored by measuring the absorbance at a range of 210-990nm using UV-Vis spectrum.

CATALYTIC REDUCTION OF DYE USING AgNPs

Dye decolourization experiments were performed against different concentration (100ppm, 200ppm, 300ppm, 400ppm, 500ppm, 600ppm, 700ppm, 800ppm, 900ppm, 1000ppm) by mixing 0.6ml of respective with 10ml of water and 4µg/ml of the synthesized silver nanoparticles from each isolates. The flasks were kept in shaker and incubated at 37°C ± 2 for 2 days. Samples were drawn after 48 hours for observation. Samples were drawn after 48 hours for observation. Then the broth was filtered and centrifuged at 8000 rpm for 20 minutes. The progress of decolourization was monitored with the help of UV-spectrophotometer at wavelength maxima (λm) of respective dye. Percentage of dye decolourization was estimated by the following formula:

% Decolourization= (Initial OD-Final OD* 100) / Initial OD.

III. RESULTS AND DISCUSSION

UV-VIS SPECTROSCOPIC STUDIES

The microbe mediated synthesis of silver nanoparticle primarily screened by UV- spectrophotometer. The UV absorption of spectrometric analysis of *Acinetobacter sp.* and *Bacillus sp.* showed a Plasmon peak at 540 nm and 510 nm implies the bio-reduction of inorganic silver (Figure 1).

Acinetobacter sp.

Bacillus sp.

Plate 2: Visual observation of silver nanoparticle synthesis before and after addition of bacterial supernatant showing colour turns to dark brown

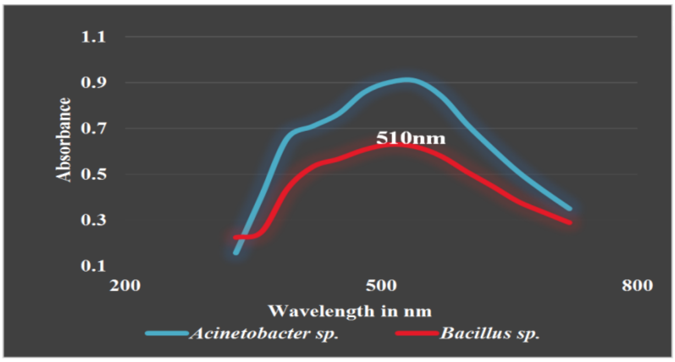


Figure 1: UV-vis spectra recorded from the bacterial strains isolated from Shrimp shell contaminated soil.

DECOLORIZATION OF AZO DYE

The dye decolourization was visually identified by colour change of the dye after 48hrs and it can be monitored by using UV- visible spectrophotometer. As per the result about 70% decolorization was achieved by *Acinetobacter sp.* and *Bacillus sp.* mediated silver nanoparticles at 100 and 200 ppm concentration of the dye Acid Orange 5 and Black 7984 after 48 hours shown in Figure 2 and 3. With respect to the dye Congo Red and Black 7984, the bacterium *Acinetobacter sp.* shows a least decolourization percentage from 300 ppm to 1000 ppm concentration (Plate 3 and 4).

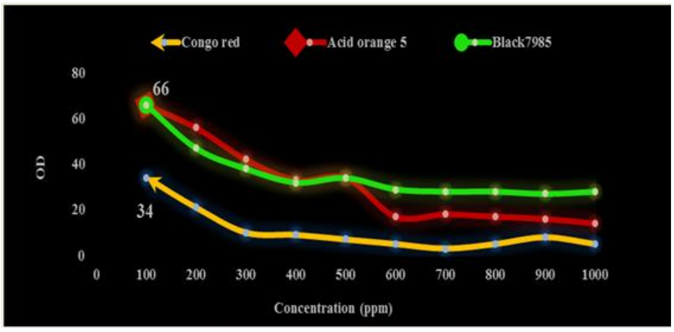


Figure 2: Decolourization of Congo Red, Acid Orange 5 and Black 7984 by AgNPs of *Acinetobacter sp.* in different concentration after 48 hrs.

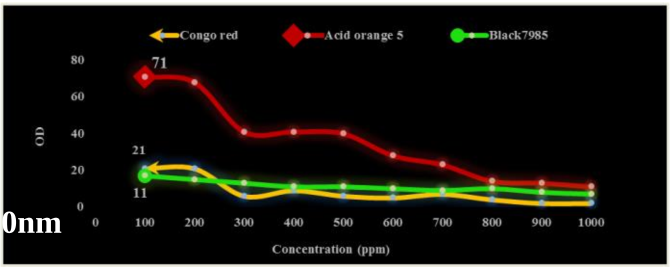


Figure 3: Decolourization of Congo Red, Acid Orange 5 and Black 7984 by AgNPs of *Bacillus sp.* in different concentration after 48 hrs.

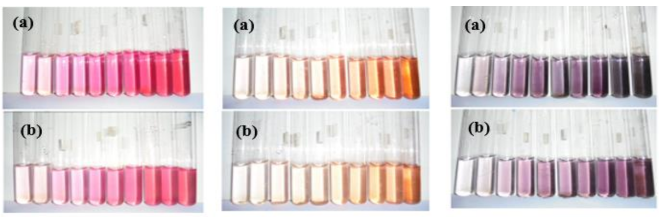


Plate 3: Nano-bioremediation of Congo red, Acid Orange 5 and Black 7984 by *Acinetobacter sp.*

(a) Initial (b) After 48 hrs

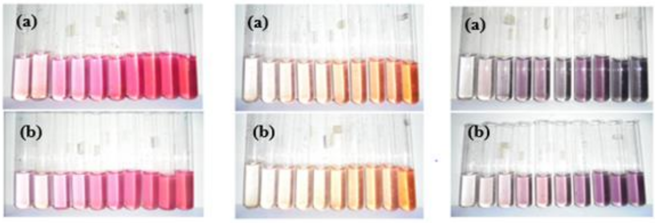


Plate 4: Nano-bioremediation of Congo red, Acid Orange 5 and Black 7984 by *Bacillus sp.*

(a) Initial (b) After 48 hrs

DISCUSSION

In the present study, *Acinetobacter sp.* and *Bacillus sp.* were isolated from Shrimp shell contaminated soil in Tuticorin coast. These two bacteria have to be reported among the most commonly isolated bacteria from the soil contain shrimp shell waste [16, 17]. Several microorganisms like bacteria, fungi, yeast and algae are capable of synthesizing metal nanoparticle [18]. The microbe mediated synthesis of silver nanoparticle primarily screened by visual observation. The change in the colour of the microbial medium from colourless to dark brown due to reduction of inorganic silver ions to silver nanoparticles suggesting the formation of nanoparticles. The appearance of this dark color due to bacterial silver reduction to silver NPs was confirmed by [19, 20]. Thus, the selected bacteria could be considered as potential factories for silver NPs. The colour of the solution is due to their surface Plasmon resonance which has been proved by UV-spectrophotometer. It is a favourable to characterize nanoparticles [21]. The selected bacterial strains show a strong absorption peak at 540 nm (*Acinetobacter sp.*) and 510nm (*Bacillus sp.*). Similar absorption was experienced by [22-24] confirmed the synthesis of silver nanoparticles. Earlier Studies reported that nanoparticle synthesized from silver effective in enhancing the dye removal [25]. Therefore, the present work was intended to decolourize textile dye. Findings suggest that almost 70% decolourisation was achieved by the nanoparticles of both bacteria against the dye Acid Orange 5 and Black 7984 at 100 and 200 ppm concentration. Similar results were reported by [26] where the silver nanoparticles from *Bacillus pumills* to bring about decolourization of Congo red.

IV. CONCLUSION

The present work reported the bio-synthesis of silver nanoparticles using microbes isolated from shrimp shell contaminated soil. The nanoparticles were characterized by UV spectrophotometer with a specific absorption band. The synthesized nanoparticles extensively used for catalytic decolourization of dye. These preliminary study can helpful to treat textile effluent. A slower rate of decolourization was attributed to higher molecular weight, structural complexicity of the dyes [27].

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