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# Green Synthesis of silver nanoparticles and their evaluation for catalytic activity

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## Abstract

The use of *penicillium species* for the synthesis of silver nanoparticles and catalytic performance of the prepared silver nanoparticles was reported in the present paper. The silver nanoparticles were characterized using UV-visible spectroscopy, Fourier transform Infrared spectroscopy and Transmission electron microscopy. The surface plasmon resonance peak was occurred at 412 nm as recorded in UV-visible spectra. The absorption bands appeared in FTIR spectra revealed the presence of biomolecules such as protein responsible for the reduction of silver ions and forming the silver nanoparticles. TEM images showed that the particles were spherical and in the size range between 11nm to 18 nm. Surface area electron diffraction pattern exhibits the crystalline nature of the particles.

**Key words:** Green synthesis, silver nanoparticles, UV- visible spectra, TEM, catalytic activity.

## Introduction

Nanotechnology deals with the design, synthesis and characterization of nanomaterials. Nanoparticle is defined as the assembly of atoms or molecules grouped together in a diameter or size in the range between 1 to 100 nm. Metal nanoparticles are gaining importance now a days as they found their applications in various fields like catalysis[1,2], antimicrobial[3], medicine etc. due to their unique optical [4],electrical and chemical reactivity. Among the metal nanoparticles silver nanoparticles are attracted much attention because of their extra ordinary absorption and scattering efficacy for the light. In addition, silver nanoparticles are known from long time for their optical and antimicrobial activities. Conventional physical and chemical methods employed for the nanoparticles preparation involve the use of toxic chemical which cause environmental pollution. Also, these methods require bulky and expensive

instruments. Therefor there is the need to synthesize the silver nanoparticles by simple. cost effective and environmentally benign route. Biological routes which utilizes the microorganisms and plants for the nanoparticle preparation has turned the viable alternative to the physico-chemical methods [5]. Organic dyes are extensively used in textile, plastic ,medicine etc. industries and hence becomes the main source of pollution of waste water. These dyes are harmful to aquatic organism[6] and also to human being [7]. Hence the removal of these dyes from the waste water becomes necessary. But the conventional water treatment methods are not found to be effective for the removal of these dyes. Silver nanoparticles are the best alternative to the

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conventional water treatment methods for the removal of these dyes from the waste water [8]. In the present work we have focussed on the green synthesis of silver nanoparticles using *penicillium species* and reveal their catalytic performance for the removal of the organic dyes from the waste water.

## Materials and Methods

### Chemicals and Ingredients

All the chemicals silver nitrate, sodium borohydride and methylene blue were of analytical grade used for the reactions. The fungus *penicillium species* was obtained from national chemical laboratory culture collection centre, Pune.

### Synthesis of silver nanoparticles

The fungus culture *penicillium species* was grown aerobically in potato dextrose broth for seven days. From the biomass the cell filtrate was obtained as described Shahnaz Majeed et.al.[ 9]. Further equal amount of cell filtrate was mixed with 1 mM silver nitrate solution and incubated at 110 rpm for 72 h and observed for the formation of silver nanoparticles.

### Characterization of silver nanoparticles

The formation of silver nanoparticles was detected by observing the change in colour of the reaction medium. Further the nanoparticles were characterized by UV-visible spectroscopy (Shimadzu 2450) for the confirmation of silver nanoparticles. The colloidal solution of silver nanoparticles was subjected to FTIR spectroscopy to detect the presence of biomolecules responsible for the synthesis process. Transmission electron microscopy measurements was performed for size and morphological details. The catalytic activity of the synthesized silver

nanoparticles was evaluated by observing the reduction of methylene blue in the presence of NaBH4.

## Result and discussion

### Visual observation

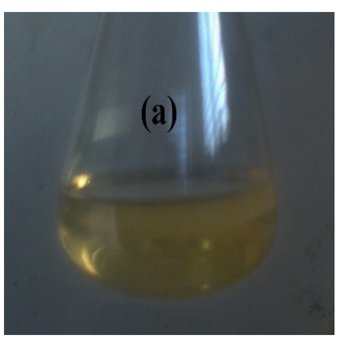


Figure 1(a) Cell filtrate

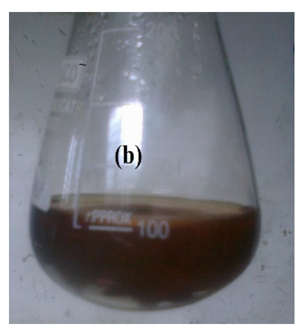


Figure 1(b) Cell filtrate treated with AgNo3

The cell filtrate pale yellow in colour is shown in Fig.1(a) . The change in the colour of the cell filtrate treated with 1mM silver nitrate solution from pale yellow to reddish brown was the primary indication for the formation of the nanoparticles Fig,2(b).

## UV-visible spectroscopy

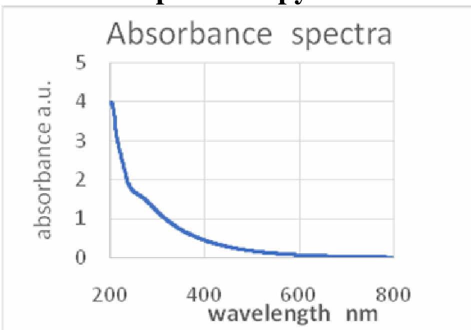


*Figure 2(a) UV-visible spectra of cell filtrate with AgNO3*

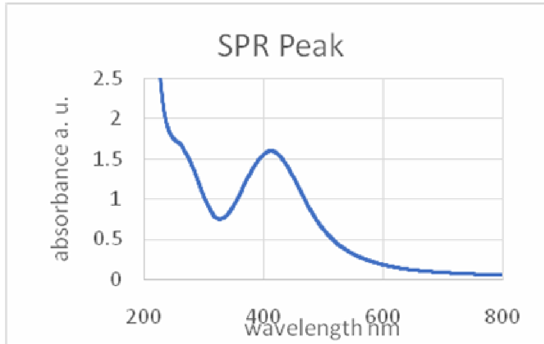


*Figure 2 (b) UV – visible spectra of cell filtrate*

The UV-visible spectra of the cell filtrate is depicted in Fig.2(a) where the absorbance was observed at 260 nm which may be attributed to aromatic amino acids of proteins [10]. Fig, 2(b) illustrated that the surface plasmon resonance peak was appeared at 412 nm

which confirm the formation of the silver nanoparticles[11] . The peak around 390 to 450 nm is the characteristic signature of the silver nanoparticles.

## FTIR spectroscopy

The FTIR spectrum is presented in Fig.3. It provides the information about the biomolecules and chemical bonds which were responsible for the reduction of silver ions and provides the stabilization to the formed silver nanoparticles. The absorption bands were appeared at 3850 $cm^{-1}$(-NH group of amine), 3452 $cm^{-1}$ (- OH group of amines), 2080 $cm^{-1}$ (aromatic -CH stretching) and 1639 $cm^{-1}$ (- NHCO of amide). Thus the information about various compounds were obtained[12].

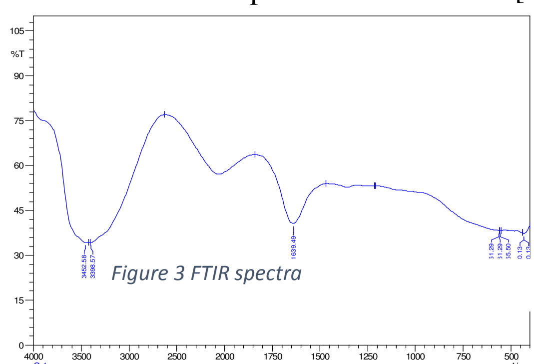


*Figure 3 FTIR spectra*

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**TEM measurement**

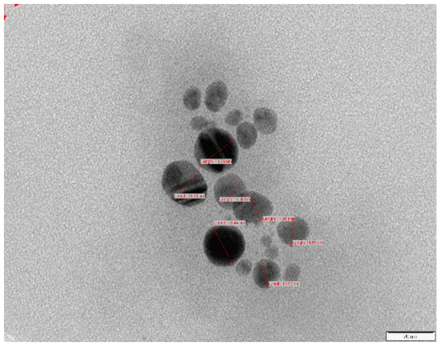

*Figure 4 (a) TEM micrograph of AgNP*

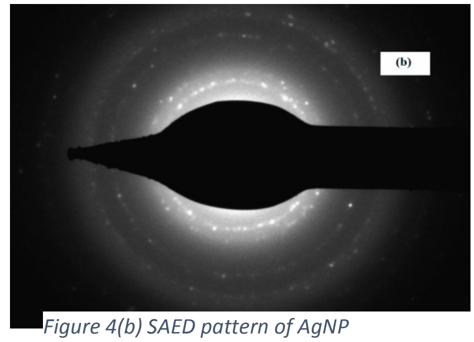


*Figure 4(b) SAED pattern of AgNP*

TEM measurement provide the information about size and shape of the nanoparticles. TEM micrograph shown in Fig.4(a) revealed that the particles were spherical and in the size range between 11 nm to 18 nm. SAED pattern presented in Fig.4(b) specified that the particles were crystalline in nature with the face centred cubic structure.

**Evaluation of catalytic activity**

*Figure 5( a) Visual detection for reduction mechanism*

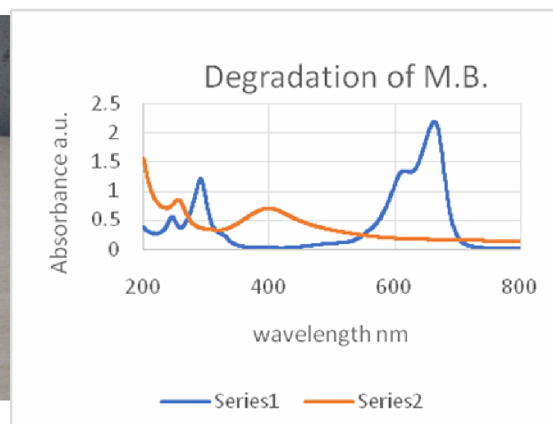


*Figure 6 UV spectra o Reduction mechanism*

For the reduction of methylene blue in the presence of NaBH4 the reaction was carried in a tube and observed visually and also examined using UV-visible spectroscope. For this 0.5ml of NaBH4 was added to 2ml of M.B. and the reaction was monitored visually and through UV-visible spectra. It was observed that M.B. remained in blue colour even kept at several hours Fig.5(a) but as the 0.3ml colloidal nanoparticle solution was added to the reaction solution immediately it becomes colourless. This indicated the reduction of M.B.in the presence of NaBH4 due to silver nanocatalyst. The result is similar to K.F. Princy et.al.[8] and Liangwei Du et.al.[ 13].

The UV-visible spectra shown in Fig.6 clarifies of the reduction of the M.B. The reaction mixture showed the maximum absorption at 663 nm Fig.6(a). But when colloidal solution of silver nanoparticles was added to the mixture, it becomes colourless and the absorption peak at 663nm drops to zero as portrayed in Fig.6.

## Conclusion

The silver nanoparticles were synthesized successfully using *penicillium species*. The single surface plasmon resonance peak indicate the formation of spherical nanoparticles which was also revealed from TEM micrographs. The size of the nanoparticles was found between 11 nm to 18 nm. The synthesized silver nanoparticles were exhibited good catalytic activity for the reduction of M.B.

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