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SYNTHESIS AND CHARACTERIZATION OF GREEN METALLIC SILVER NANOPARTICLES USING AQUEOUS EXTRACT OF *SETARIA VERTICILLATA* AND ASSESSING ITS ANTIMICROBIAL ACTIVITY

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ABSTRACT

In this work, we reported synthesized silver nanoparticles using the aqueous extract of *Setaria verticillata* and assessing its antimicrobial activity. The synthesized silver nanoparticles were characterized by UV-Visible spectrophotometry, FT-IR spectroscopy, Scanning electron microscopy and Energy dispersive X-ray analysis. The antimicrobial activity was assessed using agar well diffusion method. The average particle's size of synthesized silver nanoparticles was 12 ± 4 nm. EDAX analysis confirmed the presence of silver nanoparticles Ag (83.02 %). The antimicrobial activity study reveals that the maximum zone of inhibition was observed in *Pseudomonas aeruginosa* and lowest inhibition activity was found in *Escherichia coli.*The results indicated that *Setaria verticillata* mediated silver nanoparticles can be synthesized by green chemistry and eco-friendly approach.

KEYWORDS: ***Setaria verticillata,*** **silver nanoparticles, EDAX, SEM, FT-IR, antimicrobial activity.**

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INTRODUCTION

Silver nanoparticles are widely used in electronic[1], magnetic[2], catalytic[3], optical sensing[4] and anti microbial applications[5]. Today nanocrystalline silver particles are used in biomolecular detection and diagnostics. Silver nanoparticles are generally prepared by many chemical methods using toxic and hazardous chemicals such as sodium borohydride, sodium citrate, alcohol etc., which creates many environmental problems. In recent years many plants are used in synthesis of silver nanoparticles using plants extracts such as *Acalypha indica*[6], *Coriandrum sativum*[7], *Geranium leaf*[8], *Aloevera*[9], *neem*[10] and *Magnolia kobus*[11] for pharmaceutical and biological activities. Silver nanoparticles are not only prepared by using plants extracts. Researchers around the world are using many microorganisms such as *bacteria*[12] and *fungi*[13] can also use in synthesis of silver nanoparticles. The plant contains many phytochemicals are responsible for reduction of metal particles to corresponding nanoparticles. Silver is one of the most important metals used as an antibacterial agent and anti inflammatory agent. Lin et al reported silver nanoparticles based Surface-enhanced Raman spectroscopy (SERS) in non-invasive cancer detection[14]*Setaria verticillata* (Fig. 1) is a species of crop weed grown in most of the continents. It is annual and self pollinated plant grown in tropical and temperate regions. The leaf extract of *S. verticillata* was used as corrosion inhibitor[15] reported earlier. The present study reports rapid and eco-friendly synthesis of silver nanoparticles from aqueous extract of *S.verticillata*. The synthesized silver nanoparticles were characterized by Fourier transform Infrared spectroscopy (FT-IR), Ultra Violet-Visible spectroscopy, Energy dispersive X-ray analysis (EDAX), Scanning electron microscopy (SEM) and evaluated for its antimicrobial activity against harmful pathogens.

Figure 1
Image of setaria verticillata plant.

MATERIALS AND METHODS

i. Materials

The plant species were collected in and around agricultural lands in Coimbatore, Tamilnadu, India. The collected plant species were identified as *Setaria verticillata* by Botanical Survey of India (BSI) at Coimbatore. Reference No.1674. Analytical grade of silver nitrate was purchased from Sigma Aldrich Chemicals, India. Deionised water was used for synthesis of silver nanoparticles. All the glass wares were washed thoroughly and dried in an electric oven.

ii.Preparation of Setaria verticillata extract

About 10g of leaves were washed with tap water, ground and heated with 200 ml of deionised water at 60 ^{o}C for 10 min. Then it was filtered by using whatman filter paper the extract was stored in refrigeration at 4 °C for further analysis.

iii.Synthesis of silver nanoparticles

About 50 ml of freshly prepared *Setaria verticillata* extract was mixed with 250 ml of 1mM aqueous $AgNO_3$ solution under constant stirring. The mixture of the solution was stirred at a temperature of 100 °C for 8 hours. The product with the change of colour from yellow to brownish black was obtained. It was dried and stored in labelled containers.

iv.Characterization of silver nanoparticles

UV visible spectral analysis was made by using UV visible spectrometer. The FT-IR analysis was carried out using Shimadzu spectrometer (FTIR Shimadzu 8400S. Japan). The shape of silver nanoparticles was analyzed by scanning electron microscope. The elemental group of silver was analyzed by EDAX spectrum.

v.Antimicrobial activity

The antimicrobial study of *Setaria* mediated silver nanoparticles was estimated by the well diffusion method[16] against *Pseudomonas aeruginosa, Escherichia coli, Staphylococcus aureus, Aspergillus niger* and *Candida albicans*. Different concentrations (10 µg/ml, 20 µg/ml, 30 µg/ml and 40 µg/ml) of biologically synthesized silver nanoparticles were prepared. Tetracycline (for *bacteria*) and amphotericin (for *fungi*) (10 µg/ml) were used as positive control. Plates were incubated for 24 h at 37 °C (*bacteria*) and room temperature at 48 h (*fungi*). After the incubation period zone of inhibition was measured around the well.

RESULTS AND DISCUSSION

i.UV-Visible spectrometer analysis of silver nanoparticles

The silver nanoparticles thus prepared were observed under UV-Visible spectrometer for maximum absorbance and wavelength. It is one of the techniques to determine the size, shape and stability of nanoparticles. The colour changes from yellow to brownish black colour is due to surface Plasmon resonance. UV-Visible spectroscopy band of silver nanoparticles was found to be 455 nm which confirms the synthesis of silver nanoparticles (Fig. 2).Similar peak was obtained in UV-Visible spectra in synthesis of silver nanoparticles by shameli et al[17].The broadening of the peak indicates that the nanoparticles were poly dispersed[18].

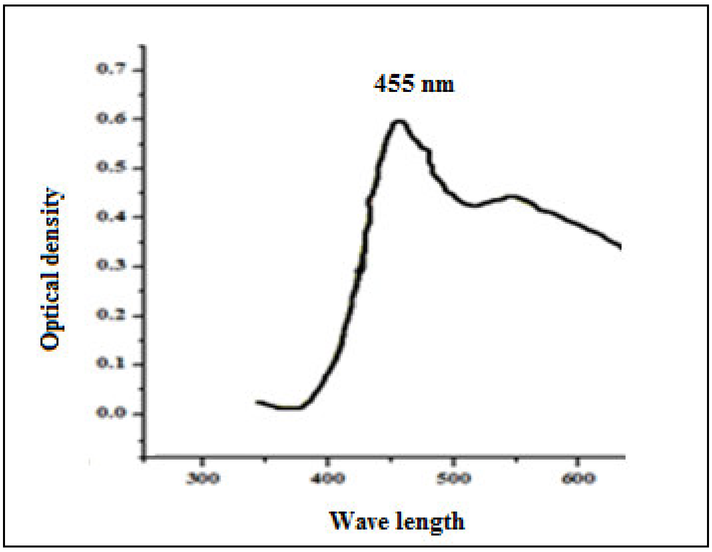

Figure 2
UV-visible spectrum of green synthesized silver nanoparticles Using plant extract of setaria verticillata

ii.FT-IR analysis of silver nanoparticles

The FT-IR analysis was carried out to find the functional groups responsible for synthesis of silver nanoparticles (Fig. 3) by using *setaria verticillata* extract. The band at 3587 cm^{-1} corresponds to O-H stretching alcohols and phenols. The strong peak at 2924 cm^{-1} corresponds to O-H stretching vibrations in carboxylic acids. A sharp peak at 1743 cm^{-1} proves the presence of C=O group of saturated aliphatic ester. The peaks at 1172, 1195, 1242, and 972 cm^{-1} confirm the presence of C-N stretching aliphatic amines and C-H bending alkenes respectively. After bio reduction of silver nanoparticles peaks appearing at 1589, 1442, 918 and 717 cm^{-1} reveals the formation of silver nanoparticles .The phytochemical analysis were carried out by muthukrishnan et al shows the *setaria verticillata* extract contains some compound like alkaloid, phenol and tannin compounds[15]. The analysis reveals that the presence of hydroxyl and carbonyl groups are involved in bioreduction of silver nanoparticles. According to the FT-IR analysis the carbonyl group and proteins bind the surface of silver nanoparticles. The FT-IR analysis peaks are similar to the synthesis of silver nanoparticles by *Ocimum* leaf extract[19].

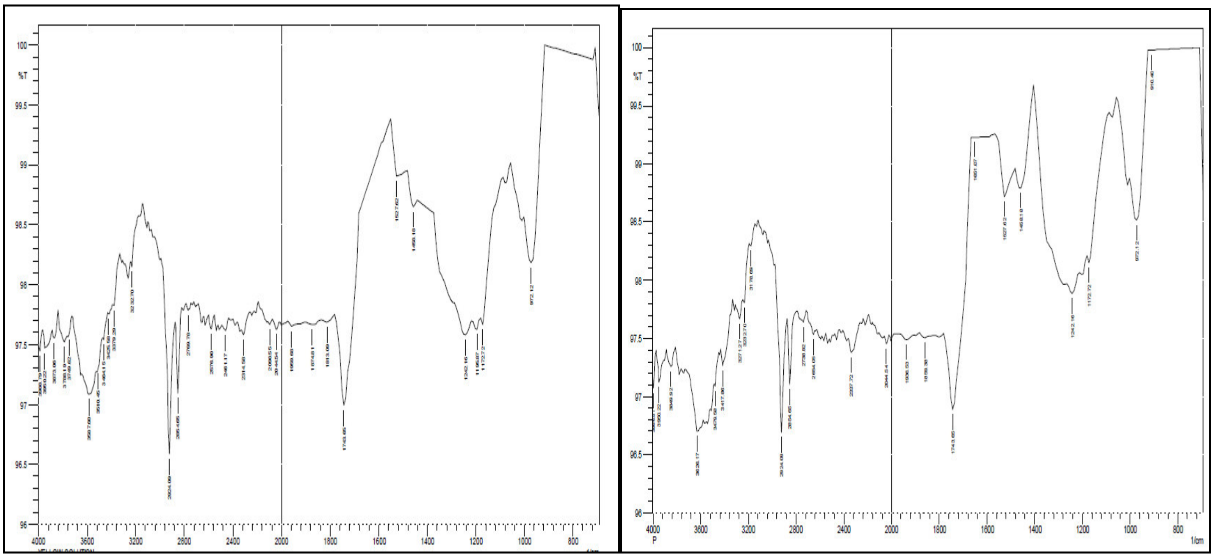

Figure 3

FT-IR spectrum of A. Plant extract of setaria verticillata B.Synthesizedsilver nanoparticles by using plant extract of setaria verticillata plant extract

iii.EDAX analysis of silver nanoparticles

EDAX is the best tool for identifying the type of nanoparticles formed. In the present study, the strong signal of silver confirms the presence of silver nanoparticles.The Y axis corresponds to X-ray counts and X axis corresponds to energy in keV. The major emission of silver (83.02) present in biologically synthesized silver nanoparticles (Fig. 4). Normally silver nanoparticles show optical adsorption peak approximately at 3 keV due to surface plasma resonance[20].

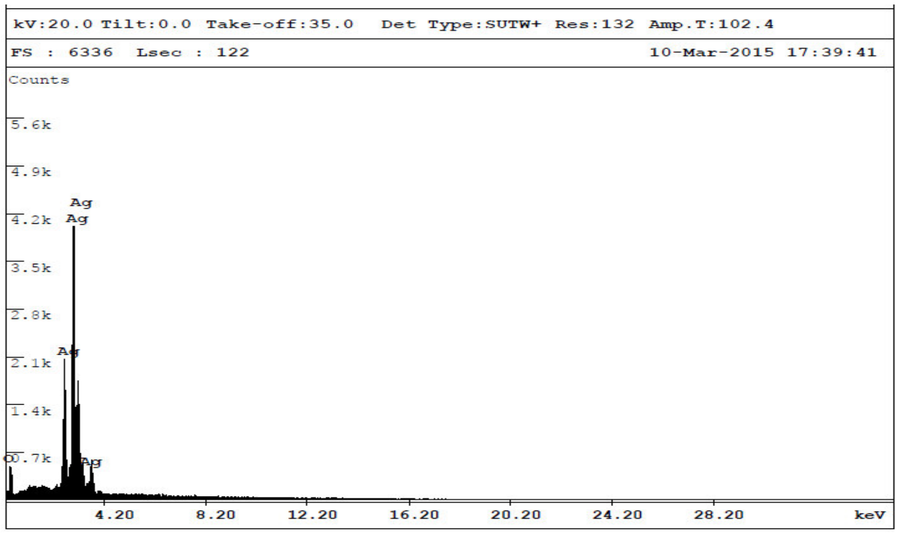

Figure 4
EDAX profile of synthesized silver nanoparticles by using setaria verticillata plant extract

iv.SEM analysis of silver nanoparticles

The SEM analysis was performed by using ICON quanta SEM analyser. SEM analysis determines the size and shape of the silver nanoparticles. It also provides information about the electrical conductivity of the nanoparticles[21].SEM image shown the average size of nanoparticles was 12 ± 4 nm (Fig. 5).

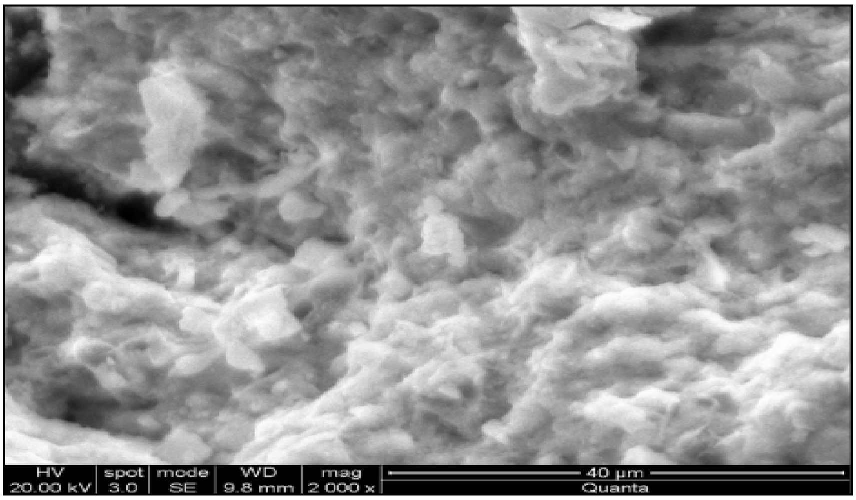

Figure 5
SEM images of synthesized silver nanoparticles by using setaria verticillata plant extract

v.Antimicrobial activity

Antimicrobial activity of green synthesized silver nanoparticles against pathogenic microbes was shown in (Fig. 6).The antimicrobial activity study reveals that the maximum zone of inhibition was observed in *Pseudomonas aeruginosa* and the lowest inhibition activity was found in *Escherichia coli.* Highest zone of inhibition was obtained in *Pseudomonas aeruginosa* with a zone diameter of 16.00 ± 1.00 mm at 40 µg/ml concentration. Lowest zone of inhibition was found in *Escherichia coli* with a zone diameter of 8.00 ± 1.00 mm at 40 µg/ml concentration of silver nanoparticles. Silver nanoparticles attached to surface of antimicrobes and block the respiration and kill the pathogenic microbes[22].

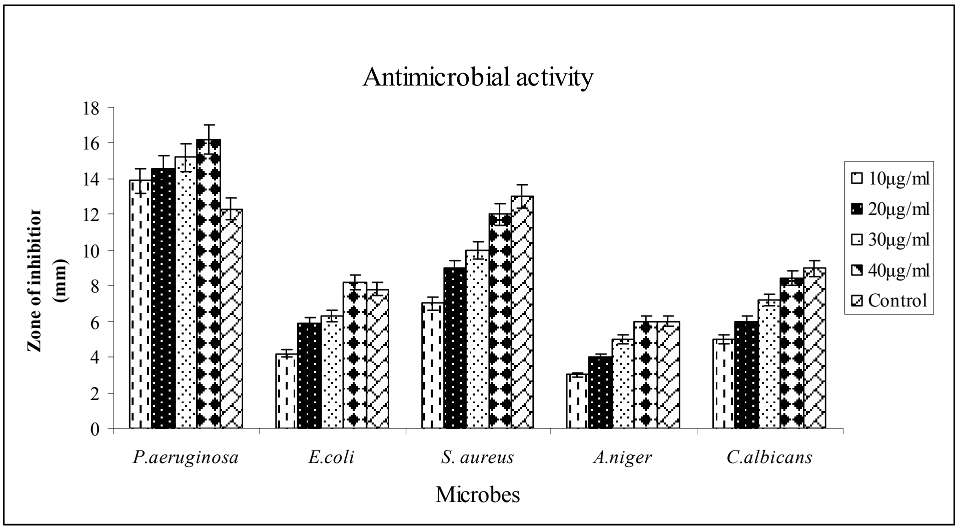

Figure 6
Antimicrobial activity of green synthesized silver nanoparticles by using plant extract of setaria verticillata plant extract

CONCLUSION

The silver nanoparticles were green synthesized by using leaf extract of *Setaria verticillata* . Reductions of metal ion through leaf extract led to the formation of well defined size and shape of silver nanoparticles. The plant species *Setaria verticillata* is available in all parts of the country. So, it can be used for synthesis of silver nanoparticles in large scale industries. The results indicated that *Setaria* mediated silver nanoparticles can be synthesized by green chemistry and eco-friendly approach. It is further confirmed that the green synthesized silver nanoparticles have antimicrobial activity and prove to be active against pathogenic microbes.

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