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Green Synthesis of Nano Particles by *Oscillatoria cortiana*

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Abstract

Cyanobacteria are procaryotic microorganisms distributed in aquatic environment that involved in the atmospheric nitrogen fixation. Such organisms have an ability to synthesize nano particles in an aqueous culture medium. The current study isolated the Oscillatoria cortiana from the paddy field soil and mass cultured under microbiology culture lab. The aqueous extract of O. cortiana synthesized silver nano particles and was confirmed by UV-Visible Spectrophotometer (showed peak at nearly 230nm and 430 nm), FTIR (peaks indicated the presence of functional groups: -C-O-C, N=O, C=O and -OH groups), SEM-EDX analysis (particle size ranged from17.79 to 19.32 nm). Synthesized O-AgNPs was tested against entero bacterial pathogens showed inhibition zone ranged from 1.4 ±0.1 to 1.8±0.2 cm for E.coli and 1.4±0.2 to 2.1±0.1cm for Bacillus cultures.This green synthesis technology of nano particle synthesis from Oscillatoria cortiana could be suggested for application in medicine, pharmaceutical field and bioremediation.

Keywords

Cyanobacteria, Oscillatoria, Nano particles and antibacterial activity.

INTRODUCTION

Cyanobacteria is commonly known as “blue green algae” and they are growing well in different environments. It can be used as a biofertilizer in Agriculture for improving soil fertility in crop field. Meanwhile it can be applied in waste degradation in environmental management system. Blue green algae mediated green synthesis of nano particles is a sustainable, cost benefit and eco-friendly metal oxide, metallic and bimetallic nano particles. Certain cyanobacterial species have an ability to synthesize the nano components under aquatic cultural conditions. Green synthesis of silver nano particles by algae showed advances, challenges and sustainability prospects [1]. Algae had the emerging sustainable source for the synthesis of silver nano particles. The present research work dealt with the green synthesis of nanoparticles using Oscillatoria cortiana. The biosynthesized nano particles can be confirmed by UV-Visible Spectrophotometer, Scanning Electron Microscopy and EDX analysis.

METHODOLOGY

Soil samples collected from the rhizosphere zone of paddy field at the depth of 6-10cm in the Selugai of Sivagangai district, Tamil Nadu, India. It was made as a suspension and inoculated in the BG0 medium and incubated at 25o C, 12 h light and 12h dark period (Light intensity 3000 lux). The algal growth was examined periodically by Trinocular microscopic observation and identified cyanobacterial species based on the keys [2], [3], [4] and [5]. Isolated cyanobacterial organisms were observed and micro photograph was taken with high power (40X) magnification. They were mass cultivated under laboratory flask culture method and such algae produced nano particles by both exogenously and endogenously. They were separated by centrifugation at 6000rpm for 10 minutes. Both algal suspension and algal pellets or algal mass were tested for the nano particle synthesis by using 2mM Silver nitrate solution. It was kept at both light and dark period for 12 hours. Development of colour appearance in the sample indicated the silver nano particles synthesized by the samples. The biosynthesized nano particles were confirmed by UV-Visible Spectrophotometer, FTIR, SEM-EDX analysis in Department of Chemistry, Consultancy on characterization of Nano materials (CCN), The Gandhigram Rural Institute-Deemed to be University, Gandhigram, Dindigul, Tamil Nadu. The aqueous extract of algal silver nano particles could be tested for anti-bacterial activity using well diffusion method using E. coli and Bacillus, organisms.

RESULTS AND DISCUSSION

The Cyanobacteria-*Oscillatoria cortiana* was isolated from the rhizosphere soil of paddy field of Selugai, Sivagangai district. They were mass cultured under microbiological laboratory condition by flask culture method. (Figure:1)

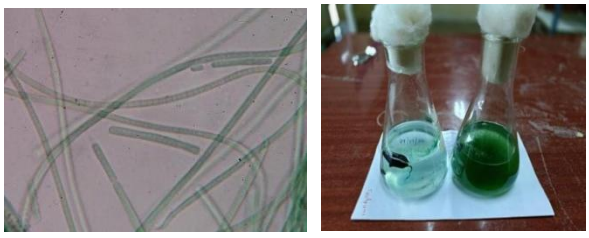

Figure 1. Isolated Cyanobacteria and Mass produced *Ocillatoria cortiana*

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Several biological methods were employed for the synthesis of nano particles using algae which was cost effective and non-toxic technology [6]. In the present study, the synthesized nano particles in both *Oscillatoria cortiana* suspension and its mass were treated with silver nitrate solution. After 12 h incubation of the sample at light and dark period, light incubation samples showed brown colour appearance while dark incubation does not show brown colour appearance in both samples. This colour appearance indicated that light intensity is essential for silver nano particles synthesis in algal samples (Figure:2). The light incubated algal silver nano particles were separated by high-speed centrifuge for 10 minutes. The AgNPs (Silver nano particles) in the algal suspension and algal mass sample was collected and dried in hot air oven at 60O C for 2 days.

Figure 2. O.cortiana culture suspension and mass treated with silver nitrate solution

The liquid O-AgNPs sample was analyzed by UV-Visible Spectrophotometer. It showed sharp peak at 230nm and broad peak at 430nm wave length (Fig:3). It confirmed the presence of nanoparticles in the algal suspension and algal mass samples which indicated that the nano particles synthesized exogenously (algal suspension) and endogenously (algal mass) by *Oscillatoria cortiana*. Such results were compared with the previous study [7] which reported that the UV-Visible spectrum analysis of selinium nano parrticles from Ulva lactuca showed the range of absorption band between 250 and 300nm spectrum and the absorbance gradually increased from 2.05 to 2.25 indicated that the reduction of nano particles and showed maximum peak found in 270nm.

The dried O-AgNPs sample was analyzed by FTIR (Figure:4) and SEM-EDX (Fig:5&6). The FTIR spectra was recorded in the frequency of 500 to 4000 cm-1. The absorption spectra of both algal suspension and algal mass sample showed distinct absorption bands which corresponding to the nano particles from different biomolecules (carbohydrates, proteins and lipids). The algal suspension sample showed peaks at 600 cm-1 corresponding to the aliphatic groups, 1050cm-1 to C-O-C group of carbohydrates, 1400cm-1 range to N=O nitro groups, 1600cm-1 to C=O stretch of amide -I of proteins and 3450cm-1 represented N-H stretch of amines and OH stretch of biomolecules. Similarly, the algal mass showed the peaks at 800cm-1 corresponding to aliphatic groups, 1100cm-1 to C-O-C group of carbohydrates, 1400cm-1 ranged to N=O of nitro groups, 1600cm-1 to amide -I stretch with C=O groups and 3400cm-1 showed the presence of OH groups. Similar study reported [8] about the functional groups of algal biomass of *Scenedesmus* spp. (-OH, -COOH, NH2 and C=O) by FTIR and they suggested that the biomass of such algae could be applied in sustainable green energy source. Another study [9] showed that microalgal isolates (*Scenedesmus* spp., *Chlorella* spp., *Monorapidium* spp., *Actodesmus* ssp. and *Cyclidium* spp.) have -OH, -COOH, NH2 and C=O organic compound groups.

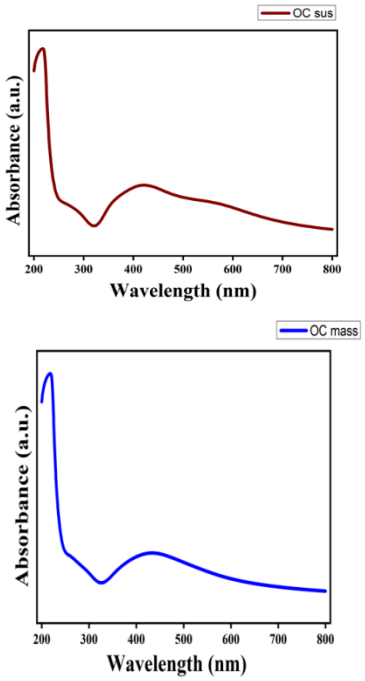

Figure 3. UV-Visible Spectrum analysis of Ag+nano particles of Oscillatoria cortiana (culture mass and suspension)

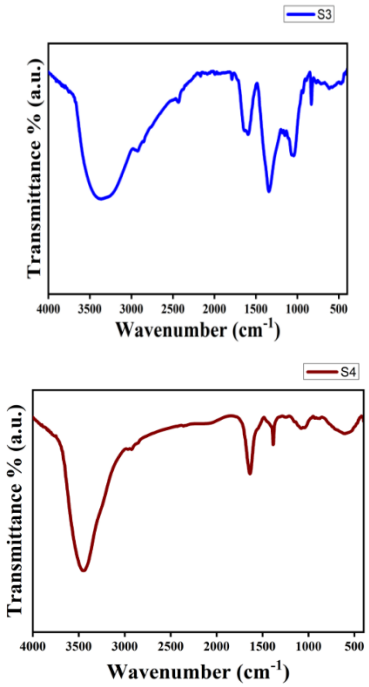

Figure 4. FTIR analysis of Ag+nano particles of Oscillatoria cortiana (culture mass and suspension)

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The Scanning electron microscopy applied for the evaluation of surface morphology of silver nano particles of both algal suspension and mass culture of *Oscillatoria cortiana*. It was observed and showed different geometrical shapes and size of silver nano particles especially as spherical, cylindrical, cuboid, triangular and polyhedral shapes with various size measured as ranged from 17.79 to 19.32 nm in size for algal suspension and 17.88 to 17.89nm for algal mass sample. Recent research [10] analyzed and reported that the nano particle with average size of 52nm which was showed as an absorption peak at 430nm. The Energy Dispersive X ray spectroscopy was a common method of trace elements determination or components in biomass samples. It was applied in the present study and analysed the *Oscillatoria* suspension sample which showed the sharp peak for Silver (Ag) nano particles and also other nano elements such as calcium (Ca), silicon (Si), Sodium (Na), Oxygen (O), carbon (C) and Nitrogen (N). Similarly, the algal mass sample showed the sharp peak for silver (Ag) nano particle and other nano elements namely sodium (Na), oxygen (O) and carbon (C) (Figure: 5 and 6).

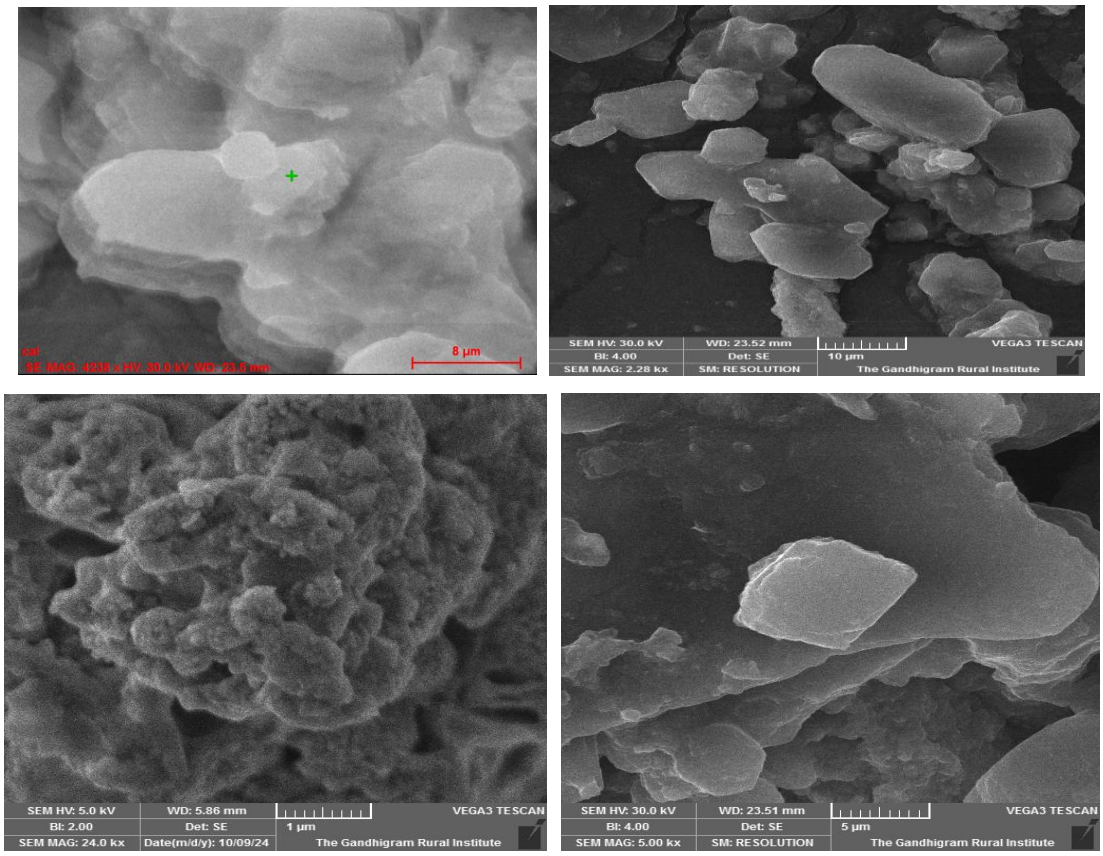

Figure 5. SEM-EDX analysis of Ag+nano particles of Oscillatoria cortiana (algal suspension)

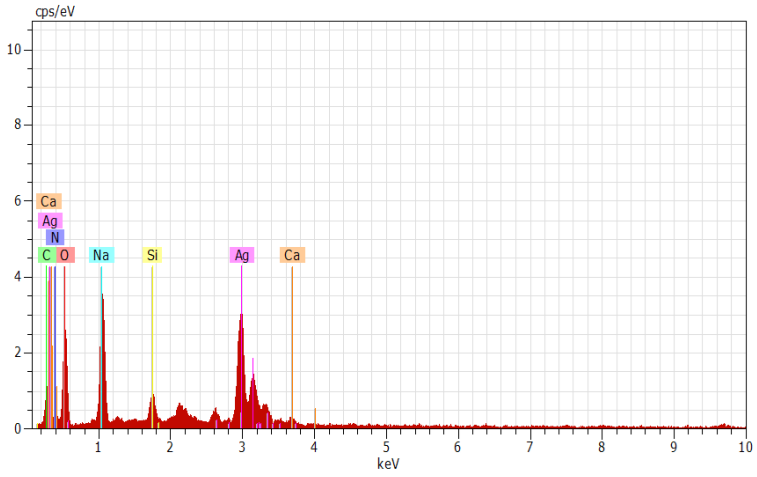

Figure 6. SEM-EDX analysis of Ag+nano particles of Oscillatoria cortiana (culture mass)

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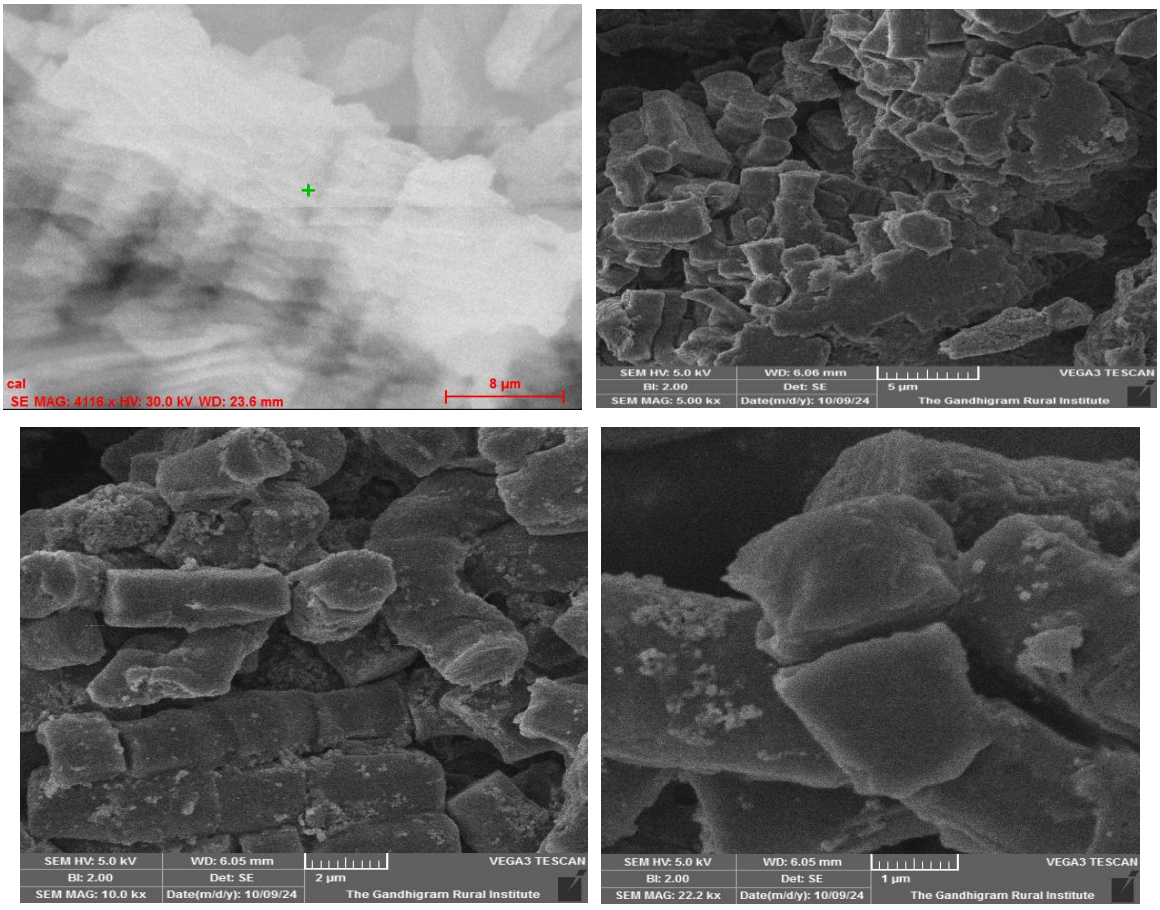

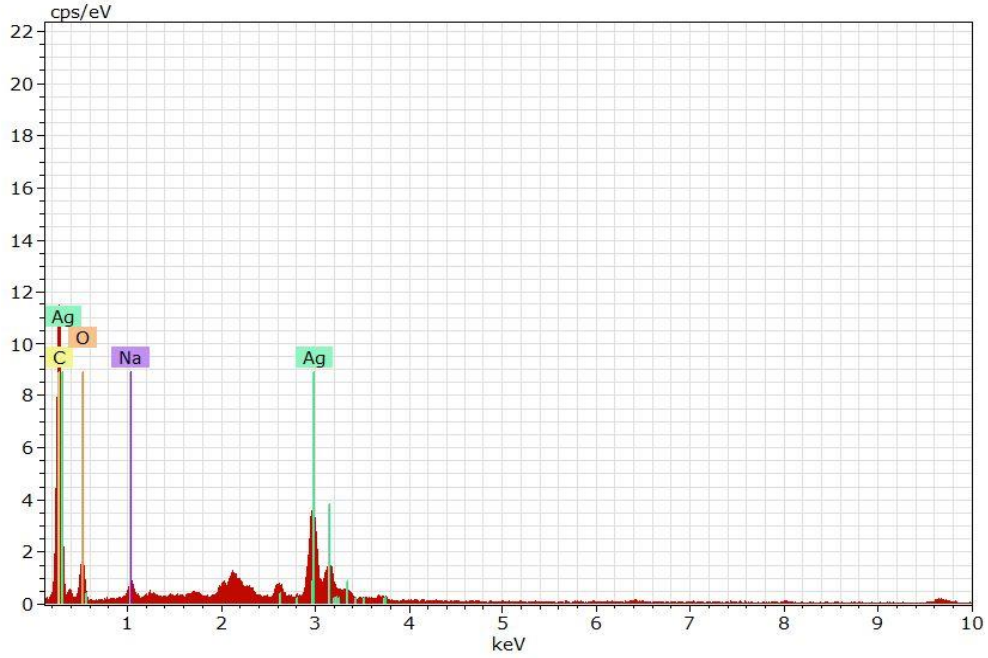

Figure 7. Antibacterial activity of silver nano particles from Oscillatoria cortiana

In the present investigation, the antibacterial activity of silver nano particles from *Oscillatoria cortiana* against enteropathogens: E.coli showed inhibition range from 1.4 ±0.1 to 1.8±0.2 cm and Bacillus spp. showed 1.4±0.2 to 2.1±0.1cm range of inhibition with 24 hours of incubation at 310C. These nano particles controlled the *E.coli* and *Bacillus* growth under laboratory condition. Similar result was reported that AgNPs created holes in the cell wall of bacteria and damaged membrane activity which inactivated the cell [11] and [12]. They were effective against both gram positive and negative bacteria [13] and [14]. But the selinium nano particles from Stenotrophomonas maltophilia

and Bacillus mycoides showed better antimicrobial activity against the gram-negative bacteria *Pseudomonas aeruginosa* and yeasts [15]. And also, the *Desmodesmus abundans* synthesized silver nano particles exhibited antimicrobial properties in the agar diffusion method against Escherichia coli [16].

The evaluation of antibacterial effects of bio-synthesized silver nano particles against the Staphylococcus aureus, Escherichia coli and *Pseudomonas aeruginosa* [17]. It highlighted the potential of silver nano particles as an effective antibacterial agents in the health care industry especially in combating hospital-acquired infections. The present study have reported that the bio-synthesized silver nano particles from *Oscillatoria cortiana* has been a good resource for the synthesis of nano particles and showed the antibacterial effect on bacterial pathogens which could be suggested in the health care industry to produce effective antibacterial agents using such nano particles.

CONCLUSION

The present study concluded that the isolated *Oscillatoria cortiana* is a good source of synthesizing nano particles at lower concentration of silver nitrate solution. The synthesized nano particles confirmed by UV-Visible Spectrum, FTIR, SEM-EDX techniques and they showed antibacterial activity on selective bacteria. Bio-synthesized nano particles could be applied in various fields of science such as pharmaceuticals, medicine and bioremediation. It was a cost effective and eco-friendly technology using micro algae for synthesizing nano particles.

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