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RESEARCH ARTICLE

BIOSYNTHESIS OF SILVER NANOPARTICLES USING HIBISCUS ROSA SINENSIS PLANT EXTRACTS

Mrunal M. Mahajan[1], Pravin B. Raghuwanshi[2] and Harshal A. Dhepe

[1]Assistant Professor, Department of Chemistry and [2]Professor, Department of Chemistry
Brijlal Biyani Science College Amravati, Maharashtra, India

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ABSTRACT

The plant-mediated synthesis of nanoparticles is a best connecting link of green chemistry that connects nanotechnology with plants. An eco-friendly biosynthesis of metallic nanoparticles is cheap & good alternative method than any toxic & chemical methods known. In this current study, the biosynthesis of silver nanoparticles (AgNp) by using flower petals of hibiscus rosa sinensis plants were identified by observing color changes after the addition of flower extract in metal nitrite solution. This report includes results and discussion about the synthesized silver nanoparticles. Structural characterization of the biosynthetic silver nanoparticles from the plant extract were carried out by using UV-Visible spectrophotometer, Fourier transform infrared spectroscopy (FTIR) for understanding the involvement and interactions of functional groups and Scanning Electron Microscopy (SEM) which approved the synthesis of nanoparticles.

INTRODUCTION

The biosynthesis of nanoparticles has been proposed as a cost-effective and environmentally friendly method, alternative to chemical and physical methods [1]. The nanotechnology and biomedical sciences open the possibility for a wide variety of biological research, nano-medical and pharmaceutical uses [2-4]. Recently, synthesis of silver nanoparticles has attracted considerable attention owing to their diverse properties like catalysis, magnetic and optical polarizability, electrical conductivity, antimicrobial activity, and surface enhanced Raman scattering (SERS) [5], also use as antifungal/ antibacterial agents [6].

Nanoparticles has many physiochemical properties as well as many applications in the various fields such as drugs & medicine, manufacturing & materials, environmental, electronics, energy harvesting, mechanical industries & many others [7]. The AgNps has good application in treatment of skin problems & many others. The synthesis of Nps by the chemical & physical method has many drawbacks because of the expensive and toxic chemicals used. To avoid these problems, the green nanotechnology plays important role for synthesis of silver nanoparticles. Thus, synthesis of biogenic Nps by using plants is called as Green Nanotechnology [8].

Among the biological alternatives, plants and plant extracts seem to be the best option. Plants are nature's "chemical factories." They are cost efficient and require low maintenance. India is rightly called the "Botanical Garden of the World" because of the largest producer of medicinal plants. It was reported that medicinal plants have been stated to comprise about 8000 species and account for approximately 50% of all the higher flowering plant species of India [9]. The different types of biological factors are responsible for the biological synthesis of nanoparticles. Specially the plants are used due to the presence of natural compounds such as alkaloids, flavonoids, saponins, steroids, tannins and other nutritional compounds can be derived from various parts of plant. Thus, the plants consider being the best precursor for the synthesis of nanomaterial in non-hazardous ways [10]. Not only this, the plant also contains various secondary metabolites, which help in the process of reduction and stabilization in the bio-reduction reaction to synthesized novel metallic nanoparticles.

The synthesis of AgNPs using ethanolic leaf extract of Hibiscus plant is also possible and this shows good and potent antimicrobial activity [11]. By using the petals of Hibiscus

*Corresponding author:**Mrunal M. Mahajan**

Brijlal Biyani Science College Amravati, Maharashtra, India

flower, biogenic AgNPs can be synthesized, it has several species with different vibrant colors of flowers, and is used as a primary ingredient in many herbal teas, due to its medicinal properties. [12]

The plant Hibiscus rosa-sinensis belong to the family Malvaceae. This plant is used as medicinal plant. Its flower extract shows anti-bacterial properties in treatments of arthritis, boils and cough. Fruits are used externally in case of sprain, wounds, and ulcers. The decoction of leaves, roots and fruits are helpful. The tea made from Hibiscus is rich in Vitamin C. The synthesis of silver nanoparticles from the Hibiscus rosa sinensis preferred due to of the presence of phytochemicals which provide natural capping and reducing agent was [13]. These plants of Hibiscus are widely planted as ornamentals whereas used in traditional medicine as anti-microbial, demulcent, aphrodisiac, anodyne, laxative and emollient with its charismatic & colorful flowers. [14]

The presence of alkaloids, flavonoids, terpenoids, saponins, tannins, steroids, cardiac glycosides and anthraquinones reducing sugar, anthocyanin pigment, carotene, thiamine, riboflavin, niacin and ascorbic acid are revealed by the qualitative phytochemical analysis from flower extract of Hibiscus rosa-sinensis. [15]

LITERATURE REVIEW

Khan et al [16] described that nanoparticles can be differentiated on their properties, shapes & sizes & also based on the parent material from which they are made up of, includes fullerenes, metal NPs, ceramic NPs, and polymeric NPs. This explained the preparation methods of nanoparticles as top-down and bottom-up synthetic techniques with merits, demerits and general remarks. G.Singhal et al [17] described bioreduction of $AgNO_3$ with tulsi leaves extract, gives the silver nanoparticles having good antimicrobial activity against gram-negative E. coli and gram-positive S.aureus. As Ag nanoparticles are found to have exclusive applications in various fields of medicine, environment, agriculture, cosmetics, etc, this research works deals with bio-synthesis of Ag nanoparticles.

EXPERIMENTAL

Preparation of plant extract

For the preparation of pure plant extract, firstly the work was started with the collection of fresh flowers of hibiscus & then selection of fresh and healthy petals of the flowers, thoroughly rinsed with tap water followed by distilled water to remove dust particles. About 25g of petals were weighed, chopped, and put into a conical flask (of 250ml) with 100 ml of distilled water. This mixture was heated for 20-30 minutes at 50°-60°C with continuously stirring by magnetic stirrer & was allowed to cool down at room temperature (22- 25°C). Lastly, the mixture was filtered. This extract is ready to use. This pure extract (H1) was stored in the refrigerator for further use, to synthesize AgNps.

Preparation of silver nitrite solution (0.1M):

For the preparation of metal nitrate aqueous solution, dry powder of Silver Nitrate (AgNO3) was dissolved into distilled water to prepare 0.1 M solution of silver nitrate. This solution was prepared freshly. It was thoroughly dissolved by continuously stirring using magnetic stirrer, the solution was filtered and used.

Biosynthesis of Silver nanoparticles:

The experimental method of biosynthesis of silver nanoparticles starts firstly with the continuous stirring and simultaneously heating of freshly prepared silver nitrate solutions (A) for 20- 30 minutes with the help of magnetic stirrer. When the temperature of solution (A) reached 60°-65°C, drop wise addition of the plant extract (H1) into the solution (A) was started which form mixture of AgNPs in Hibiscus extract i.e. (H1A). During this addition, color change in metal nitrate solution was observed in the form of bio-reduction of metal nitrate solution. This solution was then allowed to cool down at room temperature & stored in refrigerator overnight. For the crystallization purpose, this reduced solution was centrifuged at 3000-3500 rpm for 10-15 minutes. Then the supernatant was removed and the remaining centrifugate again centrifuged with the ethyl alcohol in the ratio of 1:1 & pour into the watch glass until dry. The obtained nanoparticles were weighted and collected for further analysis.

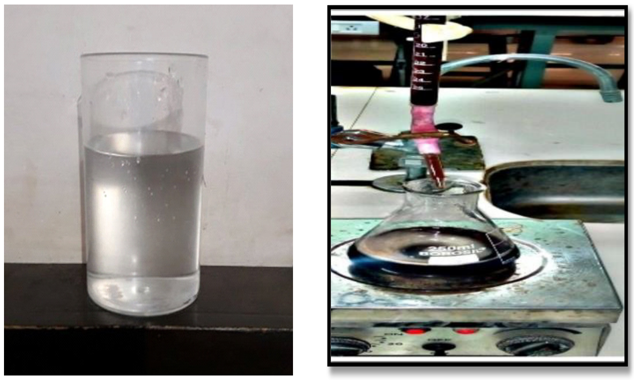

Figure 1 Experimental representation of formation of **(1)** A & **(2)** H1A.

RESULTS AND DISCUSSION

Characterization of nanoparticles by using spectral data analysis:

UV-Visible absorption spectroscopy

It is helpful for the quantitative monitoring of formation and the confirmation of silver nanoparticles by measuring the wave length of reaction mixture in the UV – Visible spectrum. The single and broad nature of the absorption peak indicates that synthesized nanoparticles are of identical shape and size and has undergone agglomeration.

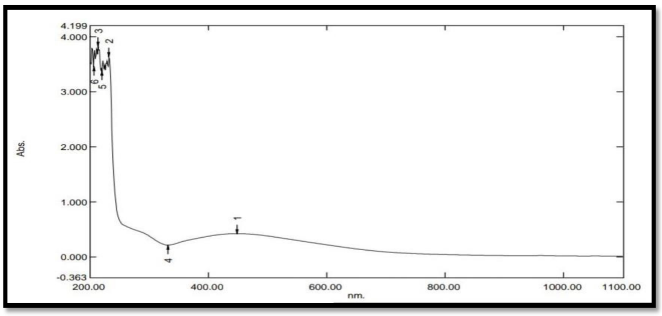

Figure 2 UV-VIS spectrum of H1A

The UV-Visible spectrum shows strong absorbance peaks at 449 nm. This peak is because of the characteristic phenomenon of surface plasmon resonance (SPR), which occurs due to the excitation of the surface plasmons present on the outer surface ofthe silver nanoparticles causes by the applied electromagnetic field.

IR spectroscopy:

It helps to obtained information about the functional groups present in the biosynthesized silver nanoparticles and their interaction in between the metal particles and phytochemicals of mixture (H1A). For FTIR study, the characterization of functional groups on the surface of metallic nanoparticles' mixture of AgNPs by plant extracts, were investigated by FTIR analysis (Shimadzu) and the spectra was scanned in the range of 4000–400 cm^{-1} range at a resolution of 4 $cm^{-1.}$ The sample was prepared by dispersing the uniformly in a matrix of dry KBr, compressedto form an almost transparent disc. KBr was used as a standard in analysis of the samples.

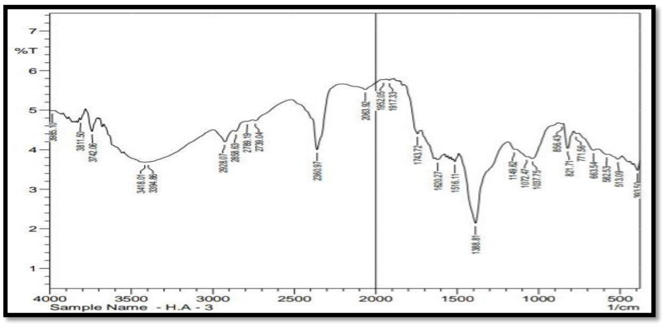

Figure 3 IR spectra of H1A

IR values for Mixture solutions of AgNPs are tabulated in following Table-1

S. No.	Frequency cm^{-1}	Bond	Functional groups
1	2928.07	C-H stretch	Alkane
2	2789.19	Ald. C-H stretch	Aldehyde
3	2360.97	C=N / C=C / O=C=O	CO2, imine/oxime, alkene
4	2063.92	N=C=S /C=N	Isothiocyanate
5	1072.47	S=O stretch	Sulfoxide
6	856.43	C-X stretch	Halo compound

Scanning Electron Microscopy

SEM studies were carried out to visualize the size and morphology of the metallic nanoparticles. It was observed that the AgNPs synthesized from Hibiscus extract were cubical or spherical in shape with maximum particles in size range within 1-20 um. The important parameters that govern the properties are the particle size, size of distribution and shape of silver nano particles. In present study, the size of biosynthesized silver nanoparticles was found to be 1-2 um which shown in following figures,

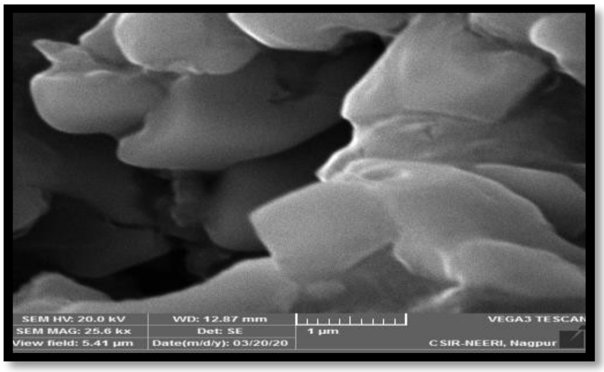

Figure 4

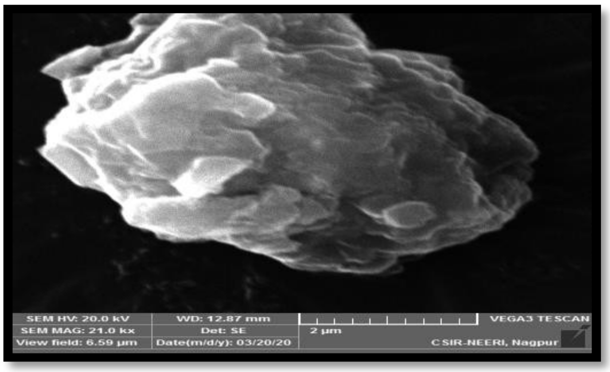

Figure 5

CONCLUSION

Thus, in the present investigation, the silver nanoparticles were successfully prepared using environmentally conscious method with fair yield and characterization.

Statements and Declarations

Funding: "This research received no external funding".

Conflicts of Interest: "The authors declare no conflict of interest.

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