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GREEN SYNTHESIS OF SILVER NANOPARTICLES FROM EXTRACT OF *Berberis aristata* AND ITS CHARACTERIZATION

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ABSTRACT

Nanotechnology finds extensive applications in nanomedicine, an emerging new field. Nanotechnology is mainly concerned with synthesis of nanoparticles of variable sizes, shapes, chemical composition and controlled dispersity and their potential use for human benefits. In this work deals with the synthesis and characterization of silver nanoparticles using *Berberis aristata* extract and evaluation of their antimicrobial activity. Synthesized nanoparticles were characterized by using UV-Vis (Ultra Violet-visible) absorption spectroscopy, Fourier transform infrared spectroscopy (FT-IR) and scanning electron microscope (SEM) analysis and then the antimicrobial activities are carried out by using different organism. The reaction mixture turned to a brownish gray color after 5 hrs of incubation and exhibits an absorbance peak around 450 nm characteristic of AgNPs. The approach of green synthesis seems to be cost efficient, eco-friendly and easy alternative to conventional methods of silver nanoparticles synthesis.

KEYWORDS: *Berberis aristata*, *Silver nanoparticles*, Ultra Violet-visible *absorption spectroscopy*, Fourier transform infrared spectroscopy, scanning electron microscope, antimicrobial activity.

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Introduction

Nanotechnology is mainly concerned with synthesis of nanoparticles of variable sizes, shapes, chemical compositions and controlled dispersity and their potential use for human benefits. Although chemical and physical methods may successfully produce pure, well-defined nanoparticles, these methods are quite expensive and potentially dangerous to the environment. Use of biological organisms such as microorganisms, plant extract or plant biomass could be an alternative to chemical and physical methods for the production of nanoparticles in an eco-friendly manner **(1).**

Particles with the size ranging between 10-9m are known as nanoparticles or sub-micronparticles. They are also known as quantum dots due to quantum property possessed by them. The original definition, translated into English "Nano-technology" is the production technology to get the extra high accuracy and ultra fine dimensions, i.e. the preciseness and fineness on the order of 1 nm (nanometer), 9-10 meter in length **(2).**

Silver nanoparticles (AgNPs) have been proven to possess immense importance and have been extensively studied. AgNPs find use in several applications such as electrical conducting, catalytic, sensing, optical and antimicrobial properties. In last some years, there has been an upsurge in studying AgNPs on account of their inherent antimicrobial efficacy. They are also being seen as future generation therapeutic agents against several drug-resistant microbes. Physicochemical methods for synthesizing AgNPs thus, pose problems due to use of toxic solvents, high energy consumption and generation of by-products. Accordingly, there is an urgent need to develop environment-friendly procedures for synthesizing AgNPs. Plant extracts have shown large prospects in AgNP synthesis (**3 and 4).**

MATERIALS AND METHODS

The research was carried out from the month of Jan 2020 to May 2020 in Biological and Bioinformatics research centre, Trichy.

Preparation of Silver Nanoparticles

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From the commercially purchased silver nitrate, 0.1 M silver nitrate aqueous solution (90 ml) was prepared, and to this, 10 ml of M. indica leaves extract was added which was then exposed to the sunlight for the synthesis of AgNPs with constant stirring. Change in a color from green to brown occurred. The particles were then subjected to centrifugation for removal of any supernatant. About 1 ml of acetone was then added to the clear suspension to exclude any extra moisture content.[5]

Ultraviolet-visible (UV-VIS) Spectra Analysis

Maximum production of AgNPs in solution was monitored by measuring the UV-VIS spectrum in the range of 300-540 nm. The duration and progress of the reaction between metal ions and the bark extract were observed. The reduction of silver ions and formation of AgNPs were occurred within an hour. Control was maintained using AgNO3 , and deionized water was used as a blank.[6]

FTIR Analysis

FTIR spectroscopy in the frequency range of 400-4000 cm−1 was used for the analysis of various functional groups present in the solution which was absorbed at their own characteristic frequencies. The peak values of FTIR were recorded where the readings were repeated twice for the spectrum confirmation[7]

SEM Analysis

Details of AgNPs such as morphology and size were analyzed using SEM. The suspension above the precipitate of plant extract biomass was taken as SEM samples and was dropped on sterile electric stubs to remove excess water before introduced into SEM. The particles cluster was focused by SEM and image was observed.[8]

RESULTS AND DISCUSSION

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Table 1: Indication of Color Change in Synthesis Zno nano Particle (SNPs)

S.No	Plant bark extract+ZnNo3	Color change		pH change		Color intensity	Time	Result
	Scientific name	Before	After	Before	After			
1	*Berberis aristata*	Light Yellow	Brown	4.0	4.60	+++	20min	Positive

Color intensity: +++ = very dark colo

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Table 2: FT IR RESULT FOR BARK EXTRACT OF *Berberis aristata*

s.no	Frequency range	Bond	Type and group
1	3414	O–H stretch, H–bonded	alcohols, phenols
2	2974	C–H stretch	alkanes
3	1638	–C(triple bond)C– stretch	alkynes
4	1418	N–H bend	primary amines
5	1243	C–H bend	alkanes
6	1030	C–C stretch (in–ring)	aromatics
7	813	C–H wag (–CH2X)	alkyl halides
8	639	C–Cl stretch	alkyl halides
9	586	C–Cl stretch	alkyl halides

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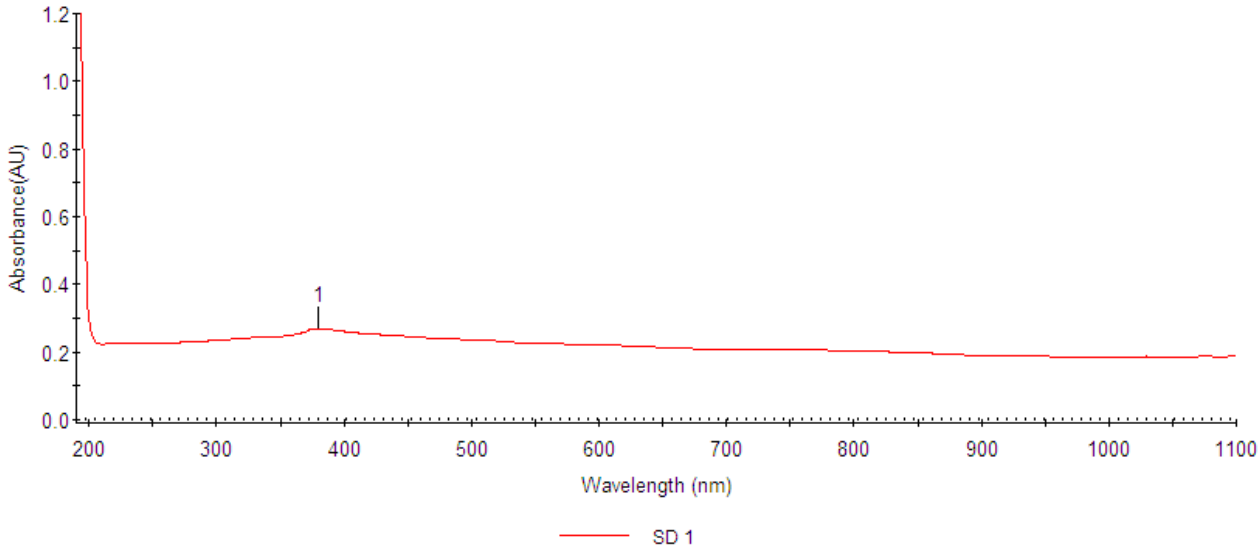

Figure:1 UV analysis of SNP

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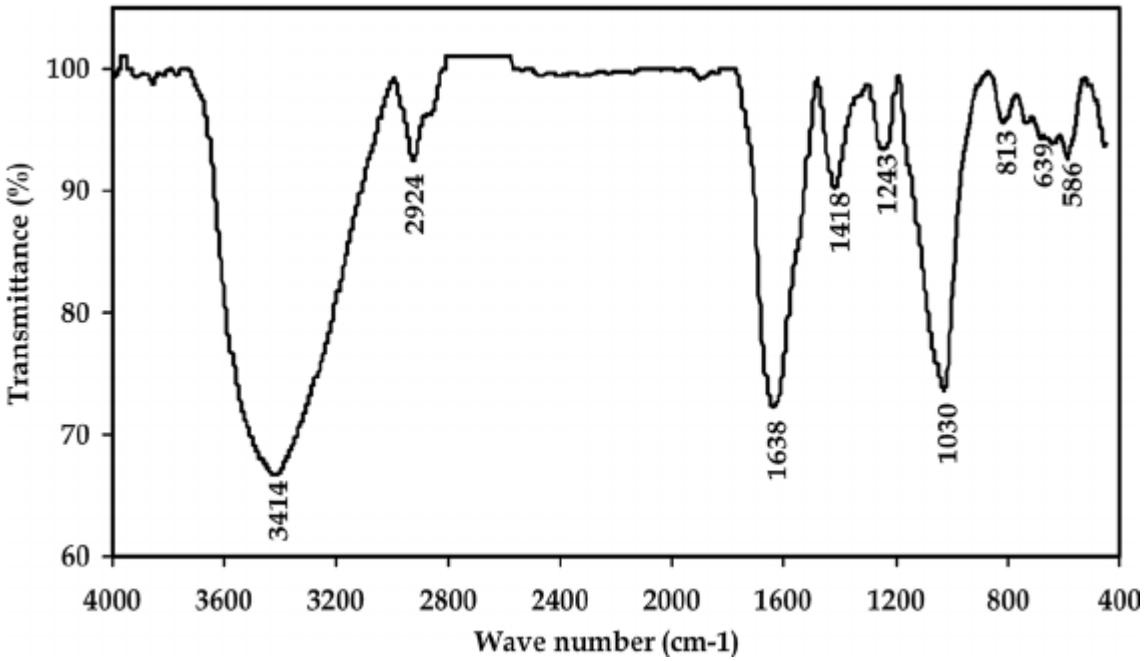

Figure 2:FTIR ANALYSIS OF SNP

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Table:3 Antimicrobial activity of *Berberis aristata* ,Silver nitrate and Silver nano particle isolated from *Berberis aristata*

S.N0	Pathogens	Zone Of Inhibition In mm		
		Silver nitrate	*Berberis aristata*	SNPs
1	Pseudomonos	10	7	15
2	Staphylococcus	12	8	16

SNPs Synthesis:

The synthesis and application of nanomaterial is in the limelight in modern nanotechnology. Plants including herbs, lower plants, higher plants, weeds etc. contain an array of secondary metabolites such as phenolic compound, terpenoids, essential oils, and flavonoids, which helps in the reduction of metal ion and formation of nanoparticles**(9)**. The present investigation demonstrate the formation of silver nano particles by the reduction of aqueous silver metal ions by bark extracts prepared from *Berberis aristata* .

Silver nanoparticles were synthesized successfully by the green synthesis method using Neem (Azadirachta indica) bark extracts (Hot and Cold methods). During exposure to extracts, reduction of silver ions into silver nanoparticles was observed as a result of the colour change from pale white to brown colour which occurred due to the Surface Plasmon

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Resonance phenomenon. The metal nanoparticles have free electrons, which helps in the formation of the Surface Plasmon Resonance absorption band, which is due to the united vibration of the electrons of metal nanoparticles in resonance with light wave (10)

Detection and Characterization of Phyto Silver Nanoparticles

Visual Observation: After treatment of *Berberis aristata* extract with AgNO3, the colour change of the reaction mixture was visually observed. The time taken for the reaction mixture to change colour was noted.

The reduction of silver ions into silver particles during exposure to the plant extract is followed by colour change from colorless or pale yellow to yellowish brown. It is well known that silver nanoparticles exhibit yellowish brown colour in aqueous solution due to excitation of surface plasmon vibrations in silver nano particles (**11).**

UV- Vis- Spectroscopy

Electromagnetic radiation such as visible light is commonly treated as a wave phenomenon, characterized by a wavelength or frequency. Wavelength is defined on the left below, as the distance between adjacent peaks (or troughs), and may be designated in meters, centimeters or nanometers (10-9 meters). Visible wavelengths cover

a range from approximately 400 to 800 nm. Optical properties of the as-prepared silver nanostructure sample was revealed by UV–Vis spectrum and photoluminescence spectroscopy at room temperature, as shown in Figure No.1. It can be seen from the Figure No.1 that there was intensive absorption in the ultraviolet band of about 300-1100 nm. The absorption wavelength at about 208 and 215 nm of sillver suggested the excitonic character at room temperature

FTIR analysis:

Two milligram of Zno nanoparticales were prepared by mixing with 200 mg of spectroscopic grade KBr. FTIR spectra were recorded using a Nicolet 520P spectrometer with detector at 4000-400 cm-1resolution and 20 scans per sample. FTIR Spectra of aqueous Silver oxide nanoparticles prepared from the Citrus aurantifolia fruit extract was carried out to identify the

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possible biomolecules responsible for capping and efficient stabilization of the metal nanoparticles synthesized by plant extract .

The results of the FTIR spectrum of hot and cold methods of *Berberis aristata* extracts of Silver Oxide nanoparticles are depicted in Figure 1and 2. The band at 437-445 cm-1 and 509-511cm-1 is attributed to SNP. The broad peak at 3402-3419cm-1 correspond to O-H band and C=O indicating the compound to be aliphatic carboxylic acid. The band at 1554-1558cm-1 is attributed to the presence of aromatic ring. The band at 1028-1033cm-1 correspond to saturated primary alcohol. The band at 2927-2931cm-1 is due to doublet absorption of C-H stretching vibration of an aromatic aldehyde. These bands are indicative of terpenoid group of compounds present in aqueous *Berberis aristata* extract. Jha and prasad , 2010 and Senthilkumar and Sivakumar, 2014).From FTIR analysis, it can be inferred that alcohols, terpenoids ketones, aldehydes and carboxylic acid were surrounded by synthesized nanoparticles. Phenolic compounds flavonoids, lignans, coumarins, tannins, quercetin, alkaloids, cynogenic glycosides present in the extract formed a strong capping on the nanoparticles(12). The prominent doublet absorption at 2927. The FT-IR studies clearly indicates the reduction and capping agents ie. biomolecules present in the *Berberis aristata* bark extract.

ANTIMICROBIAL ACTIVITY

The bark extract of *Berberis aristata* SNPs showed highest percentage of bacterial inhibition to *Staphylococcus* than compared to *Pseudomonas* . The zone of inhibition was found to be 16mm against *Staphylococcus.* The zone of inhibition was found to be 15mm against *Pseudomonas.* The reason could be that the smaller size of the particles which leads to increased membrane permeability and cell destruction. Similar results were found in *Boswellia ovalifoliolata* .

The antimicrobial effect of green synthesized SNP is attributed that the micro-organisms having of peptidoglycan, which is a complex structure and often contains teichoic acids or lipoteichoic acids and these are having strong negative charge. This charge may contribute to the sequestration of free silver ions. The findings of (**13**) suggested that the inhibition of oxidation based biological process by penetration of metallic nano sized particles across the microsomal membrane. SNPs have an ability to

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interfere with metabolic pathways and bacterial growth signaling pathway by modulating tyrosine phosphorylation of putative peptide substrates critical for cell viability and division. The SNPs synthesized from stem of *Shorea tumbuggaia* are toxic to multi-drug resistant microorganisms. It shows that they have great potential in biomedical applications.

Silveris highly antimicrobial and this effect is de- pendent on superficial contact with enzymatic systems of the respiratory chain by alter DNA synthesis .Size reduction i.e. the nano-scale particle syntheses involve the increase of surface area for contact, which is an im- portant tool for the effects of silver and reasons to consider silver as superior is its broad antimicrobial activity **(14)**

CONCLUSION

A large number of medicinal plants and their purified constituents have shown beneficial therapeutic potentials. In order to promote the use of medicinal plants as potential sources of antimicrobial compounds, it is important to thoroughly investigate their composition and activity and thus validate their use. In the present investigation, synthesis of silver nano particle was carried out in the bark extracts of *Berberis aristata*.

In conclusion, this green chemistry approach toward the synthesis of AgNPs or SNPs possesses several advantages *viz*, easy process by which this may be scaled up, economic viability, etc. Applications of such eco-friendly nanoparticles in bactericidal, wound healing, other medical and electronic applications makes this method potentially stimulating for the large-scale synthesis of nanomaterials. The present study included the bio-reduction of silver ions through medicinal plants extracts.

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