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Safed Musli (*Chlorophytum borivilianum L.*) tuber Mediated Green synthesis of Silver Nanoparticles and their characterization

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Abstract: Synthesis of silver nanoparticles using plant extracts is one of the most rapid, efficient, economical, and ecofriendly strategy which diminish the use of toxic chemicals. How ever in current years, various environment friendly techniques for the efficient synthesis of silver nanoparticles have been demonstrated by utilizing aqueous extracts of plant parts, this investigation revealed the green synthesis of silver nanoparticles (AgNPs) using root extracts *Chlorophytum borivilianum.* AgNO3 solution used with the aqueous root extract revealed a change in color from yellow to brown showing to the bio reduction reaction. extracted AgNPs were characterized by using Scanning electron microscopy (SEM), X-ray Diffraction (XRD), and Fourier Transform Infrared Spectroscopy (FTIR). XRD pattern with typical peaks indicated the crystalline nature of silver. SEM analysis confirmed the presence of spherical-shaped AgNPs, having an average size of 48.0 nm. The FTIR analysis revealed the nanoparticles were stabilized by non-aromatic compounds present in aqueous extract and its significant role in the formationof bio reduction to form nanoparticles. Hence, these silver nanoparticles (AgNPs) possess significant power for utilization in various biomedical applications in coming era.

Keywords: *Chlorophytum borivilianum,* aqueous extract, AgNPs, bio reduction.

Introduction

The keystone of nanoscience and nanotechnology is nanoparticles, which possess enormous potential and have various applications across diverse fields. Nanoparticles are synthesized through physical and chemical methods, though these approaches are limited by concerns over toxicity [1]. Green synthesis of nanoparticles is a relatively new and emerging field, offering economic and eco-friendly advantages over traditional chemical and physical methods. In recent years, silver nanoparticles (Ag NPs) have attracted significant interest from scientists and researchers due to their wide range of applications in fields such as photonics, catalysis, biology, textiles, optics, pharmaceutics, and drug delivery systems. Due to these versatile applications, numerous studies have focused on the rapid and efficient synthesis of Ag NPs [2]. Green synthesis, an eco-friendly alternative to conventional methods, involves the use of biological entities such as microbes, fungi, and plant extracts to address concerns over environmental toxicity [3].

Chlorophytum borivilianum, commonly known as Safed Musli is a traditional rare medicinal herb which has many therapeutic applications in Ayurvedic, Unani, Homeopathic and Allopathic system of medicines. Its roots (tubers) are well known for diverse therapeutic applications viz. adaptogenic, aphrodisiac. Immune modulatory and antidiabetic. It is used to heal physical illness and weakness, as an aphrodisiac agent and revitalizer, as general sex tonic, remedy for diabetes, arthritis and increasing body immunity, curative for natal and postnatal problems, for rheumatism and joint pains, increase lactation in feeding mothers, also used in diarrhoea, dysentery, gonorrhoea, leucorrhoea etc [4]. A number of plants are suitable for preparation of Ag NPs but we have selected *Chlorophytum borivilianum*, which is in use for centuries in Ayurvedic because of its anti-oxidative, anti-inflammatory, anti-diabetic and antifungal actions. On the basis of the available literature.

The*Chlorophytum borivilianum*extracts, are inherently rich in various phytochemicals, which could be used in the synthesis of silver nanoparticles [2].

In the present investigation, our findings shown that the green synthesis of silver nanoparticles (AgNPs) by an eco-friendly method including the in-situ reduction of silver ions by the leaf extract of *C.borivilianum* [5,6]. AgNPs were synthesized according to an efficient protocol using *C.Borivilianum* tuber extract. Fourier transform infrared spectroscopy (FTIR) analysis was used to identify the biomolecule responsible for reducing silver nano particle ion and stabilizing silver nanoparticle. Further formation of silver nanoparticle was confirmed by X-ray diffraction. Moreover, surface morphology and particle size and its distribution were confirmed using scanning electron microscopy (SEM).

MATERIAL AND METHODOLOGY

1. Collection of plant material

Healthy *Chlorophytum borivilianum*plant tubers were collected from MGM University Campus,Chh. Sambhajinagar, Maharashtra, India. The selected plant tubers were collected,thoroughly washed with distilled water, sun-dried, and ground to fine powder .AgNO3 was used as a silver precursor, (Sigma Aldrich, USA). All reagents used were of analytical grade. All solutions were freshly prepared and kept in dark to avoid any photochemical reactions.

2. Root Extract Preparation

The tubers were washed under running tap water to remove the dust particles and dried under shade for a week to completely remove the moisture. The root was cut into small pieces, powdered in a mixer grinder and then sieved to obtain fine powder. For the preparation of extract, 10g of *C. borivilianum* tuber powder was added to 100 ml double distilled water and boiled for 10min at 60 ^{0}C, and obtained extract was filtered through Whatman filter paper No.1 and stored at 4^{0}C in refrigerator for further use.

Synthesis of *Chlorophytum borivilianum* silver nanoparticles

For the synthesis of silver nanoparticles from aqueous *C. borivilianum* powder extract, 10ml of plant extract was added drop wise to 100 ml of 5mM de-ionized aqueous $AgNO_3$ solution. The resulting solution became reddish brown (orange) in colour. The reduction process, all solutions were kept at a room temperature in the dark to avoid any photochemical reactions. The silver nanoparticles obtained were centrifuged at 10,000 rpm for 10 min and subsequently dispersed in sterile distilled water to obtain rid of any uncoordinated biological materials

3. Characterization of Synthesized Silver Nanoparticles

3.1 Scanning Electron Microscopy (SEM) EDAX

The shape and morphological structure of silver nanoparticles (AgNPs) are measured by implementing a SEM. After centrifuging silver nanoparticles, the pellets are collected and deposited in a dehydration oven at 50 C to remove any remaining water. SEM study was performed to study shape, size and surface area of the silver nanoparticles (AgNPs). The AgNPs solutions were ultra- sonicated at room temperature for 15 min and one drop of the sample was placed on a glass slide. After drying, the glass slide was coated with silver and visualized under SEM [6,7,8]. Scanning Electron microscopy (SEM) and EDAX analysis was done by using (SU8010, Hitachi) machine, used to characterize the shape of AgNPs. On the carbon-coated copper grid, a thin film of the dried samples was made by simply placing a little sample followed by drying for 5 min under the mercury lamp. A Field-Emission Scanning Electron Microscope (FESEM) images were used to study the size, morphology and crystalline nature of AgNPs.

3.2 FTIR Analysis

FTIR spectrometer was used to study the chemical composition of the synthesized silver nanoparticles. The synthesized nanoparticles pellets were dried at 60°C and powders were subjected to FTIR spectroscopy measurement in the range 3997–693 cm^{-1} using KBr pellet method [6,7,8].

RESULTS AND DISCUSSION

Green synthesis of AgNPs has attracted to researcher due to its more importance in recent times, that the green synthesis yields stable and uniform AgNPs with highly pharmacological application [7,9].

The present investigation reveals the use of Safed musli tuber extract as a substrate to synthesize AgNPs. Mostly, the yield and characters of nanoparticles vary depending on the principle compounds present in solvent extracts of a specific plant species [8]. The addition of AgNO3 solution with the aqueous tuber extract of Safed musli, there was a change in the colour from yellow to light brown due to bio reduction reaction (Figure 2). This colour changes reveals the biosynthesis of AgNPs, is correlated to the excitation of surface plasmon resonance vibrations in AgNPs [8]. The colour change was instantly observed within an hour, and the intensity of the colour enhanced with the incubation time up to 12hours. Although, more than 12 hours of incubation exhibit no observable change in the colour. The colour intensity enhanced moderately with an enhancing of incubation time and continues the highest after 12 hours of incubation. Several researchers, have stated that the incubation duration for formation of the bio reduction of silver ions to form AgNPs differ from one plant species to other because of variation in the presence of phytoconstituents in the plant extracts [8, 9].

FT-IR analysis

FT-IR spectroscopy was revealed the primary biomolecules within the aqueous extract of *C. Borivilianum* tubers, which promoted the reduction of Ag+ ions to elemental silver (Ag0), increasing in the formation of silver nanoparticles (AgNPs). The Ag.NPs, FT-IR spectrum is presented in Fig.10. Showed peaks at693 cm^{-1} and 3997 cm^{-1}: Referred to N-H stretching vibrations revealing presence of aliphatic primary amines. (15). The broad peaks in FTIR spectrum was observed 1550 cm^{-1} indicating O-H stretching vibrations, of alcohols in the aqueous extract. The peak of 2896cm^{-1} significantly conforms presence of O-H stretching vibrations from carboxylic acids. N-H stretching from amine salts. Peaks found in the range 1672cm^{-1} shown C=O stretching vibrations from aldehydes, esters, aliphatic ketones, may also represent C-H bending vibrations from aromatic compounds. The range of pic in1305cm^{-1} correspondence by C-H bending vibrations from alkanes, O-H bending from alcohols, and C-F stretching vibrations from fluoro compounds. Peak observed in1182cm^{-1}: shown presence of C-N stretching vibrations from amines. Presence of peak at 1060 cm^{-1} C-N stretching vibrations from amines. The observed peak in range of 938, 815, 693cm^{-1}: correspondence to C-Cl, C-Br, and C-I stretching vibrations from halo compounds, and C=C bending vibrations from alkenes with C-H bending from substituted compounds. 16After synthesis of Ag NPs revealing the presence of these groups (OH−, C=O, and C-H, respectively) in the synthesis of Ag.NPs. Our findings are similar with previous study of green synthesis of silver nanoparticles in *Argyria nervosa* and *Zingiber officinale* [7].

Scanning Electron Microscopy (SEM) EDAX

Silver nanoparticle was synthesized from a tuber extract using such as *C. borivilianum.* The colour transformed from dark pale yellow to darker brown when *C. borivilianum* tuber extract was introduced droplet manner to the silver nitrate mixture, indicating Ag NPs formation. The morphological nature of AgNPs is examined by employing SEM, it shows rod-like structure, spherical with some agglomeration where an average particle shape was 30, 45 and 50 nm respectively. The particle size, morphological, and crystalline were examined by employing SEM and Particle size analyser[10].SEM was revealed to describe the morphology of the synthesized AgNPs. SEM analysis showed the spherical shape and average size range 50 nm, though the size of few particles was either large or very small (Fig. 7). The sizes obtained between 30-50 nm with an average particle size of 45 nm (Fig 7). The crystalline nature of CB-AgNPs was confirmed by the Selected Area Electron Diffraction (EDX) pattern (Fig 7d) these findings were similar with Singh and vyas 2018 [10].

In the EDX spectrum, the strong peak at 4 keV was due to the presence of the silver element. Carbon, chlorine, zink and oxygen were also detected in the spectrum, which were associated with the organic compounds of the tuber extract on the surface of Cp-AgNPs and significant role in the reduction and stability of biosynthesized Cp-AgNPs [11].

The presence of zink peaks may be due to the same being present in the grids. It has been showed that nanoparticles synthesized using plant

extracts are composed by a thin layer of some cappingorganic material from the plant tuber broth and are, thus, stable in solution up to 4 weeks after synthesis [12]. This is significance of nanoparticles extracted using plant extracts instead of synthesized using chemical methods [13].

Fig. 1 *C. borivilianum* tubersFig.2*C. borivilianum* PowderFig.3 *C.borivilianum* Solution

Fig. 4 AgNPs Solution

Fig:5 Synthesizes AgNPs

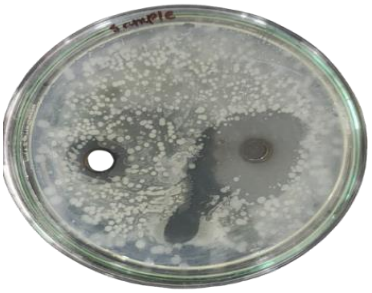

Fig. 6 Antibacterial Activity Against *E.coli*

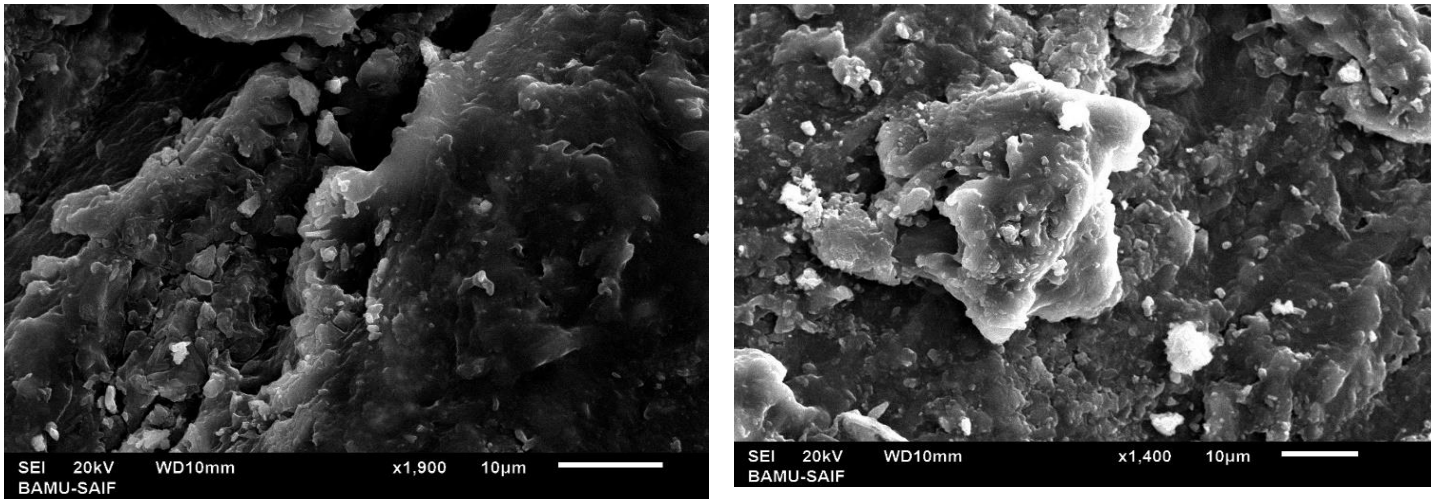

Fig. 7 Field emission scanning electron microscopy (SEM) of AgNPs at magnification of 1,900 x& 1,400 x.

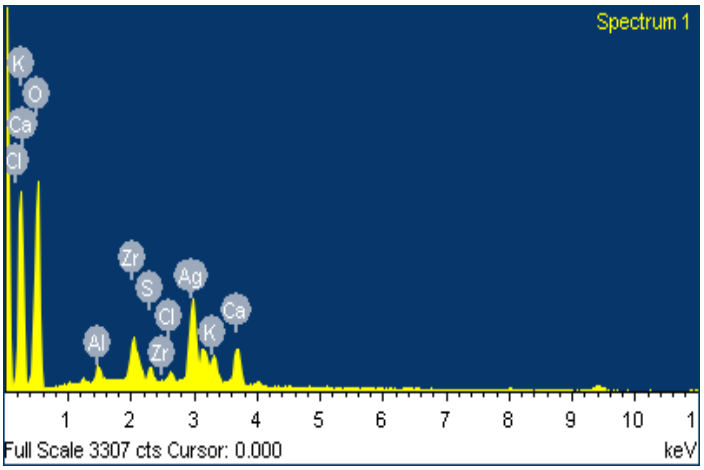

Fig. 8 EDAX spectra of synthesized AgNPs

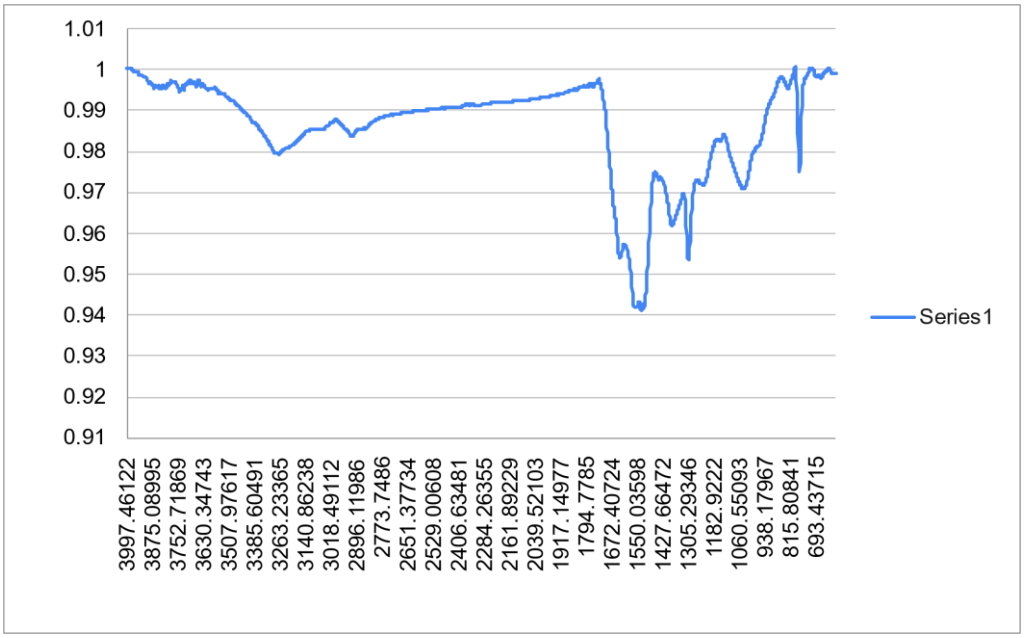

Figure 9. FTIR spectrum of synthesized AgNPs.

Element	Weight%	Atomic%
Al K	1.16	0.93
S K	1.26	0.85
Cl K	0.67	0.41
K K	1.88	1.04
Ca K	4.35	2.35
Zr L	6.89	1.64
Ag L	18.05	3.63
Totals		100.00

Table 1. Elements present in synthesized silver nanoparticles.

CONCLUSION

In this study, a successful, rapid, and green synthesis of AgNPs was achieved using *C. borivilianum* L. tuber extract as an effective reducing and capping agent. Different methods, including like SEM-EDX and FTIR, were successfully used to characterize the synthesized AgNPs. This novel method for the environment-friendly synthesis of AgNPs has a number of attractive features and provides an effective and affordable means of protecting the environment.

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this paper.

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