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SYNTHESIS AND CHARACTERIZATION OF SILVER NANOPARTICLES USING *GOMPHRENA GLOBOSA* FLOWER EXTRACT

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ABSTRACT

A green synthesis of silver nanoparticles was done using aqueous flower extract of *Gomphrena globosa*. Synthesised silver nanoparticles (AgNPs) were characterized with UV-Vis-spectroscopy, Fourier transform infrared (FTIR) analysis and Scanning Electron Microscope (SEM). UV spectra showed maximum absorbance at 430nm. FTIR analysis of synthesized nanoparticles confirmed the phenol, alkanes, aliphatic amines, secondary alcohol, alkenes and aromatic amines compound. SEM analysis was carried out to understand the topology and the size of the Ag-NPs, which showed the synthesis of higher density polydispersed spherical Ag-NPs of various sizes that ranged from 22 to 30 nm. Therefore, the present work has been undertaken to synthesize the AgNPs using flower extract of *Gomphrena globosa* flower to characterizion.

KEYWORDS: *Gomphrena globosa* flower, silver nanoparticles, phytochemical analysis.

INTRODUCTION

Green synthesis of nanoparticles has attracted considerable attention in recent years. In this regard, plants extracts and natural resources such as microorganisms and enzymes have been found to be good alternative reagents in nanoparticles synthesis. Utilizing green substances has several advantages including low energy consumption and Moderate operation conditions (eg. pressure and temperature) without using any toxic chemicals.[1] Therefore, green synthesis techniques using various biological organisms such as yeast, mold, algae and bacteria and plant extracts have been developed for nanoparticles synthesis.[2]

Incorporation of green chemistry techniques and methodologies into nanotechnology is of great interest which has gained much attention over the past decade.[3] Green chemistry which is the use of chemistry principles to reduce or eliminate using of toxic reagents, has resulted to significant reduction in the amount of harmful residues to human health and environment. Green chemistry is defined as chemistry aided processes for pollution prevention which can be extended to specific areas include in green analytical chemistry, environmentally friendly analytical chemistry and clean analytical methods.[4]

Medicinal plants are those whose extract or isolated compounds directly or indirectly involved in human ailment. *G. globosa* belongs to Amaranthaceae family, commonly known as glove amaranth is an annual branched herb which is cultivated as ornamental flowering herb in garden.[5] It is reported that *G. globosa* grows well throughout in Bangladesh and known as Bottam phul. It is native to North-America, South-America, Myanmar and India. Amaranthaceae is a large family comprising saround 10 sub families, 176 genera and 2400 species available all over the world.[6,7] *G. globosa* is a folk remedy for oliguria, heat and empacho, hypertension,cough and diabetes and expectorant for animals.[8] The present study was undertaken to synthesise and characterize the silver nano particles from *Gomphrena globosa* flower extract.

MATERIALS AND METHODS

Collection of plant materials

The flowers of *Gomphrena globosa* were collected from Muthupet, Thiruvarur district, Tamil Nadu, India. The collected *Gomphrena globosa* flowers were washed several times with distilled water to remove the traces of impurities from the flower. Then examined carefully, old infected and fungus damaged portion of the flower were removed. Healthy flower were spread out in a plain paper and shade dried at room temperature for about 10 days and makes a fine powder using grinder mixture. The powder materials were used for further studies.

Preparation of plant extract

2 gram of the powder of *Gomphrena globosa* flowers were transferred in to different conical flask (250ml)

The conical flask containing 100ml of water. The conical flask containing *G. globosa* flowers was shake it well for 30 minutes by free hand. After 24 hrs, the extract was filtered using whatman filter paper No.1 was transfer in to china dish. The supernatant was completely removed by keeping the china dish over water bath at 45ºC. The obtained extract was used for phytochemical analysis.

Phytochemical screening

Phytochemical tests were carried out on the aqueous extract using standard procedures to identify the constituents.[9,10,11]

Synthesis of silver nanoparticles from *Gomphrena globosa* flower extract

Preparation of flower extract

The dried flowers were pulverized well with mortar and pestle to make a powder. Twenty grams of powder sample was mixed into 100 ml of deionized water and the mixture was boiled for 10 min. After cooling the flower extract was filtered with Whatman No. 1 filter paper. The filtrate was stored at 4°C for further use.

Synthesis of Ag nanoparticles using flower extract

For the Ag nanoparticles synthesis, 5 ml of *G.globosa* flower extract was added to 45 ml of 1 mM aqueous $AgNO_3$ solution in a 250 ml Erlenmeyer flask. The flask was then incubated in the dark at 5hrs (to minimize the photo activation of silver nitrate), at room temperature. A control setup was also maintained without flower extract. The Ag nanoparticle solution thus obtained was purified by repeated centrifugation at 10,000 rpm for 15 min followed by re-dispersion of the pellet in de-ionized water. Then the Ag nanoparticles were freeze dried using SEM analysis [12].

Characterization of Nanoparticles

UV and FTIR Spectroscopic analysis

The biosynthesis of Ag nanoparticles were scanned in the wavelength ranging from 380-800 nm using Perkin Elmer Spectrophotometer and the characteristic peaks were detected. FTIR analysis was performed using Perkin Elmer Spectrophotometer system, which was used to detect the characteristic peaks in ranging from 400-4000 cm^{-1} and their functional groups. The peak values of the UV and FTIR were recorded. Each and every analysis was repeated twice for the spectrum confirmation.

Scanning Electron Microscope (SEM)

The freeze dried sample of Ag NPs solution was sonicated with distilled water and small drop of this sample was placed on glass slide and allowed to dry. A thin layer of platinum was coated to make the samples conductive. Jeol JSM-6480 LV SEM machine was operated at a vacuum of the order of 10-5 torr. The accelerating voltage of the microscope was kept in the range 10-20 kV. Compositional analysis on the sample was carried out by the energy dispersive X-ray spectroscopy (EDS) attached with the SEM. The EDX analysis of Ag sample was done by the SEM (JEOLJSM 5800) machine. The EDX normally reveals the presence of phases.

RESULTS

Phytochemical screening of *G. globosa* flower extract

On the basis of therapeutic potential of secondary metabolites, the phytochemical characters of the *Gomphrena globosa* flower were investigated and represented in Table1. The qualitative phytochemical analysis of aqueous extract of *G. globosa* flower was found to contain triterpenoids, tannin, saponins, glycosides, carbohydrate, terpenoids, anthraquinone while flavonoids, steroids, phlobatannins, alkaloids, and polyphenol were absent.

Table 1: Preliminary phytochemical screening of *G. globosa* flower extract.

S. No.	Phytochemicals	Aqueous Flower extract
1.	Tannin	+
2.	Phlobatannins	-
3.	Saponin	+
4.	Flavonoids	-
5.	Steroids	-
6.	Terpenoids	+
7.	Triterpenoids	+
8.	Alkaloids	-
9.	Carbohydrate	+
10.	Amino acid	+
11.	Anthroquinone	+
12.	Polyphenol	-
13.	Glycoside	+

"+" indicates presence of the compounds; "-" indicates absence of the compounds,

Synthesis of Silver nanoparticles

Phytosynthesis of Ag nanoparticles by the aqueous flower extract of *G.globosa* flower was carried out. During the visual observation, silver nitrate incubated with flower extract showed a colour change from yellow to brown after 5 hrs whereas no colour change could be observed in silver nitrate without flower extract. The appearance of brown colour in flower extract treated flask is clear indication for the formation of Ag nanoparticles.

UV-Vis spectral analysis

It is generally recognized that UV–Vis spectroscopy could be used to examine size and shape-controlled nanoparticles in aqueous suspensions. The UV-Vis spectra recorded from the reaction medium after 5 hours. In the UV–Vis spectra of the reaction mixture of silver nitrate solution with *G. globosa* flower extract the peak was observed at 430nm indicating the presence of silver nanoparticles which is synthesized by *G. globosa* flower extract. The peak was raised due to the effect of surface plasmon resonance of electrons in the reaction mixture

and the broadening of peak indicated that the particles are polydispersed. Appearance of this peak assigned to a surface plasmon, is well-documented for various metal nanoparticles with size ranging from 2 nm to 100 nm[13](Figure 1).

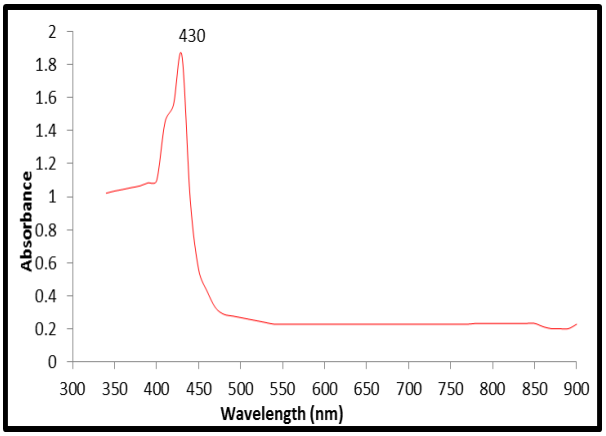

Figure 1: UV-Visible spectral analysis of AgNPs

Fourier Transform Infra-Red spectral analysis of AgNPs

FTIR spectrum of Ag nanoparticles was examined to identify the possible biomolecules responsible for capping and efficient stabilization of the Ag nanoparticles synthesized by plant flower extract. The results of FTIR analysis confirmed the presence of alcohol, phenol, alkanes, aldehydes, carboxylic acid, aromatics and aliphatic amines compound **(Table 2 and Figure 2)**.

Table 2: FTIR analysis of AgNPs and their functional groups.

S. No.	Peak Values (Cm^{-1})	Functional groups
1	3387.16	Alcohol, Phenol
2	2949.71	Alkanes
3	2524.22	Aldehydes
4	2181.61	Alkeynes
5	2044.45	Alkeynes
6	1653.95	Carboxylic acid
7	1415.58	Aromatics
8	1112.43	Aliphatic amines
9	1021.00	Aliphatic amines
10	679.54	Alkanes

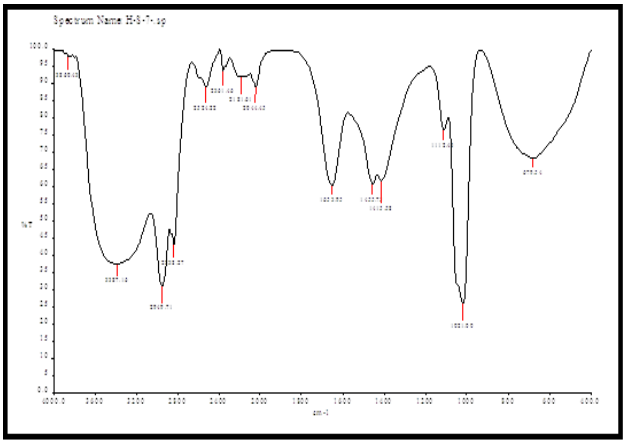

Figure 2: FTIR spectrum of Ag nanoparticles synthesized from *G. globosa* extract.

Scanning Electron Microscopical (SEM) analysis of AgNPs

SEM analysis was carried out to understand the topology and the size of the Ag-NPs, which showed the synthesis of higher density polydispersed spherical Ag-NPs of various sizes that ranged from 10 to 40nm as well the face-centered cubic structure of the nanoparticles. Most of the nanoparticles aggregated and only a few of them were scattered, when observed under SEM (**Figure 3).**

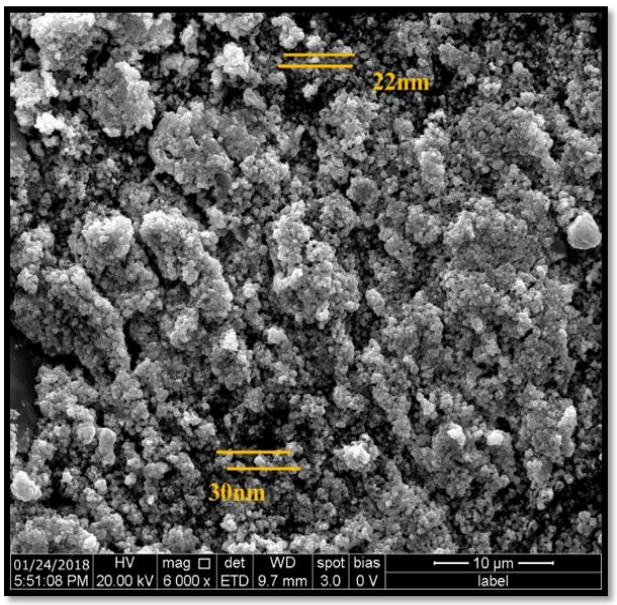

Figure 3: High resolution Scanning Electron Microscopic (SEM) image of silver nanoparticles (AgNPs).

DISCUSSION

Nanotechnology is a broad interdisciplinary area of research, development and industrial activity which has grown very rapidly all over the world for the past decade. It plays a vital role in technologies of new millennium. Nanomaterials may provide solutions to technological and environmental challenges in the areas of solar energy conversion, catalysis, medicine and water treatment.[14] Nanosilver can be used as a colloid and also it is used in

the textile industry by incorporating it into the fiber. There are many consumer products and applications utilizing nanosilver in consumer products; nanosilver plays major role in bringing out commercial products.[15] Chemical and physical methods may successfully produce pure, well defined nanoparticles, but these techniques are more expensive, energy consuming and potentially toxic to the environment. Biosynthetic methods can employ either microorganism cells or plant extract for nanoparticles production. An exciting branch of biosynthesis of nanoparticles is the application of plant extracts to the biosynthesis reaction. Recently, the green processes for the synthesis of nanoparticles are evolving into an important branch of nanotechnology.[16]

The use of plants as the production assembly of silver nanoparticles has drawn attention, because of its rapid, ecofriendly, non-pathogenic, economical protocol and providing a single step technique for the biosynthetic processes. The reduction and stabilization of silver ions by combination of biomolecules such as proteins, amino acids, enzymes, polysaccharides, alkaloids, tannins, phenolics, saponins, terpenoids and vitamins which are already established in the plant extracts having medicinal values and are environmental benign, yet chemically complex structures.[17]

Natural products such as plant extracts provide unlimited opportunities for new drug discoveries because of unmatched availability of chemical diversity, either as pure compounds or as standardized extracts, and recent evidences from the pharmaceutical companies shows that it still represents an extremely valuable source for the production of valuable chemical entities that can be used for the treatment of some complex diseases.[18] These medicinal plants can be rich in phenolic compounds, alkaloids, diterpenoid, steroid and other compounds which inhibit the development of various microorganisms. Besides these, phytochemicals in the plant extracts can act as reducing and capping agent in the reduction of metal ions to metal nanoparticles,[19] and thus have found widespread use in the biosynthesis of metal nanoparticles.

Characterization of nanoparticles is important to understand and control nanoparticles synthesis and applications. Characterization is performed using a variety of different techniques such as scanning electron microscopy (SEM), Powder X-ray diffractometry (XRD), Fourier transform infrared spectroscopy (FTIR) and UV–Vis spectroscopy.[20,21,22] These techniques are used for determination of different parameters such as particle size, shape, crystallinity, fractal dimensions, pore size and surface area. Moreover, orientation, intercalation and dispersion of nanoparticles and nanotubes in nanocomposite materials could be determined by these techniques.

It is generally recognized that UV–Vis spectroscopy could be used to examine size and shape-controlled nanoparticles in aqueous suspensions. In order to verify the synthesis of AgNPs, the test samples were subjected to UV–Vis spectrophotometric analysis. Spectrophotometric absorption measurement in the wavelength ranging from 400 to 450 nm is used to characterize AgNPs.[23] In the present study the analysis of AgNPs showed the sharp absorbance at around 401nm, which was specific for AgNPs. The UV–Vis absorption band in the current visible light region (380–460 nm) is an evidence for the presence of surface plasmon resonance (SPR) of silver nanoparticles and is well-documented for various metal nanoparticles with size ranging from 2 nm to 100 nm.[24] The reduction was ascribed to the phenolics, terpenoids, polysaccharides, and flavones compounds present in the extract.[25]

The surface morphology, size and shape of the silver nanoparticles were analyzed by Scanning Electron Microscope (SEM). The SEM images show individual silver nanoparticles which are predominantly spherical in shape as well as number of aggregates with no defined morphology. The presence of biomolecules in the flower extract has resulted in the synthesis of spherical silver nanoparticles and the aggregation may be due to the presence of secondary metabolites in the flower extract. The SEM image shows the size of the silver nanoparticles ranging from 10 to 40nm. Similar result of the silver nanoparticles size was reported by using *Euphorbia hirta* extract.[26]

CONCLUSION

From the results it was concluded that *Gomphrena globosa* flower extract can act as a source of synthesis for the silver nanoparticles. These findings add to the existing growing relevance of biogenic AgNPs for potential applications in nanomedicine.

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