

PARTHENIUM LEAF EXTRACT MEDIATED SYNTHESIS OF SILVER NANOPARTICLES: A NOVEL APPROACH TOWARDS WEED UTILIZATION

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In this paper we describe the synthesis of silver nanoparticles using Parthenium leaf extract. Transmission electron microscopy analysis of these particles shows that they are ~ 50 nm in range and assembled in very irregular shape of variable morphology. The most needed outcome of this work will be the development of value-added products from *Parthenium* for biomedical and nanotechnology based industries.

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1. Introduction

The use of environmentally benign materials like plant leaf extract, bacteria and fungi for the synthesis of silver nanoparticles offers numerous benefits of eco-friendliness and compatibility for pharmaceutical and biomedical applications as they do not use toxic chemicals in the synthesis protocols. Chemical synthesis methods lead to the presence of some toxic chemical species adsorbed on the surface that may have adverse effects in medical applications. Bioinspired synthesis of nanoparticles provides advancement over chemical and physical methods as it is a cost effective and environment friendly and in this method there is no need to use high pressure, energy, temperature and toxic chemicals¹.

However, it is well known that inorganic nanomaterials are good antimicrobial agents. Current research in bactericidal nanomaterials has opened a new era in pharmaceutical industries. Silver nanoparticles are the metal of choice as they hold the promise to kill microbe's effectively². The silver nanoparticle act on a broad range of target sites both extracellularly as well intracellularly. In fact, microbes generally have a harder time developing resistance to silver than they do to antibiotics^{2,3,4}. Silver nanoparticles take advantages of the oligodynamic effect that silver has on microbes, whereby silver ions bind to reactive groups in bacterial cells, resulting in their precipitation and inactivation. Some well known examples are, synthesis of gold nano-triangles using Lemmon grass and tamarind leaf extract^{5,6}, synthesis of silver nanoparticles using geranium leaf⁷, fungus^{8,9}, soluble starch¹⁰, silver tolerant yeast strain MKY3¹¹, synthesis of bimetallic Au core-Ag shell nanoparticles using Neem (*Azadirachta Indica*) leaf broth¹², biosynthesis of silver based crystalline nanoparticles of well defined composition and shapes (such

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as equilateral triangles and hexagons) within the periplasmic space of bacteria *Pseudomonas stutzeri* (AG259) isolated from silver mines^{13,14}.

Herein, we report synthesis of silver nanoparticles, reducing silver ions present in the aqueous solution of silver nitrate complex by the extract of *Parthenium hysterophorus* L leaves. The obnoxious weed *Parthenium* popularly known as Congress weed¹⁵ was accidentally introduced in India in around 1956 and has since spread over most part of the country. *Parthenium* now occurs throughout the tropical and subtropical America from southern United States of America to southern Brazil and to Northern Argentina. It causes contact dermatitis in livestock and is reported to be poisonous to sheep. Humans are also affected by this weed with respiratory malfunction and dermatitis. Main toxin responsible for the effect is Parthenin¹⁶. *Parthenium* is also reported as promising remedy against hepatic amoebiasis¹⁷, neuralgia and certain types of rheumatism¹⁸. In the Caribbean and Central America *Parthenium* is used as folk remedy¹⁹. In Jamaica, the decoction is used as a Flea-repellent both for dogs and other animals²⁰.

Although *Parthenium* plant is considered as undesirable plant, but to the best of our knowledge we are the first to report its use in synthesizing silver nanoparticles, which can provide a new platform to this noxious plant making it a value added weed for nanotechnology based industries in future.

2. Material and Methods

2.1 Preparation of the Extract

Extract have been prepared by bringing fresh leaves of *Parthenium hysterophorus* L from Allahabad University campus to the laboratory. Leaves weighing 25 g were thoroughly washed thrice in distilled water for 15 min, dried, cut into fine pieces and were boiled in a 500 ml Erlenmeyer flask with 100 ml of sterile distilled water up to 5 min and were filtered.

2.2 Synthesis of Silver Nanoparticles

Silver nitrate (AgNO_3) was purchased from Merck India Ltd. and used as same. 50 ml of fresh leaf extract was added into the aqueous solution of 1 mM Silver nitrate. Average size of the particles synthesized was 50 nm with size range 30 to 80 nm with irregular shape. Due to our interest to get much smaller particles, above solution was centrifuged at a rate of 1200 rpm up to 15 minutes and investigated that particles present in the supernatant were nearly homogenous with average size of 7 nm (Data not shown).

2.3 UV-Vis Spectra analysis

The reduction of pure Ag^+ ions was monitored by measuring the UV-Vis spectrum of the reaction medium at different time intervals after diluting a small aliquot of 100 μL of the sample with 1 ml deionized water. UV-Vis spectral analysis has been done by using a Perkin-Elmer Lambda-25 spectrophotometer.

2.4 TEM analysis of silver nanoparticles

Transmission Electron Microscopic (TEM) analysis was done using a Techni G² 300 kV. Thin film of the sample were prepared on a carbon coated copper grid by just dropping a very small amount of the sample on the grid, extra solution was removed using a blotting paper and then the film on the TEM grid were allowed to dry by putting it under a mercury lamp for 5 min.

3. Results

Fig.1 shows the optical photograph of the color change in the colloidal solution of nanoparticles reduced by *Parthenium* plant (Fig.1) leaf extract with time (in the inset). UV-Vis

spectrograph of the colloidal solution of silver nanoparticles has been recorded as a function of time. Absorption spectra of silver nanoparticles formed in the reaction media at 10 min. has absorbance peak at 474 nm, broadening of peak indicated that the particles are polydispersed (Fig. 2(A)). TEM Micrograph (Fig.2 (B)) of the silver nanoparticles synthesized after 10 min of the reaction kinetics having irregular shapes of 30 to 80 nm with average size 50 nm. The selected area electron diffraction (SAED) pattern of the nanoparticles in Fig.3 shows face centered cubic (fcc) crystalline structure of silver with indexed different diffracting planes.



Fig. 1. *Parthenium* plant and in the inset optical photograph of the colloidal solution of silver nanoparticles reduced by *parthenium* leaf extract.

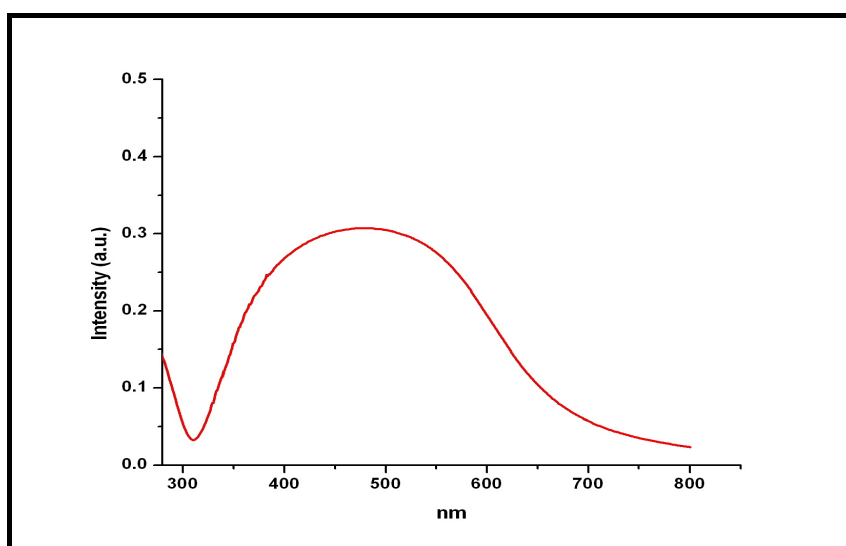


Fig. 2(A) UV-Vis. Absorption spectra recorded as a function of time of reaction of 1:1 solution of silver ions by *Parthenium* leaf extract in the range 30 nm to 80 nm after 10 minutes reaction kinetics.

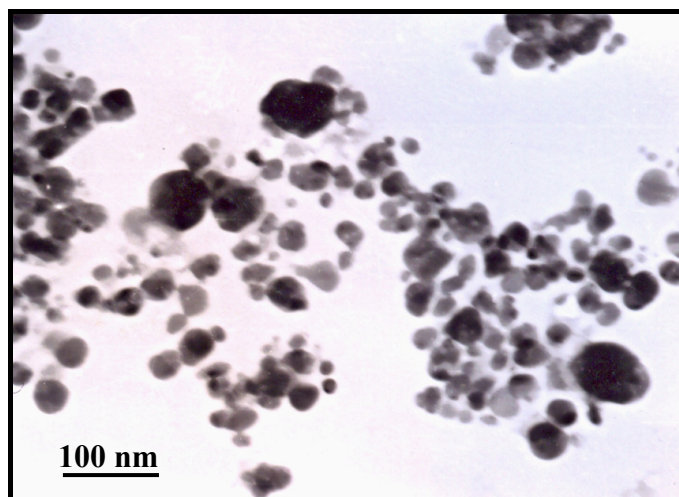


Fig. 2 (B) TEM Micrograph of the sample after the 10 minute reaction kinetics with treating leaf extract with silver ions complex(1mM) in the ratio of 1:1, showing particles of irregular shapes which varies in size from 30 nm to 80 nm (average particle size is 50nm).

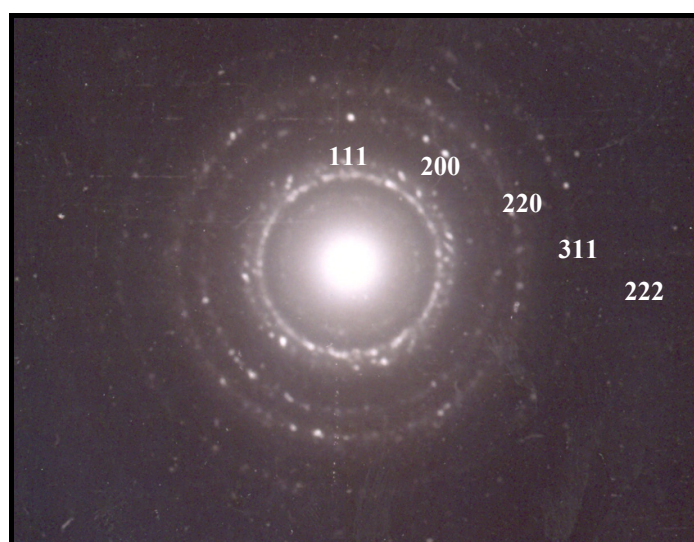


Fig. 3. SAED-Micrograph of nanoparticles particles in the sample.

4. Discussion

Reduction of silver ions present in the aqueous solution of silver complex during the reaction with the ingredients present in the plant leaf extract observed by the UV-Vis spectroscopy revealed that silver nanoparticles in the solution may be correlated with the UV-Vis spectra. As the *Parthenium* leaf extract was mixed in the aqueous solution of the silver ion complex, it started to change color from water color to yellowish brown (Fig.1); color was changed due to excitation of surface plasmon vibrations, which indicated formation of silver nanoparticles²¹. UV-Vis spectroscopy is well known to investigate shape and size controlled of nanoparticles. UV-Vis spectrograph of the colloidal solution of silver nanoparticles has been recorded as a function of time by using a quartz cuvette with water as reference, repeated experiments were carried out with varying the amount of silver ion complex (1mM) and leaf extract it was observed that precursors in the ratio of 1:1 gave best results of our interest. It is interesting to note that most of the particles

in the TEM pictures are not in physical contact but are separated by a fairly uniform interparticle distance. The sharp spots in the SAED pattern (Fig. 3) indicate that the silver nanoparticles are single crystalline in nature.

5. Conclusions

In conclusion, the bio-reduction of aqueous Ag⁺ ions by the leaf extract of the plant *Parthenium hysterophorus* L has been demonstrated. The reduction of the metal ions through leaf extract leading to the formation of silver nanoparticles of fairly well-defined dimensions. This green chemistry approach toward the synthesis of silver nanoparticles has many advantages such as, ease with which the process can be scaled up, economic viability, etc. The use of noxious weed *Parthenium* has the added advantage that this unwanted plant can be used by nanotechnology processing industries. Applications of such eco-friendly nanoparticles in bactericidal, wound healing and other medical and electronic applications, makes this method potentially exciting for the large-scale synthesis of other inorganic materials (nanomaterials). Toxicity studies of *Parthenium* mediated synthesized silver nanoparticles are under investigation.

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