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Green Synthesis and Characterization of Zero Valent Silver Nanoparticles from the Leaf Extract of *Datura Metel*

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Subject: Nanotechnology

Abstract

In the present work, nano scaled zero valent silver were synthesized from the plant extract of ***Datura metel*** under atmospheric conditions through green synthesis. A systematic characterization of silver nanoparticles was performed using UV, SEM,TEM and antimicrobial studies. The diameter of silver nanoparticles was predominantly found within the range 50-100 nm.The novelty of this study is to comprehend a suitable biocompactible herbal reductant for biosynthesis of zerovalent silver nanoparticles at a very cost effective level and the results are quite encouraging.

Keywords: *Silver nanoparticles ; green Synthesis; UV, SEM, antimicrobial*

1. Introduction

Nanotechnology is a reliable and enabling environment friendly process for the synthesis ofnanoscale particles. Nanosizeresults in specific physicochemical characteristicssuch as high surface area to volume ratio, whichpotentially results in high reactivity [1]. Biosynthesis of nanoparticles is a kind of bottom up approach where the main reaction occurringis reduction/oxidation. With the antioxidant or reducing properties of plant extracts, they are usually responsible for the reduction of metal compounds into theirrespective nanoparticles. Green synthesis provides advancement over chemical andphysical method as it is cost effective, environment friendly, easily scaled up for largescale synthesis and in this method there is no need to use high pressure, energy, temperature and toxic chemicals[2]. Green synthesis offer better manipulation, control over crystal growth and their stabilization. This has motivatedan upsurge in research on the synthetic routes that allows better control of shape and size forvarious nanotechnological applications.

Silver has long been recognized as having inhibitory effect on microbes present in medical and industrial process [3, 4]. The most important application of silver and silver nanoparticles is in medical industry such as topical ointments to prevent infection against burn and open wounds [5].

A number of approaches are available for the synthesis of silver nanoparticles for example, reduction in solutions[6] chemical and photochemical reactions in reverse micelles [7], thermal decomposition of silver compounds [8], radiation assisted [9], electrochemical [10], sonochemical[11], microwave assisted process [12] and recently via green chemistry route [13,14,15].

Here in the current work we have reported the synthesis of green silver nanoparticles using the leaf extract of the plant – Datura metel (common name-Kamkamawlaw). Aqueous silver nitrate solution, after reacting with datura leaf extract, led to rapid formation of highly stable, crystalline silver nanoparticles. The rate of nanoparticle synthesis was very high, which justifies use of plants over

microorganisms in the biosynthesis of metal nanoparticles through greener and safer methods. In the subsequent sections we have described the synthesis of silver nanoparticles based upon the change in color, change in pH, change in absorbance and the particle size formed after reduction.

2. Plant Description

Datura metel

Family : *Solanaceae*

Common name : Kamkamawlaw

It is a medicinal plant widely used in phytomedicine to cure diseases such as asthma, cough, convulsion and insanity. The leaves and seeds are widely used in herbal medicine as anesthetic, antispasmodic, bronchodilator and as hallucinogenic .A variety of phytochemicals comprising of alkaloids, flavonoids, phenols, tannins, saponins and sterols have been found in it. The total alkaloid content is 0.26 - 0.42 %. The plant and fruit are spasmolytic, anticancerous and anthelmintic. Leaf is antitumour, antirheumatic and vermicide. Flower is antiasthamatic, anaesthetic and is employed in swellings and eruptions on face [16].

Fig 1.a. Datura Plant (*Datura metel*)

3. Material and Experimental methods

3.1 Reagents and Chemicals

0.001 M Silver Nitrate was obtained from Sigma Aldrich. Freshly prepared triple distilled water was used throughout the experiment.

3.2 Collection of extracts

Datura leaves were collected from the local region. They were washed and cleaned with triple distilled water and dried with water absorbent paper. Then it was cut into small pieces with an ethanol sterilized knife and crushed with mortar and pestle dispensed in 10 ml of sterile distilled water and heated for 2-3 minutes at 70-80°C. The extract was then filtered using Whatman No.1 filter paper. The filtrate was collected in a clean and dried conical flask by standard sterilized filtration method and was stored at 4°C.

3.3 Synthesis of Zero Valent Silver Nanoparticles

During the synthesis of Silver Nanoparticles both the precursor and the reducing agent were mixed in a clean sterilized flask in 1:1 proportion. For the reduction of Ag ions, 5ml of filtered plant extract was mixed to 5 ml of freshly prepared 0.001 M aqueous of AgNO3 solution with constant stirring at 50-60^{0}C. The Silver Nanoparticles so prepared were stabilized by adding 1% of chitosan and 1% of PVA.

3.4 UV-Vis Spectra analysis

The reduction of pure Ag ions to Ag^0 was monitored by measuring the UV-Vis spectrum by sampling of aliquots (0.3 ml) of Ag Nanoparticle solution diluting the sample in 3 ml distilled water. UV-Vis spectral analysis was done by using UV-Vis spectrophotometer Systronics 118 at the range of 200-600 nm and observed the absorption peaks at 400-440 nm regions due to the excitation of surface plasmon vibrations in the AgNPs solution, which are identical to the characteristics UV-visible spectrum of metallic Iron and it was recorded.

3.5 pH analysis

1 mM aqueous silver nitrate ($AgNO_3$) solution shows 3.8 pH, there is concerned change in pH was determined of silver nanoparticle synthesis using extracts of plant and spices, which was determined using Digital pH meter Systronics.

3.6 SEM analysis

Scanning Electron Microscopic (SEM) analysis was done using Hitachi S-4500 SEM machine. Thin films 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 SEM grid were allowed to dry by putting it under a mercury lamp for 5 min.

3.7 TEM analysis

After bioreduction,the mixtures were sampled for TEM observation on H-600 Electron Microscope (Hitachi) at a voltage of 120kV.

3.6 Antimicrobial Activity

3.6.1 Antibacterial assay

By disc diffusion method, the antibacterial activities of the datura plant extract reduced AgNPs were

studied. LB (Luria bertoni) media was used ,sterilized and solidified.Then three bacterial strains(*E.coli* , *S.aureus* , *S.typhi*)were swabbed on the plates.Sterile discs were dipped in silver nanoparticles solution (20 µg/ml) and placed in the nutrient media plate and kept for incubation at 37ºC for 24 hrs. Zones of inhibition for control, SNPs and silver nitrate were measured and the mean values of zone diameter were presented.

3.6.1 Antifungal assay

Potato dextrose agar plates were prepared, sterilized and solidified.After solidification ,three fungal cultures (*F.oxysporum* , *R.arrhizus, A. niger*) were swabbed on these plates. The sterile discs were dipped in silver nanoparticles solution (20 µg/ml) and placed in the agar plate and kept for incubation for 7 days. After 7 days zone of inhibition was measured.

4. Results and Discussion

4.1 Synthesis of silvernanoparticles

Datura leaf extract is used to produce silver nanoparticles in this experiment. Ag ions were reduced into Ag^0 nanoparticles when plant extract is mixed with $AgNO_3$ solution in 1:1 ratio. Reduction is followed by an immediate change in color from light green to pale greyish and change in pH of the solution. It is well known that silver nitrate exhibit colorless appeareance in distilled water. On mixing the plant extract with the aqueous $AgNO_3$solution it changed the color of the solution immediately and reducing the pH, which may be an indication of formation silver nanoparticles. In this experiment it was observed that the pH changed from high acidic to low acidic.

Table 1. Change in color of the solution during Iron Nanoparticle synthesis

Sr. No	Solution	Color change		Color intensity	Time
		Before Reduction	After Reduction		
1.	Datura Leaf Extract	Light green	Pale greyish	++	2 hr
2.	0.001 MAgNo Solution	colourless			

Color intensity: - += Light color, ++= Dark color, +++= Very dark color

4.2 pH analysis

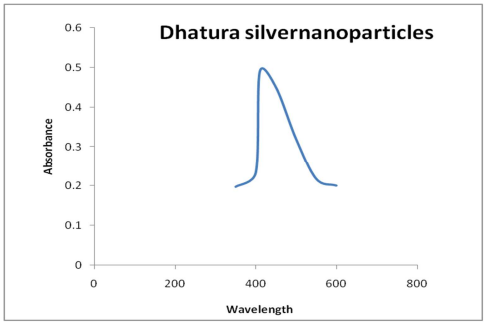
Table 2 . Change in pH during iron nanoparticle synthesis

Plant Extract		Plant Part Taken	Ph change		UV range	Result
Binomial Name	Local name	Leaves	Before	After	400-440 nm	+
Datura metel	Kamkamawlaw		5.69	4.60		

Result: - += Positive, -= Negative.

4.3 UV visible spectroscopy and color change for the Green synthesized silver nano particles

UV –Vis spectroscopy is most widely used technique for structural characterization of silver nanoparticles.The absorption spectrum in the figure 1 of the silvernanopartiles showed a surface plasmonan absorption band with maximum of 410 nm indicating the presence of spherical or roughly spherical nanoparticles.



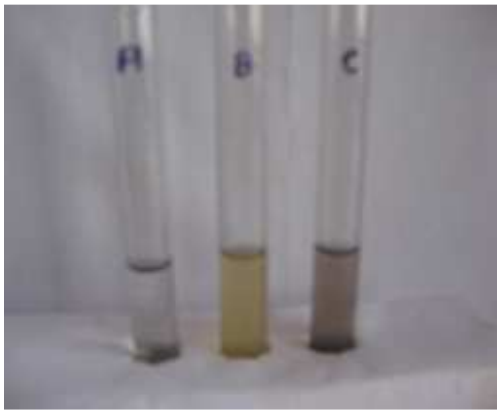


Fig.1 a)Dhatura silver nanoparticle SPR at 410 nm, b)Tube A- silver nitrate, Tube B- Extract, Tube C- Dhatura silvernanoparticle solution.

4.4. SEM Analysis

The SEM micrographs of nanoparticle obtained in the filtrate showed that silver nanoparticles are spherical shaped ,well distributed without aggregation in solution with an average size of about 5-50nm as shown in figure 2.

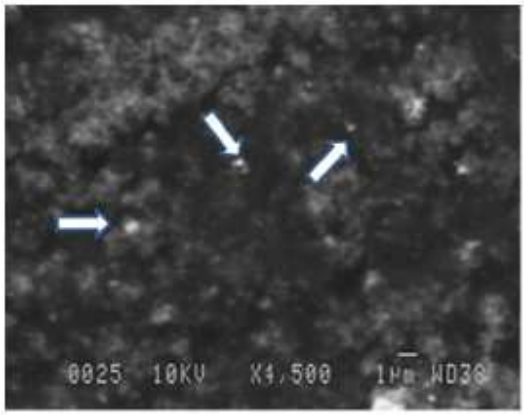


Figure 2: SEM image of Ag nanoparticle

4.5. TEM Analysis

The shape and size distribution of synthesized silver nanoparticles were characterized by transmission electron microscope as shown in figure 3 .As can be seen from the figure , the particles are highly monodispered with average diameter of 12.5 nm .

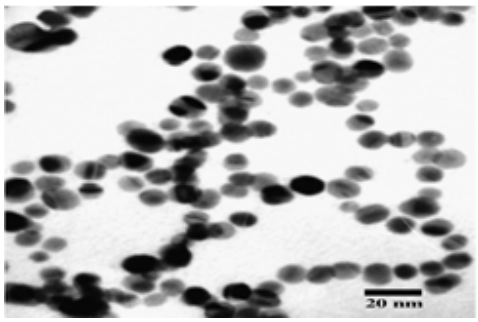


Figure 3: TEM image of Ag nanoparticle

4.5 Antimicrobial tests

The antibacterial tests provide evidence that the silver nanoparticles formed due to reduction by datura plant extract show sufficient antimicrobial resistance against bacterial and fungal pathogens especially against *E.coli* & *R. Arrhizus* .

Sr no.	Microbial Strain	Inhibition zone (mm)		
		Control	SNPs	$AgNO_3$
1	*E.coli*	7	11	14
2	*S.aureus*	6	10	12
3	*S.typhi*	5	9	9
4	*F.oxysporum*	Nil	7	6
5	*R.arrhizus*	6	10	11
6	*A. niger*	Nil	10	7

5. Conclusion

It has been demonstrated that Datura leaf extract is capable of producing silver nano particles that shows good stability in solution, under the UV-Visible wavelength nano particles shown quiet good surface plasmon resonance behavior. Silver nitrate with reducing agent i.e plant extract has shown a remarkable color change with concerned change in pH of solution. Success of such a rapid time scale for synthesis of metallic nanoparticles is an alternative to chemical synthesis protocols and low cost reductant for synthesizing iron nano particles.

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