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Green Synthesis of Silver Nanoparticles Using Plant (*Azadirachtaindica*) Leaf Extract

KEYWORDS: Silver; Silver Nanoparticles; Neem extract; Antimicrobial activity

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ABSTRACT *Silver nanoparticles were green synthesized from freshly prepared Azadirachtaindica(Neem) leaves broth at room temperature. An aqueous solution of silver nitrate (AgNO3) was treated with neem leaf extract. The silver nanoparticles formed were characterised using UV-Visible spectrophotometer and Transmission Electron Microscopy. The UV-Visible absorption peak at 427 nm clearly indicates the formation of Silver nanoparticles. The TEM images confirmed that the silver nanoparticles were spherical in shape and their size ranged between 50-200 nm. Silver nanoparticles were exhibited effective anti-microbial activity against Escherichia coli. Toxicity of silver nanoparticles were carried out using MTT (3-(4, 5-dimethylthiazolyl)-2,5-diphenyltetrazolium bromide) dye assay indicates considerable cytotoxic effect against chicken bone marrow cells.*

Introduction:

Nanotechnology has emerged as one of the most innovative scientific fields in decades. Nanotechnology is rapidly gaining importance in a number of areas such as health care, cosmetics, food and feed, environmental health, mechanics, optics, biomedical sciences, chemical industries, electronics, space industries, drug-gene delivery, energy science, optoelectronics, catalysis, reprography, single electron transistors, light emitters, nonlinear optical devices, and photo electrochemical applications.

Metal nanoparticles have received significant attention in recent years as they show good antibacterial properties due to their large surface area to volume ratio. Even though many nanoparticles like copper, zinc, titanium, magnesium, gold, alginate and silver have come up but silver nanoparticles (AgNPs) have proved to be most effective as it shows good antimicrobial efficacy against bacteria, viruses and other eukaryotic micro-organisms and low toxicity to humans cells (Sivakumar *et al.* 2011). Silver nanoparticles are reported to possess anti-fungal (Kim *et al.*2009), anti-inflammatory (Nadworny *et al.*2008) and antiviral activity (Rogers *et al.*2008).

*Azadirachtaindica*commonly known as neem belongs to the family *Meliaceae*is well known in India for more than 200 years as one of the most versatile medicinal plant having a wide spectrum of biological activity. *Azadirachtaindica*leaf extract has also been used for the synthesis of silver, gold and bimetallic (silver and gold) nanoparticles. Neem leaves has been used in this study as it is a quite commonly available plant and abundant in nature, it does not need any external stabilizing agent to be added during synthesis, it offers synergistic effects to enhance the antimicrobial properties of the synthesized silver nanoparticles and all parts of neem plant (leaf, seed, fruits, bark, and flower) are useful for medicinal value.

Hence the objectiveGreen synthesis and optimization of Silver nanoparticles using plant (*Azadirachtaindica*) leaves extract and characterization of nanoparticleswas framed for this study.

Materials & Methods

Preparation of neem leaf extract & Synthesis of Silver nanoparticles:

Fresh neem leaves (*Azadirachtaindica*) were finely cut and washed with distilled water. 20g of leaves was added to 100 ml of distilled water and boiled for 2 minutes in a water bath. After cooling, it was filtered through Whatman Filter paper no. 1 to obtain aqueous extract of definite concentrations. Freshly prepared aqueous extract was used for synthesis.

For synthesis of silver nanoparticles, neem leaves extract was added to 0.01 M $AgNO_3$ solution at 1:4 ratio and the mixture was stirred continuously for 5-10 minutes using magnetic stirrer with 650 rpm. The silver ions were reduced to silver nanoparticles within few minutes by neem leaves extract. The quick conversion of solution colour showed the formation of silver nanoparticles by observing colour change from yellow to brown colour.

Characterisation of synthesised Silver Nanoparticles

The characterization study of silver nanoparticles was done by the examining size, shape and quantity of particles. The absorption of biosynthesized AgNPs were measured by UV–VIS spectroscopy. The morphology, shape and size of nanoparticles were examined by transmission electron microscope (TEM).

Results& Discussion:

In this study, silver nanoparticle was synthesised with *Azadirachtaindica*leaf extract using green synthesis process. When the leaf extract was stirred with silver nitrate solution using magnetic stirrer, silver ions were reduced to nanosized silver particles. A changein the colour was observed indicating the formation of silver nanoparticles.

Characterisation of synthesised silver nanoparticles

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The synthesised silver nanoparticles were characterized using UV-Vis spectral analysis and Transmission Electron Microscopy (TEM).

UV-Vis spectroscopy

UV visible spectroscopy is one of the most widely used techniques for characterization of silver nanoparticle. The absorption spectrum of the brown colour solution prepared showed a surface Plasmon absorption band with a maximum of 427 nm indicating the presence of silver nanoparticles as shown in Figure 1. The results obtained are in agreement with the results of Asmita*et al.* 2012 for synthesis of AgNPs using *Azadirachtaindica*leaves extract, the maximum peak found at420nm.

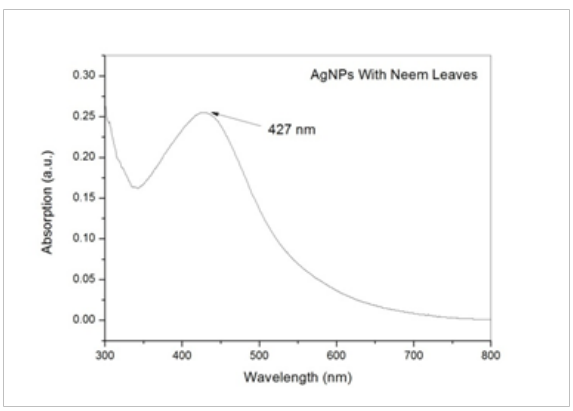

Fig 1UV-Vis spectra of silver nanoparticles synthesized by*Azadirachtaindica*

Transmission Electron Microscopy

TEM analysis reveals that the silver nanoparticles are predominantly spherical. Figure 2 shows that the TEM of the silver nanoparticles with different magnification. The overall morphology of the silver nanoparticles produced by reduction of Ag+ ions with 0.01mM $AgNO_3$ is composed of almost uniform and monodispersive in nature. The size of the silver nanoparticles was found to be 50–200 nm, with an average size of 126.60 nm that lies in the nanorange. These findings concurred with the findings of Shankar *et al.* 2004. In their study, the silver nanoparticles formed were predominantly spherical and polydisperse with diameters in the range 5 to 35 nm.

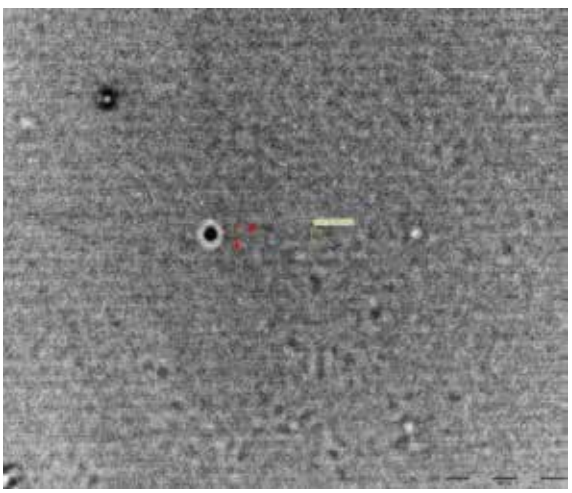

Fig 2 TEM Images of Silver Nanoparticles Synthesised from *Azadirachtaindica leaf* extract

Conclusion:

The method of Green synthesis of silver nanoparticles by the help of *A. indica*wasvery cost effective, safe, non-toxic, eco-friendly route of synthesis which can be manufactured at a large scale. Moreover, this plant mediated synthesismethod represents a considerable improvement in the preparationof silver nanoparticles because of various advantages such as reduced reaction time, no need of capping agent and better control over their sizeand shape.

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