ECO-FRIENDLY SYNTHESIS AND CHARACTERISATION OF GOLD NANOPARTICLE USING *Zingiber officinale*

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Abstract: Biofabricated metal nanoparticles are under exploration due to wide biomedical applications and research interest in nanotechnology. Biosynthesis of gold nano particles was achieved by reduction of Gold (III) chloride hydrate (HAuCl4), using ginger rhizome (Zingiber officinale) extract. Then, biosynthesized gold (AuNPs) nanoparticles were characterized by using UV–Vis spectroscopy, FTIR, EDX and SEM.Antimicrobial activity of gold nanoparticles biosynthesized using *Ginger* also showed clear zones of inhibition of microbial growth indicating that gold nanoparticles synthesized from ginger has antimicrobial activity.
IndexTerms **:** Gold nanoparticle, *Zingiber officinale*, UV-Vis, FTIR, Antimicrobial activity.

INTRODUCTION

The field of nanobiotechnology is one of the booming active areas of research in modern pharmaceutical industry. Especially nanomaterials with nano specific characteristics on size, distribution and morphology shows tremendous applications in the field of biomoleuclar detection, diagnostics, antimicrobials and therapeutics (Elechiguerra et al., 2005). Eventhough, there are more applications, concern for environmental contamination due to chemical synthesis is high thus there is a need for green synthesis that includes clean, nontoxic and environment-friendly methods of nanoparticle synthesis (Mukherjee et al. 2001) with sustainable commercial viability. Green synthesis makes use of environmental friendly, nontoxic and safe materials (Sharma et al. 2009) like plant leaf extract, bacteria, fungi and enzymes for the synthesis of silver nanoparticles that offer numerousbenefits of being eco-friendly and compatible for pharmaceutical and other biomedical applications.

The characteristic properties earmarked for gold nanoparticles are their (a) small size (1–100 nm) and correspondingly large surface-to-volume ratio, (b) unique physical and chemical properties that can be changed according to requirements of size, composition, and shape, (c) high robustness shown by some of the nanostructure materials, and (d) quantitive and qualitative target-binding properties (Rosi et al., 2005; Vigderman et al., 2013).

Ginger (*Zingiber officinale*) is a flowering plant whose rhizome, ginger root or simply ginger, is widely used as a spice or a folk medicine. It is a herbaceous perennial which grows annual stems about a meter tall bearing narrow green leaves and yellow flowers (Marx et al., 2013). It is known for its medicinal values such as to treat skin diseases, colorectal cancer, arthritis, heart condition and also have been reported for its antibacterial properties. In addition to these medicinal uses, ginger continues to be valued around the world as important cooking spice (foodpaper.com; university of Maryland(2006)). The approach followed by us appears to be cost efficient alternative to conventional methods and completely biogenic method of synthesis of gold nanoparticles

MATERIALS AND METHODS

Collection and Extract Preparation

The rhizome of the *Zingiber officinale* (Figure no.1) belonging to the family *Zingiberaceae* were collected. The rhizomes were rinsed with sterile distilled water to remove any associated debris. These clean fresh rhizomes were cut into fine pieces and ground in a pestle and mortar (20 g of the sample in 100 ml of distilled water). The resulting infusion was filtered thoroughly using Whatmann No.1 filter paper. The mixture was centrifuged at 10,000 rpm for 15minutes.The supernatant was collected and stored at 4°C until its use.

Synthesis of gold nanoparticles

Aaqueous solution of Gold (III) chloride hydrate ($HAuCl_4.3H_2O$) was prepared (Figure no.2). 5 ml of extract was added to 50 ml of 1.0×10^{-3} M $HAuCl_4$ solution at room temperature. The flask was thereafter put into shaker (120 rpm) at 37°C and reaction was carried out for a period of 48 hours. The extract was dried to powder using vacuum dry evaporator. This powdered extract is preserved until its use .

UV-VIS Spectra analysis

The reduction of pure Au+ ions was monitored by measuring the UV-Vis spectrum by diluting a small aliquot of the sample into distilled water. UV-Vis spectral analysis was done by using UV-Vis spectrophotometer at the range of 190- 1100 nm (Figure no.3).

FTIR analysis

FT-IR measurement of sample was performed using Shimadzu FT-IR spectrophotometer (Figure no.4).

SEM with EDX analysis silver nanoparticles

Scanning Electron Microscopic (SEM) analysis was done using Thermo scientific 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 minutes (Figure no. 5). EDX analysis was also performed for the confirmation of elemental silver.

Antimicrobial activity

Microbial plating was done for antibacterial and antifungal studies. The Mueller hinton agar medium(MHA) was prepared and sterilized for 121°c for 15 minutes before plating for well diffusion method. 100µl of 0.5 McFarland standard cultures of bacteria were spread on MHA agar poured petriplates. Wells were punched in the medium with sterile cork borer. 50µl of samples along with standard ofloxacin discs were inoculated into the wells and the plates were incubated at 37°c overnight. Petri plate inoculated with fungi was kept in room temperature. E.coli, Klebsiella and Staphylococcus are the bacteria used for studies and Aspergillus niger was the fungi used for study.

Figure no. 1 *Zingiber officinale*

Figure no. 2 Synthesis of Gold nanoparticle

Figure no. 3 UV-Vis spectra analysis

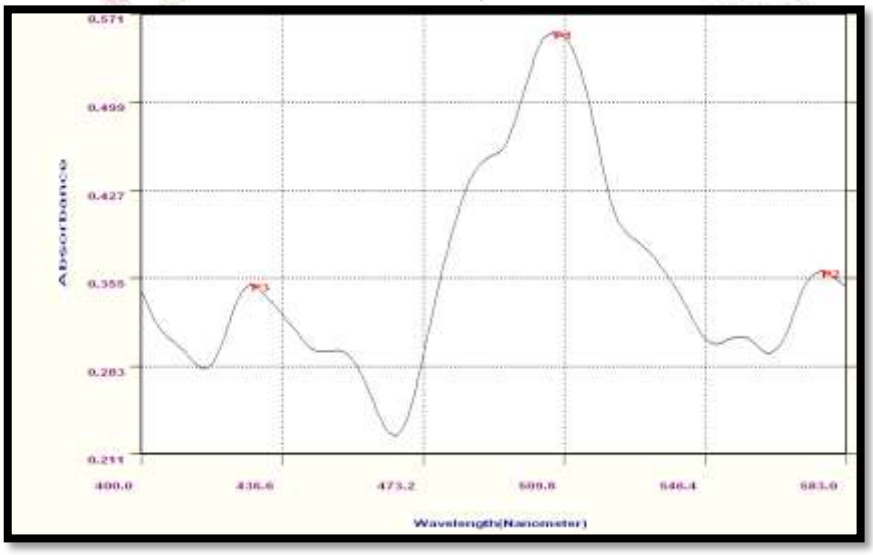


Figure no. 4 FTIR analysis

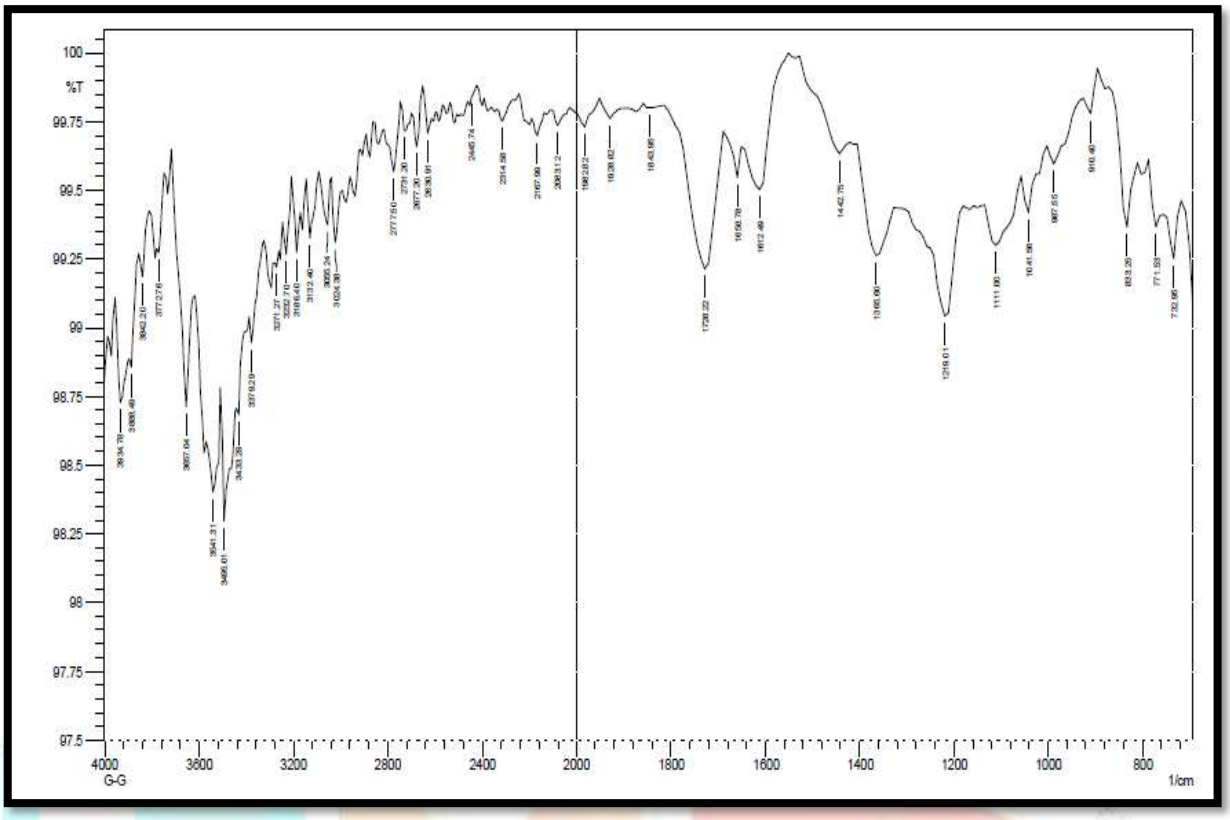


Figure no. 5 EDX image with five dominant peaks

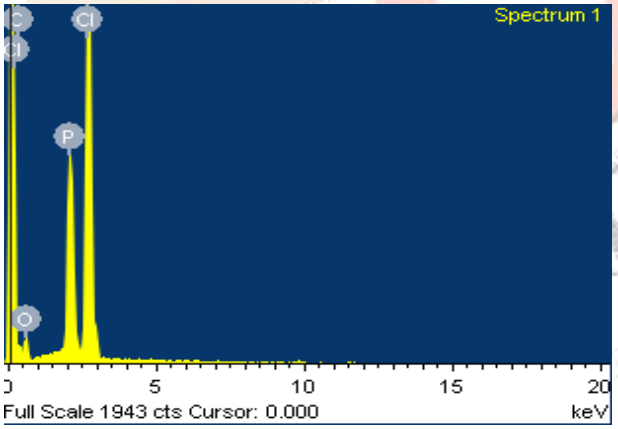


Figure no. 6 SEM analysis

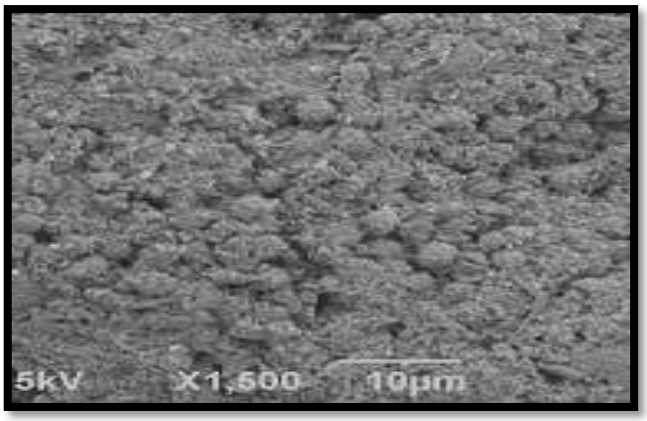
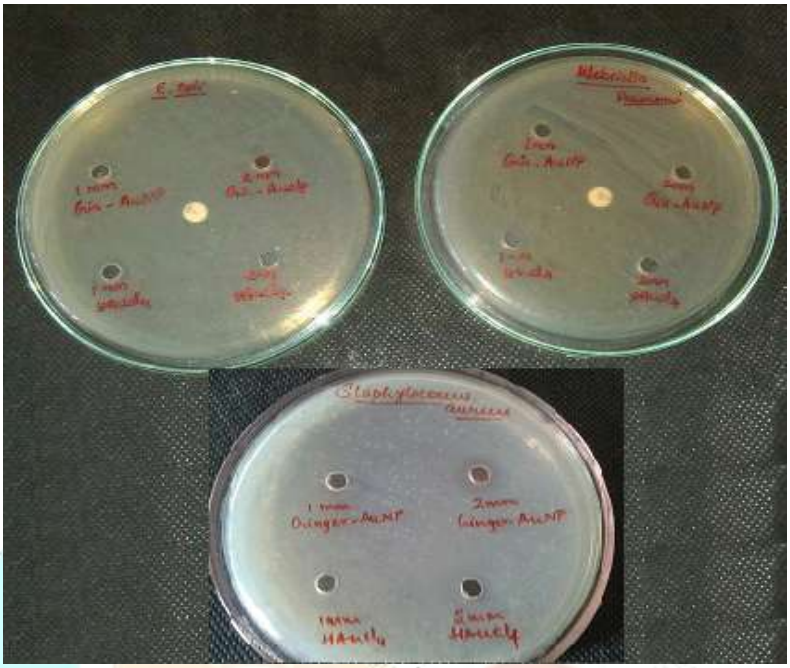


Figure no. 7 Antibacterial activity of *Zingiber officinale*



RESULTS AND DISCUSSION

SYNTHESIS OF GOLD NANOPARTICLE

The first proof for synthesis of nanoparticles was the appearance of golden color (Figure no.2). The change in colour was obtained within few minutes of addition of plant extract. After 24 hours, the color was intense with a powdered appearance of particles in solution.

UV-Vis SPECTRA ANALYSIS

The maximum absorptions were obtained at a wavelength 509nm (Figure no. 3). The SPR bands centered between 500 – 600nm, confirms the formation of GNPs in the solution. The appearance of the peak is due to the size dependent quantum mechanical phenomenon called Surface Plasmon Resonance (SPR). This effect become influential when the De – Brogile wavelength of the valence electrons becomes equal to or less than the size of the particle (less than 50nm)(Sunil et al., 2012).

FTIR ANALYSIS

FTIR measurements were performed to identify the potential biomolecules in the ginger rhizome responsible for reduction and then providing stability to the bioreduced gold nanoparticles (Figure no. 4). The FTIR spectra of AuNP; the peak was centered at 2000 cm-1 which was not observed in the FTIR spectra of GNP, which indicated presence of NO3 - in the residual solution (Luo et al., 2005). The maximum absorbance peaks band observed the regions of 3000 -3600 cm-1. Now various functional groups mentioned above are mainly derived from heterocyclic compounds and these are the water soluble components of ginger rhizome. So it can be assumed that different water soluble heterocyclic compounds such as alkanoids, flavoinds etc worked as the capping ligand for the synthesis of gold nanoparticles and the presence of oxygen atoms helped in the stabilization of nanoparticles by facilitating the absorption of heterocyclic compounds on nanoparticles (Chandan et al., 2011).

SEM ANALYSIS

SEM analysis of the AuNPs revealed that well-dispersed, AuNPs were formed. Morphological examination also revealed that the nanoparticle crystals sized ~100nm with speherical and cubic in shape (Figure no. 6).This results is similar to the particle size mentioned in Umesh et al., 2011. The characteristic peak obtained in the Energy-dispersive X-ray (EDX) image (Figure no. 5) in accordance with the structural view of SEM confirms the efficient synthesis of gold nanoparticle.

ANTIBACTERIAL ACTIVITY

The microbially synthesized gold nanoparticles prepared by *Zingiber officinale* showed antimicrobial activity against only E. coli, Staphylococcus and Klebsiella sps. The antimicrobial activity can be identified by zone formation. The green synthesized gold nano particles prepared by *Zingiber officinale* showed activity against Klebsiella sps. The antibacterial activity of gold nanoparticles was investigated against various pathogenic bacteria of Gram-positive (Staphylococcus aureus) and Gram

negative (Escherichia coli, Klebsiella sp.) strains using disc diffusion method. Antibacterial activity of gold nanoparticles against human pathogens with the largest zones. (a) Klebsiella, (b) Staphylococcus, (c) E. coli and in control no zone of inhibition was observed (Figure no. 7) (Chandran et al., 2006).

CONCLUSION

In this study, the synthesis of gold nanoparticle is presented with low cost, simple, rapid approach for the bioreduction and replacing the chemical procedures usually applied for the synthesis. Analysis of antimicrobial activity with AuNP synthesized from ginger is also a new approach and a beginning of evaluation of its pharmacological activity. Further experiments demonstrating the pharmacological activity and stability of AuNP are required to confirm its drug action and prove as a boom to pharmaceutical industry.

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