Synthesis of silvernanoparticles using *Hevea* leaf and latex

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Abstract

Nanoparticles are the fundamental building blocks of nanotechnology. The most effectively studied nanoparticles are made from noble metals such as Silver, Platinum, Gold and Palladium. These nanoparticles have applications in the area of catalysis, optoelectronic, diagnostic biological probes and display devices. Among the noble metals mentioned, silver nanoparticles (AgNPs) play significant role in the field of biology and medicine. A number of chemical and physical methods are available for its synthesis. In this respect nanoparticle synthesis using plants can be advantageous over other biological processes because it eliminates the elaborate process of maintaining cell cultures and can also be suitably scaled up for large-scale synthesis of nanoparticles under non-aseptic environment. Already scientists have started utilizing the bio-based synthesis of nanomaterials using leaf extracts and microorganisms. Synthesis utilizing plants/ parts of plants was advantageous and often found to be kinetically favourable than other bio-processes. A number of plant species has been successfully used for synthesis of silver nanoparticles. The present study was conducted to evaluate the unexploited plant sources in the development of silver nanoparticles. *Hevea* leaf extract and latex was used and their rate of reduction of silver nitrate was investigated.

Fresh and healthy *Hevea* leaves were collected, washed thoroughly with distilled water and cut in to small pieces. About 5g of this finely cut *Hevea* leaves were weighed and transferred in to 250 ml Erlnmeyer flask containing 100 ml milli Q water, mixed well and boiled for 5 minute. After cooling, the extract obtained was filtered through Whatman No.1 filter paper and the filtrate was collected in 100ml Erlnmeyer flask and stored in refrigerator. Aqueous silver nitrate ($AgNO_3$) solution (2 mM) was prepared for the synthesis of silver nanoparticles from *Hevea* leaf extract. 0.1ml of 0.1 N NaOH was added to the leaf extract. 5ml of *Hevea* leaf extract was added to 20ml of aqueous solution of 2 mM AgNO3 for reduction in to silver ions. Similarly about 50ml of latex was taken in a100 ml beaker into this 15ml 3%acetic acid was added and the extract was collected and stored. Aqueous solution of $AgNO_3$ (10 mM) was prepared for the synthesis of silver nanoparticles from latex extract. 5 ml of latex extract was added to 20 ml of aqueous solution of 10 mM AgNO3 for reduction in to silver ions. These reaction mixtures were heated in a water bath at 85°C for 30 minute. The reduced silver nanoparticles were characterized using UV-VIS, X – ray diffraction (XRD) and Scanning electron microscopy (SEM). The qualitative analysis for nitrate reduction and the antimicrobial activity of the synthesized nanoparticles was also performed. It was found that the leaf extract and latex could be able to reduce silver ion and produce AgNPs. Visually this was identified by the gradual clour change of the reaction mixture. Formation of silver nanoparticle was evaluated through spectrophotometer in a range of wavelength from 300 to 600 nm. The reaction mixture exhibited strong absorption at 390 and 420 nm and broadening of peak indicated that the particles are polydispersed. The silver nanostructure synthesized using bio-extract from *Hevea* leaf and latex was further demonstrated and confirmed by XRD. The XRD pattern showed intense peaks in the whole of spectrum of 2θ value ranging from 20 to 80. Peaks observed at 39^0, 65.3^0, 78^0 angle in the case of leaf extract and in the case of latex it was at 38.8^0, 65.19^0, 78.36^0. This confirms the crystalline nature of nanoparticles synthesized. SEM analysis reveals the structural view of the silver nanoparticles. The SEM images show the high density nanostructures synthesized by *Hevea* leaf extract and latex and the size of nanoparticle was less than 80nm. This is

SYNTHESIS OF SILVER NANOPARTICLE USING *HEVEA* LEAF AND LATEX

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Company	Product	Advantage
Air quality		
NanoStellar	NC catalyst	Reduced cost
American Elements	MnO_2 NPs as catalyst	Remove VOC
Batteries		
Zpower	Ag-Zn NPs in silver cathode	*power density, *combustibility
Cleaning products		
Samsung	AgNPs – Refrigerator,	Reduce odour
Nanotec	Spray on liquid with NPs	Repels water & dirt
Fabrics		
Nano horizons	Fabric with AgNPs	Reduces odour
Sporting goods		
Easton	Bicycle components – C nanotubes	Strong, light weight components
Cosmetics, Nanonurtients		

Background

- Nanotechnology

Deals with research for design, synthesis and manipulation of structures of particles with smaller dimensions
Nanoparticles have applications in the area of catalysis, optoelectronic, diagnostic biological probes and display devices

Nanobiotechnology

It combines biological principles with physical and chemical procedures for the synthesis of nanostructures of specific functions

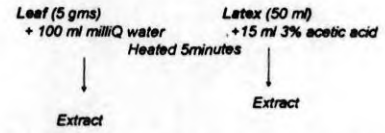
Source	Nanoparticle	Phytochemical	reference
Black tea leaf	Ag/ Au	Polyphenols/ flavonoids	Begum et al (2009)
Neem leaf	Ag/ Au	Terpenoids, polysacchandes	Shankar et al (2004) Tripathy et al., (2009)
Capsicum sp	Ag	Protiens	Li et al (2007)
Jatropha curcans	Ag	Curcain, curacycline A & B	Bar et al (2009)
	Ag	Tannic acid	Sankar et al (2009)

Mechanism of nanoparticle formation

- Recognition process – silver ions trapped on protein in extract via electrostatic interactions
- Reduction and nucleation – reduction & change in secondary structure & formation of silver nuclei
- Accumulation phase (Growth process) - silver ions grew further by reduction of silver ions and accumulation silver nuclei

Materials and Methods

Synthesis of silver nanoparticles



- *Silver nitrate solution ($AgNO_3$) – 2 mM and 10 mM*
- *5 ml leaf extract + 20 ml 2 mM $AgNO_3$ solution*
- *5 ml latex extract + 20 ml 10 mM $AgNO_3$ solution*

Both the reaction mixtures heated at 85ºC for 30 minutes.

Objectives

- *To evaluate the possibility of using Hevea leaf and latex in silver nanoparticle synthesis.*
- *The antibacterial activity of the silver nanoparticles synthesized using Hevea leaf and latex.*

Characterisation of synthesized silver nanoparticles

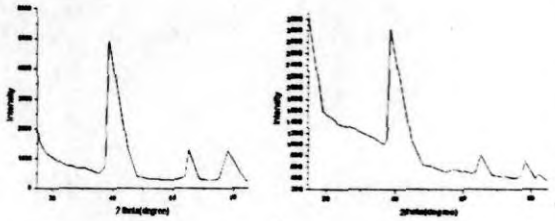
a) UV-VIS spectra analysis
UV-VIS spectrophotometer
(UVD-3500, labomed line)
b) XRD spectra analysis
X'pertPro X-ray diffractometer (D8 Advance)
c) SEM analysis
JSM 6390 (model 7582)

Antibacterial assay
Luria Bertani (LB) media, E.coli (JM 109 cells)
a) Agar well diffusion method
b) Agar disc diffusion method

Results and Discussion

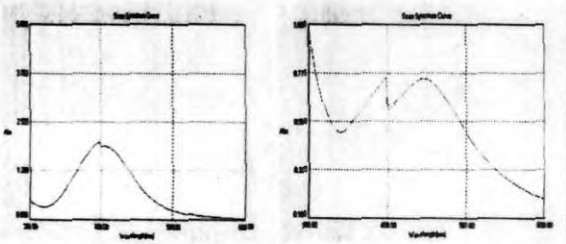
Fig. 1(a) Silver nitrate solution (b) & (c) before and after the process of reduction of Ag+ to Ag nanoparticles using *Hevea* leaf and latex extract respectively.

XRD pattern of silver nanoparticles synthesized using (a) leaf and (b) latex extract



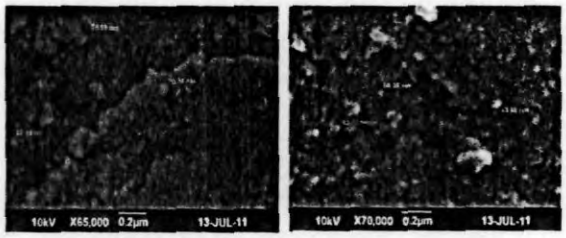
a b

UV-VIS absorption spectrum of silver nanoparticles synthesized using (a) leaf and (b) latex extract



a b

SEM image of silver nanoparticles synthesized using (a) leaf and (b) latex extract



a b

Antibacterial activity of AgNPs synthesized using leaf
(a) control (b) well diffusion method
(c) disc diffusion method

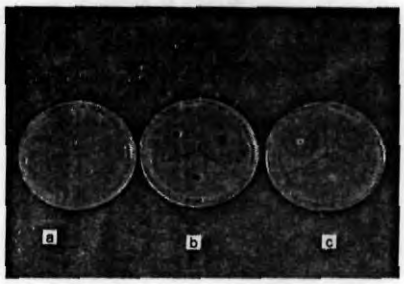
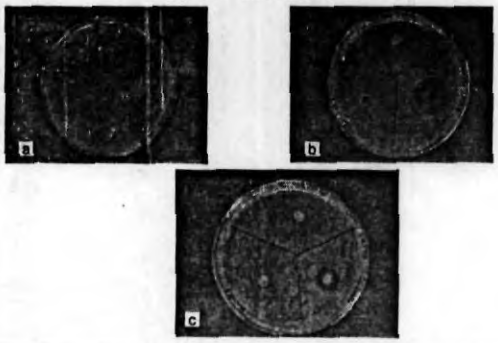


Table. 1. Antibacterial activity of AgNPs showing the diameter of inhibition zone

Sample	Zone of inhibition					
	Disc diffusion method			Well diffusion method		
	AgNPS	Ampicilin	Water	Ag NPs	Ampicilin	Water
Leaf	22 mm	28 mm	No inhibition	44 mm	42 mm	No inhibition
Latex	20 mm	28 mm	No inhibition	42 mm	48 mm	No inhibition

Antibacterial activity of AgNPs synthesized using latex
(a) control (b) well diffusion method
(c) disc diffusion method



Conclusions

- Eco friendly route for the synthesis of nanoparticles was proved efficient using *Hevea*.
- Antibacterial activity of the synthesized AgNPs was comparable with that of standard drug


Thank you