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Bio-mimetic synthesis of s ilver nanoparticles

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ABSTRACT

Silver nanoparticles have their demand in various fields of science and technology and their applications extend even in medical and pharmaceutical arenas. They have been used as preservatives, diagnosing aids and potent antibacterial agents. But their production is a serious matter of concern when it comes to cost, efficacy and toxicity issues. Overcoming these limitations green synthesis has taken its advantage for their commercial and large scale synthesis. This research concentrates on the preparation of silver nano particles by using purified leaf extract of *Lannea coromandelica* and evaluation of the same using UV-Vis Spectrophotometry, FTIR, EDXS, SEM and particle size analysis. The produced nanoparticles exhibited surface plasmon resonance at 420nm in UV spectroscopy. EDS Spectrum showed the presence of metallic silver in the solution. They are roughly cubic in shape, smooth surfaced and measure about 10-20nm in diameter which is evident from the particle size analysis. FTIR studies revealed the presence of O-H groups indicating polyphenols and also confirms capping of proteins over the nanoparticles. The results proved the eco-friendly synthesized silver nanoparticles. The prepared nanoparticles have been analyzed using sophisticated analytical instruments. The results confirm the formation of silver nanoparticles. The biomimetic synthesis of silver nanoparticles is relatively safer and cost effective. The potency and effect of silver nanoparticles was determined yet the toxicity was to be considered for establishing it as a therapeutic agent.

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INTRODUCTION

Nanoparticles, now days have gained their importance in various fields of medicine and technology. Concerning their advantages over other forms they are widely and exclusively used as diagnostic and medical aids. They can be synthesized using various methods with their own advantages and disadvantages. But most significantly green synthesis of metallic nanoparticles is found to be an emerging trend in nano biotechnology when the health safety issues are concerned. These processes are eco-friendly, less toxic and most efficient methods

for the synthesis of nanoparticles.

Silver is used as an antimicrobial agent as evident from the history since 500 AD. Since ages silver is used to store water, wine, vinegar and milk based on an assertion that silver prevents them from spoiling [1] though without scientific evidence. Silver nano particles have been used extensively used for health and household purposes even though the mechanism and toxicity was not completely investigated. But still the toxicity of silver nanoparticles is a matter of concern and is a topic on which probing research work has to be done. The high potency and efficacy of silver against any kind of bacteria makes it a best antimicrobial agent known to and prescribed by physicians. Even though scientists developed many derivatives which overcome bacterial resistance to synthetic antibiotics, such drugs come under cause unwanted side-effects or costly to afford. So in view to the above disadvantages of the antibacterial drugs nano silver took its way to establish itself as a potent and safer antibacterial agent from histories. Not only as a pharmaceutical product but also silver nanoparticles have a wide range of usage in electronics and related technologies [2].

Many investigations reveal the preaparation of silver nano particles through herbs like Neem leaf (*Azadirachta indica*), *P. graveolens* leaves, Soap nuts (*Sapindus trifoliandus*), Cinnamon (*Cinnamomum zeylanicum*), Citrus (*Citrus limon*), Tea, Coffee, Tannic acid and many micro organisms. So this research concentrates on the biogenesis of silver nanoparticles using the *Lannea coromandelica* leaves. Silver nanoparticles are formed by the reduction of silver ions to metallic silver nanoparticles. Lannea extract contains rich polyphenols [3] which can be utilized for reduction of metallic silver into the silver nano particles.

MATERIALS & METHODS

Collection and extraction of material

Leaves of *Lannea coromandelica* were collected from S.V.University, Tirupathi and duly authentified by Prof. P. Jayaraman, PARC, Chennai. The leaves were air dried; finely powdered and 50gm of the powder was macerated with 250 ml double distilled water for 24hrs with constant stirring. The macerate was filtered under vacuum. The obtained filtrate was filtered using a whattman filter paper twice to get a clear solution and was directly used for further experiments.

Preparation of silver nanoparticles

50ml of 1mM Silver nitrate was added to different volumes of plant extract like 1ml, 5ml, 10ml separately and the volume is made upto 200ml and centrifugation was done at 18000rpm for 25min to separate any precipitates. The supernatant was heated at 50ºC to 60ºC [4] . A distinct change in the colour of the solution was noted while in the heating process. The resultant solutions were named as SNP 1, SNP 5, SNP 10 respectively.

Evaluation

UV spectrum is used to estimate the reduced silver ions in the reaction medium at 30 min, 1, 2 and 3 hrs. the particle size analysis was measured by a Zeta sizer Nano ZS-90 (Malvern Instruments Ltd., UK) attached with the DTS software. The surface morphology and elemental analysis was performed using SEM (Zeiss-DSM 940 A) and Energy Dispersive X-ray Spectroscope, EDXS attached with SEM. FTIR spectrometric analysis was performed by using a Perkin Elmer-1600 spectrophotometer.

RESULTS AND DISCUSSION

Physical characteristics

The formation of silver nano particles was confirmed with the change in colour of the *Lannea coromandelica* extract containing silver nitrate after heating. The solution was greenish yellow before heating and changed to dark brown in figure 1, suggests the formation of silver nano particles (Figure 1).

UV spectral analysis

UV-Visible spectral analysis revealed the surface plasmon resonanace by metallic nanoparticles at 420 nm [5]. Peaks were observed at time intervals of 30 min, 1hr, 2hrs, 3hrs respectively and are shown in Figure 2. The spectra obtained at 3hr showed the absorption maximum at 420nm. The height of the peaks increased indicating a formation of nanoparticles as proportional to the time. The peak tend to become sharp and more intense at 3^{rd} hr suggesting the formed nanoparticles are even in size compared to those formed at 1^{st} and 2^{nd} hrs. The absorption at shorter wavelengths infers that the silver nanoparticles were formed due to the intervention of some organic molecules like secondary metabolites from plant extract. So it can be reported that reducing agents and antioxidants like polyphenols and flavonols present in the plant might be the reason for formation of silver nano particles.

Particle size analysis

Particle size distribution of the silver nanoparticles formed with different concentrations of extracts was analysed and the results showed a poly dispersed particles with a size range of 10-100 nm. The parti-

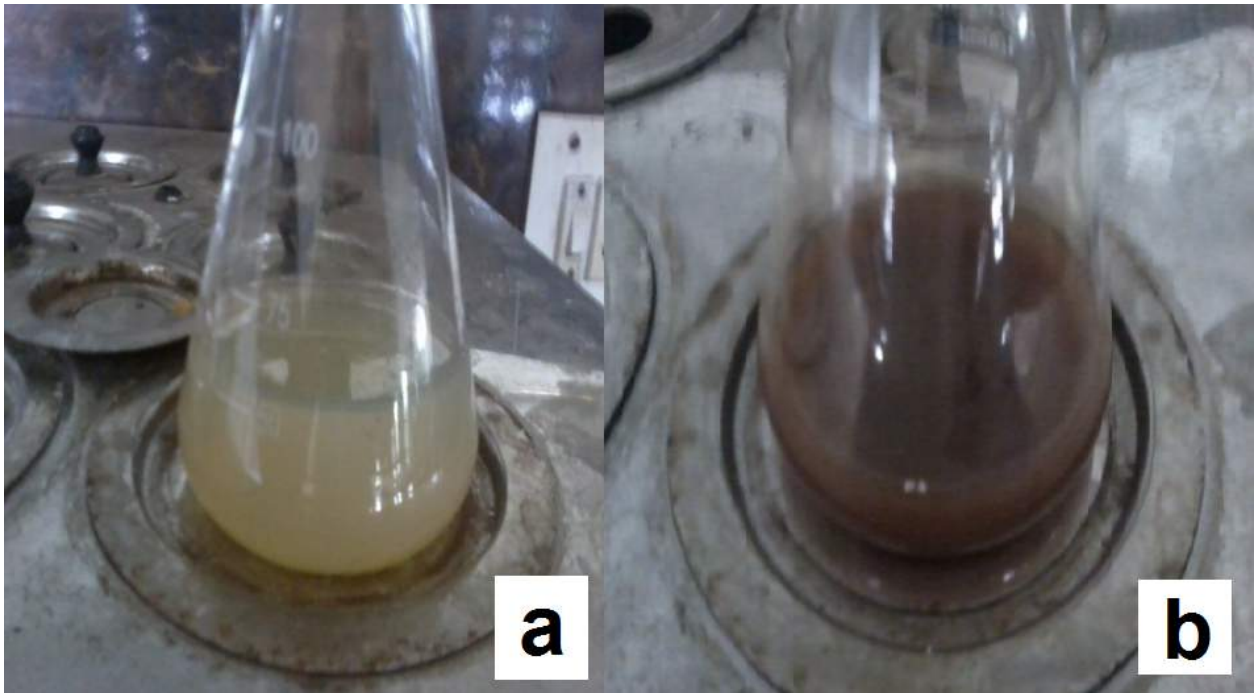

Figure 1: Color change in extract solution; a. before heating b. after heating

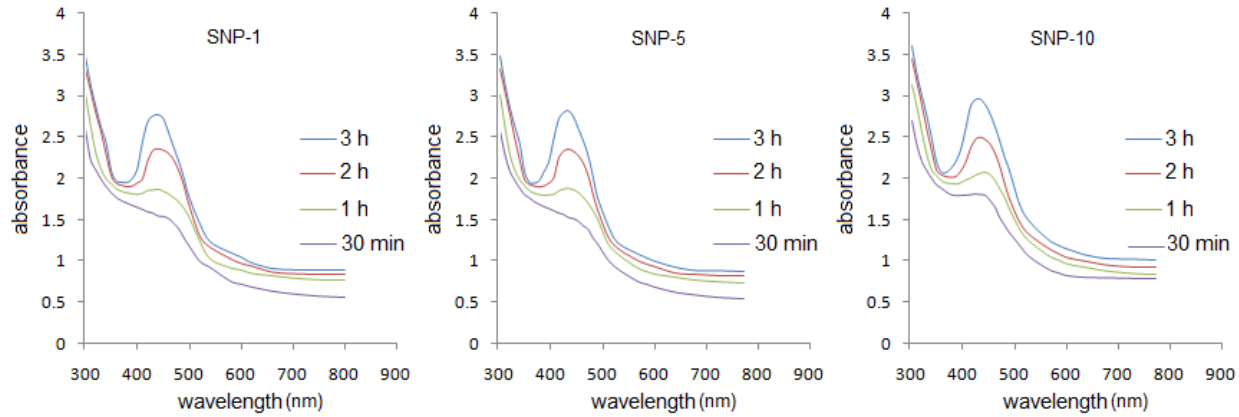

Figure 2: UV-Vis spectrum of silver nanoparticles

cles in SNP-10 were even in size and ranged from 10-30nm. They were significantly smaller compared to particles in SNP-5 and SNP-1. From this it can be inferred that the increase in concentration of extract reduced the silver ions better and resulted in the formation of smaller metallic nanoparticles. The particle size analysis and the size ranges were showed in Figure 3. Even smaller and wide size ranges of nanoparticles can be produced by altering the process variables like incubation temperature, incubation time, pH and type of extract [6] .

EDS spectral analysis

The EDS spectrum showed the presence of distinguished signal at 3 KeV which is characteristic to elemental silver (Figure 4). Signals corresponding to elements like C, O, S and Cl suggest their presence in the extract in the form of proteins and other organic molecules capping over the silver nanoparticles [7]. The signal for silver is relatively high compared to other elements stating the presence of silver nanoparticles in reliably significant amounts.

FTIR analysis

The capping of organic molecules around the formed nanoparticle is clear from the FTIR spectrum (Figure 5) which showed a characteristic peak at 1634 cm^{-1} which indicates the stretching of amide linkages usually present in proteins. This confirms that proteins are capped around the formed silver nanoparticles. Additional peaks at 3436 $cm^{-1}$and 1439 cm^{-1} corresponding to O-H groups and C=O groups respectively are seen, which are present in polyphenols and flavonols. It confirms that the ionic

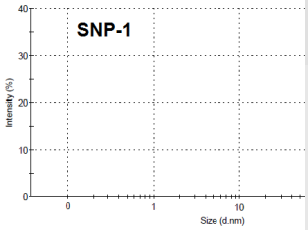

Figure 3: Particle size a

silver has been reduced in
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flavonols present in the pl

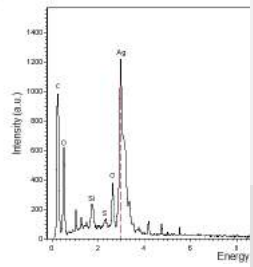

Figure 4: EDS analysis o

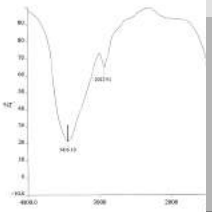

Figure 5: FTIR spectrum

SEM analysis

The SEM photograph (Fi
face morphology of the fo
They are roughly cubic i
surface about 20-50 nm
of the nanoparticle appe
the core which indicates t
them.

Figure 6: SEM analysis of silver nanoparticles

CONCLUSION

Silver have been used as medicinal and diagnosing agent and it is evident from the literature, nano particles are potent and effective compared to normal drugs. The silver nanoparticles were found to have potential advantages over many available drugs. But their synthesis became a serious concern towards the cost and toxicity. So the bio-mimetic synthesis of silver nanoparticles was carried out using leaf extract of *Lannea coromandelica* and investigations revealed the prepared nanoparticles are potent antibacterial and wound healing agents. The bio-mimetic synthesis of metallic nanoparticles was proven safer and cost effective. They are relatively safe and effective compared to available antibacterial drugs and chemically produced silver nanoparticles either. The potency and effect of silver nanoparticles was proven yet the toxicity was to be considered for establishing it as a therapeutic agent.

AUTHORS' CONTRIBUTIONS

Dr. G. Avinash Kumar Reddy contributed in the designing of the study and drafted the manuscript. BV Krishna Reddy participated in drafting the manuscript. G Nageswara Rao helped in the evaluation of silver nano particles. All authors have read and approved the final content.

CONFLICT OF INTEREST

Authors declared no conflict of interest.

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