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Green Synthesize of Silver Nanoparticle by *Semecarpus anacardium, Plumbago zeylanica* and *Curcuma longa* Extracts and Characterization of Silver Nanoparticle.

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ABSTRACT

Development of efficient green synthesis of metal nanoparticles has become a major focus of research to find an eco-friendly method for production of nanoparticles. The reducing agent used to deliver nanoparticles were from aqueous extract of *Semecarpus anacardium, Plumbago zeylanica* and *Curcuma longa* plants. Silver nanoparticle (AgNPs) produced by herbal reducing agents was observed by change of colour and UV-Visible spectroscopy. The UV-Visible range demonstrated a peak 431 nm relating to the Plasmon absorbance of the AgNPs. The characterization of the AgNPs, their size and shape was analysed by Scanning Electron Microscopy (SEM), and X-Ray Diffraction which demonstrated a size range of 11 to 96 nm of silver nanoparticle. Fourier transform infrared spectroscopy investigation confirms the presence of plant constituents in green reduced silver nanoparticle as capping agent.
Keywords: Green synthesis, silver nanoparticles, SEM, XRD, FTIR,

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INTRODUCTION

The improvement of green procedures for synthesize of nanoparticles is developing into an essential branch of nanotechnology [1-2]. In light of the fact that organic strategies are viewed as safe for the nanomaterial creation as a different option for customary physical and synthetic techniques. The green strategies are by and large engineered courses that use moderately non-toxic chemicals to create nanomaterial, and incorporate the utilization of non-harmful solvents, for example, water, organic concentrates and microwave. This ecological safe way to synthesize nanoparticles is more compelling, efficient and safe [3]. In any case, synthesize of nanoparticles utilizing such plant constituents or micro-organisms has not yet been considered for countless plants and organisms. Studies shows *Semecarpus anacardium, Plumbago zeylanica* and *Curcuma longa* plant extract effectively reduces silver into silver nanoparticle.

MATERIALS AND METHODS

Preparation of Extract

Selected herbs were dried separately under shade for about 20 days and then powdered into coarse particle. The aqueous extraction was done separately for each 20 gm. of plant in a 500 ml Erlenmeyer flask with 100 ml of sterile distilled water and boiled up to 15 min. and filtered for the removal of dust.

Synthesis of Silver Nanoparticles

10 ml of each plant extract added separately into 90 ml of 3mM $AgNo_3$ effectively reducing silver nitrate into silver nano particle (see Figure 1, 2, 3&4). This can be confirmed by the change in colour over the period of time. Further measuring UV spectra of the sample confirms the formation of silver nanoparticle. Silver nanoparticle gives dark yellowish brown colour in aqueous solution due to excitation of surface plasmon resonance property of silver [4].

Figure: 5 shows combined extract of *Semecarpus anacardium, Plumbago zeylanica* and *Curcuma longa* gives maximum absorption at 431 nm when compared to individual herbs, so combination of these herbs is more effective in the reduction of silver ions into silver nanoparticle.

CHARACTERIZATION OF SYNTHESIZED SILVER NANOPARTICLES

UV-Spectroscopy

UV-Vis. spectral analysis was done by using UV-Vis. spectrophotometer UV-2450 (Shimadzu). Synthesis of silver nanoparticles was initially characterized by position of SPR band at different wavelengths from 350 to 600 nm. Combined extracts of plants reduces silver into silver nanoparticle more effectively and gives maximum absorption of 2.717 at 431 nm [4]. (See Figure: 5)

X-RAY - Diffraction

The Silver-nano herbal mix was purified by repeated centrifugation at 5000 rpm for 20 min. followed by redispersion of silver nanoparticles into 10 ml of deionized water. After freeze drying of the purified silver particles, the structure and composition were analysed by XRD. Structural characterization was performed using XRD analysis. The typical XRD pattern for the synthesized silver nano particles were in cubes was shown in Figure 6. Three distinct diffraction peaks at 32.2°, 38.13° and 46.22° were found due to reflections from (111), (200) and (220) planes of silver in the face centered cubic lattice.

Resolving Braggs equation $\lambda = 2d \, Sin\o$ and Scherrer equation (Figure 6) gives particle size ranging from 11 nm to 96 nm of face centered cubic structure of silver nanoparticle.

FTIR – Study

(Fourier transform infrared spectroscopy)

FTIR spectra indicates various functional groups present at different positions that have been found to be responsible for the reduction of silver ions when using the plant extract for the synthesis of silver nanoparticle similar to the use of microorganisms such as fungi for the synthesis of metal nanoparticles[5].

The FTIR spectrum in Figure: 7 shows peaks between 600 cm^{-1} to 3600 cm^{-1}[6]. The peaks at 3408, indicate the presence of O-H, The peaks at 2923 indicates C-H stretching, peak at 1843 indicates the presence of C=O groups. The peaks at 1627 and 625 cm^{-1} are corresponding to Ag−O stretching and deformation vibration, respectively. The metal-oxygen frequencies obtained nm for the separate metal oxides are as per literature study [7]. Comparative FTIR investigations of silver nanoparticles were accounted for by N. D. Singho and his associates [8] support the outcomes. Peak at1627 also corresponds to N-H bending of amide.

FTIR spectrum (Figure: 7) results confirms the presence and action of herbals in reducing and capping of silver nano particle and it also confirms the presence of silver nanometal in the complex [9].

SEM –Analysis

SEM (Scanning Electron Microscope) was utilized to examine and describe the state of the silver nanoparticles that were produced by green technique. SEM investigation demonstrates that the plant extracts has great effect in reducing silver into silver nanoparticles which were cubic in shape and were consistently dispersed.

The morphology and the extent of the nanoparticles were subjected to describe by SEM investigation as appeared in Figure 8 & 9. The states of the silver nanoparticles were generally cubic in shape. Furthermore, size of herbal silver nanoparticle measured randomly at a particular point was found to be in the range of 120 nm. Lower resolution pictures demonstrates the nanoparticles were appended in a complex matrix which might be the herbal stabilizing components from the plant extracts of *Semecarpus anacardium, Plumbago zeylanica* and *Curcuma longa* alongside silver nanoparticle [10].

RESULTS AND DISCUSSION

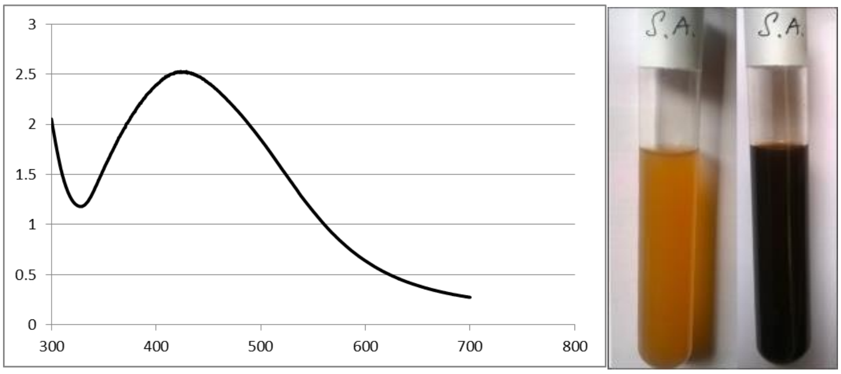
It is surely understood that silver nanoparticles show a dark yellowish-brown colour in aqueous medium because of excitation of surface plasmon vibrations of silver nanoparticles. Reduction of silver into silver nanoparticles could be trailed by a colour change and UV-Vis. spectroscopy measurement has turned out to be exceptionally helpful for the examination of nanoparticles [11-13].

The silver nanoparticles were observed by UV-Vis spectroscopy, a standout amongst the most broadly utilized systems for structural characterization of silver nanoparticles [14-15]. The absorption range (Figure 1, 2, 3 and 4) of the dark yellowish-brown silver-nano herbal complex arranged with the proposed technique demonstrated a surface plasmon band with a peak at 431 nm proving the presence of silver nanoparticles.

XRD investigation of the diffracted intensities were recorded from 10° to 70°at 2 theta angles. The diffraction design in Figure 6 relates to silver metal powder. The XRD design demonstrates that the nanoparticles had a cubical structure. The observed peak and noise were most likely identified with the impact of nanosized particles and the presence of different natural macromolecules in the plant extracts.

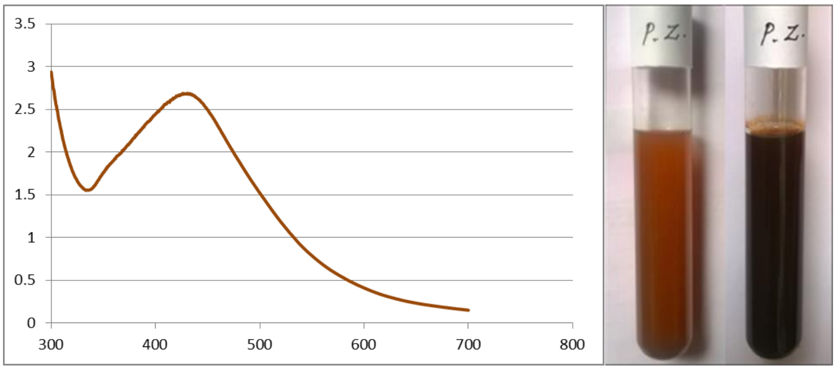
FTIR study produced characteristic peak (Figure 7) for silver nano metal oxide stretching and peaks corresponding to organic functional groups. This confirms phytochemical presence as reduction as well as capping agent in silver nanoparticle.

Structure of silver nanoparticle was confirmed by SEM pictures (see Figure 8 & 9). Scanning electron microscopy gave further knowledge into the morphology and size subtle elements of the silver nanoparticles. Correlation of test results demonstrated that the diameter of nanoparticles in the mix was around 120 nm. Figure 8 & 9 shows the scanning electron micrograph of silver nanoparticle reduced by selected plant extract.



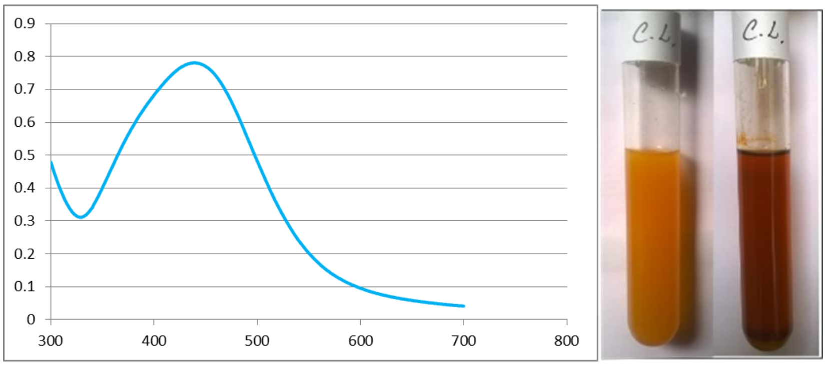
Maximum absorption 2.527 at 429 nm

Figure: 1 UV Spectra – Silver nanoparticle reduced by *Semecarpus anacardium* ext.



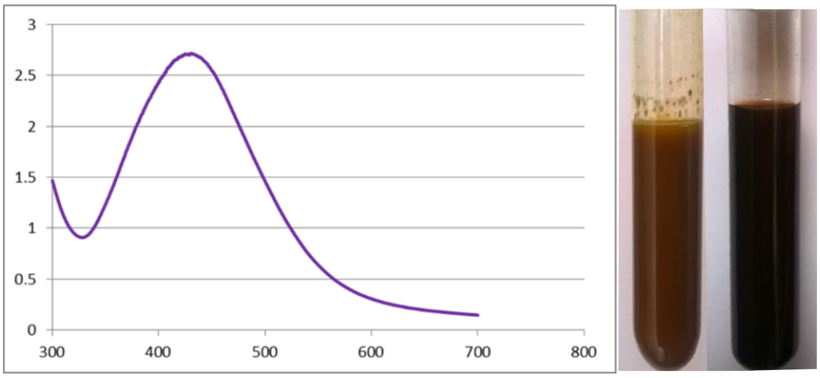
Maximum absorption 2.688 at 430.5 nm

Figure: 2 UV Spectra – Silver nanoparticle reduced by *Plumbago zeylanica* ext.



Maximum absorption 0.779 at 435 nm

Figure: 3 UV Spectra – Silver nanoparticle reduced by *Curcuma longa* ext.



Maximum absorption 2.717 at 431 nm

Figure: 4 UV Spectra – Silver nanoparticle reduced by combined ext. of *Semecarpus anacardium, Plumbago zeylanica* and *Curcuma longa*

Comparison of individual herb reduction potential of silver nanoparticle with combined extract

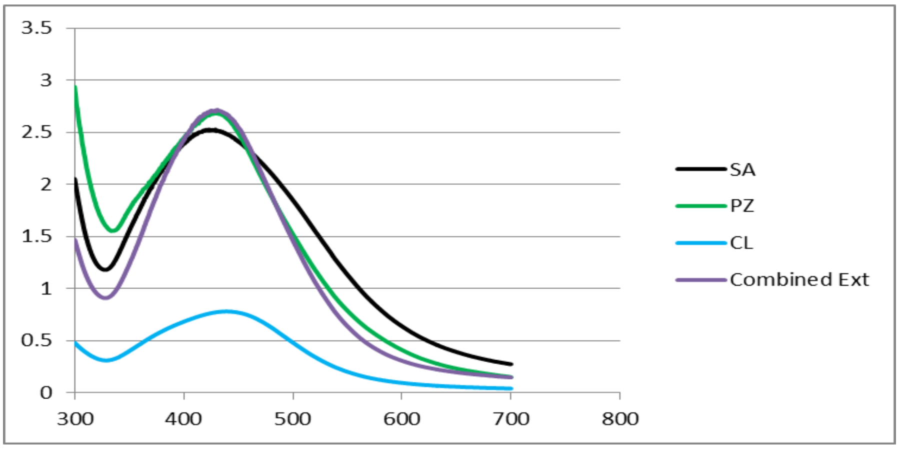


Figure: 5 Comparative study.
SA-*Semecarpus anacardium*, PZ- *Plumbago zeylanica*, CL- *Curcuma longa*

XRD – STUDY- of Silver-nano Herbal mix.

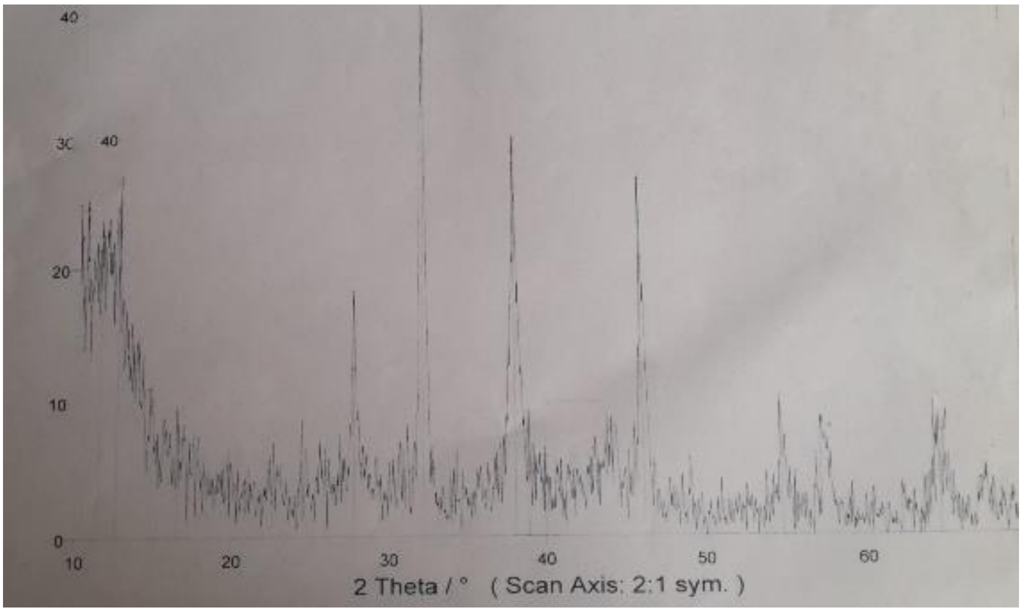


Figure: 6 XRD study of Silver-nano Herbal mix.

Scherrer equation $$D_P = \frac{K\lambda}{\beta_{1/2} \cos \phi}$$

K – Constant 0.94
λ - Wavelength of X-ray 1.54
$\beta_{1/2}$ – FWHM
Ø - Bragg angle

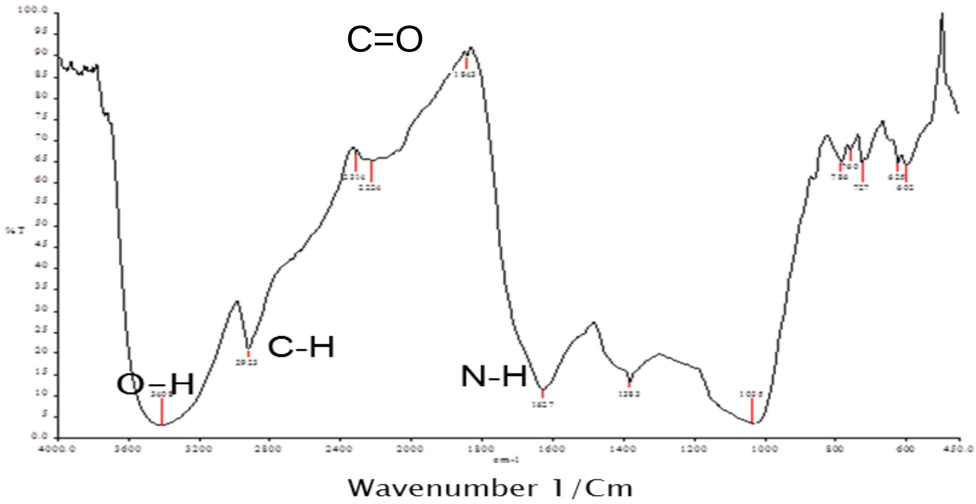


Figure: 7 FTIR study of Silver-nano Herbal mix

SEM – Analysis of Silver-nano Herbal mix.

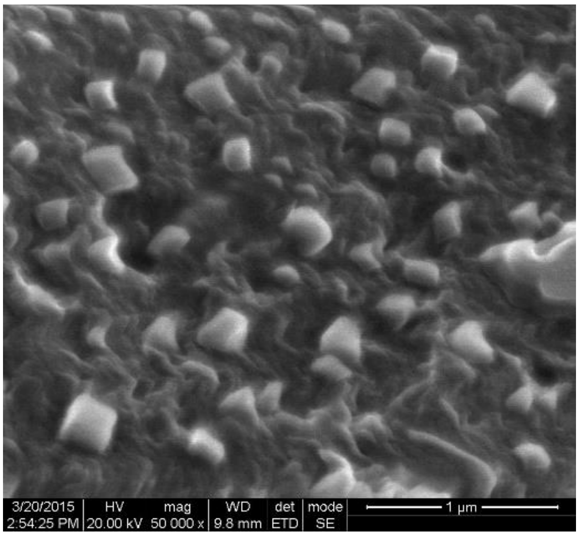


Figure: 8 SEM Analysis of Silver-nano Herbal mix

SEM – Analysis of Silver-nano Herbal mix.

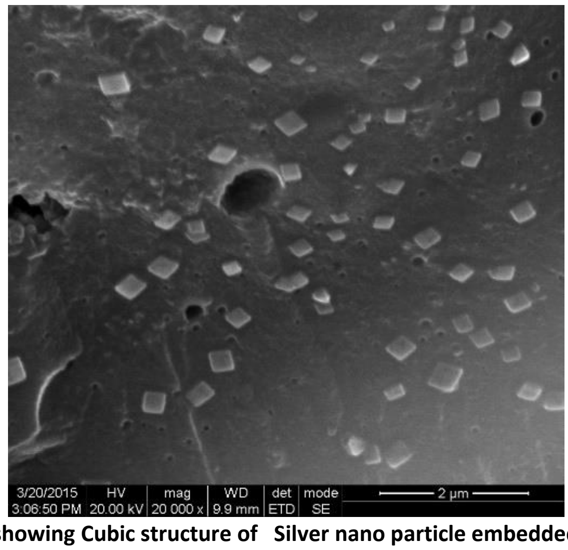


Figure: 9 SEM Analysis showing Cubic structure of Silver nano particle embedded in dense herbal matrix

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CONCLUSION

A basic need in the field of nanotechnology is the improvement of solid and eco-accommodating procedures to produce metallic nanoparticles. Here, we have reported a straightforward natural and minimal effort approach for planning of stable silver nanoparticles by reducing silver with aqueous extracts of plants as reducing agent. The qualities of the produced silver nanoparticles were contemplated using UV-Vis, XRD, FTIR and SEM procedures. The outcomes confirms the reduction of silver into silver nanoparticles with high dependability and with no contamination. Examination of exploratory results demonstrated that the normal size of synthesized silver nanoparticles was around 120 nm. Using aqueous extracts of herbals to synthesize nanoparticle is safe, simple and effective method.

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