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Fourier-transform infrared spectroscopy Analysis of Hexane/ Methanol extract of *Jatropha curcas* L. (Eupharbiaceae) Latex Silver Nanoparticles

Solesi, A. Obafemi[1], Solaja,O. Olatunde[2], Abiodun, A. Sunday[2], Adetoyi H. Nwakaego[2], Daini, T. Grace[3], Sowole Ayodele R[3]. and Aborisade Monininuola V[3].

[1] Department of Pharmaceutical Techniques, School of Basic Medical Sciences
[2] Department of Environmental Sciences and Diseases Control
[3] Department of Medical laboratory Technician
[1, 2, 3] Ogun State College of Health Technology, Ilese- Ijebu.

ABSTRACT

The utilization of plants in the biosynthesis of nanoparticles involves the content of secondary metabolites as reducing agents, and are being considered as the best candidates for synthesis of AgNps. Medicinal plants like Jatropha curcas have played a major role in treating various diseases, including bacterial and fungal infections. Fourier-transform infrared spectroscopy is a high-resolution analytical technique to characterize compounds using their functional group's contents in the compounds and the structure of the molecules. This study is aimed at the characterization of the reduction of silver nitrate to nanoparticles by Jatropha curcas latex utilizing Fourier-transform infrared spectroscopy. The latex of Jatropha curcas used in the biosynthesis of AgNPs gave a brown colour after incubation and this could be linked to the surface plasmon resonance of silver. The peaks ranged from 3242 per cm - 1043 per cm. The peak at 3242 per cm was assigned as – OH stretching in alcohol and phenolic compounds with strong hydrogen bonds. The peak of 2143 per cm is assigned with C≡C stretching in alkynes. The Peak at 1617.7 per cm that is relevant to the C=O bond of the carbonyl group and the stretching vibrations of amides also emerged in this range. The peak at 1442.5 per cm was assigned as P-C with organo-phosphorus (aromatic bond) compounds. The peaks ranged from 1222.8 per cm to 1013.8 per cm stretching and were assigned as C-O with ethers/ aromatics compounds. SEM analysis shows high-density AgNPs synthesized by jatropha curcas latex. It was shown that organic nanofibers, crystalline, are interconnected to each other forming three-dimensional network structures of AgNPs. This study showed that plants' latex and other parts might be used to biosynthesize AgNPs, which may be utilized by the pharmaceutical industries and other biomedical applications.

CONTACT Solesi Obafemi A Ogun, State College of Health Technology, Ilese-Ijebu, Nigeria Email: solesi.obafemi@gmail.com

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INTRODUCTION

Nanoparticles are particles with a size of 1–100 nm and, the nano-material has novel, distinct, and superior physicochemical properties with respect to its bulk structure, as a result of an increase in the spatial quantity of the material or the theparticle[1]. The utilization of plants in the biosynthesis of nanoparticles involves the content of secondary metabolites as reducing agents[2]. Biological agents had been identified as reducers, and stabilizers, sometimes acting as both in forming nanoparticles[3].

Medicinal plants like Jatropha curcas have played a major role in the treatment of various diseases, including bacterial and fungal infections. The scientific name of the physic nut is "Jatropha curcas." The genus name Jatropha derives from the Greek word jatr´os (doctor) and troph´e (food), which implies medicinal uses[4]. And it belongs to the Euphorbiaceae family, a shrub or tree that can withstand dryness, well distributed in the wild or semi-cultivated areas in any part of the world [5,6,7]. All of its parts have been used in folk fare medicine for centuries[8]. Plants can be employed for green synthesis, and are being considered the best candidates for the synthesis of AgNps[9]. It was also reported that nano-silver is non-toxic to humans at low doses[10,11].

Para and Bhanu[12] carried out the FTIR spectroscopic analysis of the methanol leaf extract of Ampelocissus latifolia for antimicrobial compounds. Similarly, Thangarajan Starlin and co[13] detected the elements and functional groups in the ethanol extract of the whole plant of Ichnocarpus frutescens using the FTIR spectroscopic method. Hence, this present study is to analyze the functional groups of bioactive compounds present in the Jatropha curcas Latex Silver Nanoparticles.

METHODS

Collection of Samples

A Fresh sample of crude latex of *Jatropha curcas* was collected from its stem by incision with a sharp sterile knife. The milky latex was stored air-tight in a brown bottle and refrigerated at 4 °C for other use.

Production of Silver Nanoparticles (AgNPs)

The hexane/ methane (1:1) extract of the *Jatropha curcas* latex was used for the biosynthesis of silver nanoparticles. One hundred milliliters of 1 mM of the aqueous solution of silver nitrate (AgNO3) was prepared in 250 mL Erlenmeyer flasks and 40 mL of 3 % of the hexane/ methane latex extract was added into labelled conical flasks for the bio-reduction of the silver- nitrate (AgNO3) into Silver (Ago) ions. This mixture was observed for colour changes and later placed in an incubator for the complete bio-reduction at a temperature of 37ºC for 24 hours to 72 hours[14].

Characterization of *Jatropha Curcas* Latex extract Silver Nanoparticles

Visual observation

The gradual colour change of the mixture in the Erlenmeyer flask was visually observed and noted.

Ultraviolet-visible spectra analysis

The optical property of the formed AgNPs was characterized by using 1 ml samples of the suspension collected periodically in order to allow for the monitoring of the completion of bio-reduction of Ag+ in an aqueous solution, followed by dilution of the samples with 2 ml of deionized water and subsequent scan in UV-visible (vis) spectra, between a wavelength of 200-900nm in a spectrophotometer having a resolution of 1 nm. The UV-Visible spectra were recorded at intervals of 24, 48 and 72 hours.

Scanning Electron Microscopy Analysis (SEM)

The Jatropha curcas latex extract silver nanoparticles were characterized for nanoparticles shape with a scanning electron microscope (ZEISS EVO-MA 10, Oberkochen, Germany)[15].

Fourier-Transform Infrared Spectroscopy

Analysis Fourier-Transform Infrared (FTIR) was done to identify the functional and composition of silver nanoparticles. The analysis of the dried SNPs was carried out through the potassium bromide (KBr) pellet (FTIR grade) method in a ratio of 1:100[16]. The spectrum was recorded using JASCO FT/ IR-6300 Fourier transform infrared spectrometer equipped with JASCO IRT-7000 Intron Infrared Microscope using transmittance mode operating at a resolution of 4 per cm.

RESULTS

Visual observations

Plate 1: Visual observations of the bio-synthesized AgNPs

Ultra-Violet spectra of the AgNPs

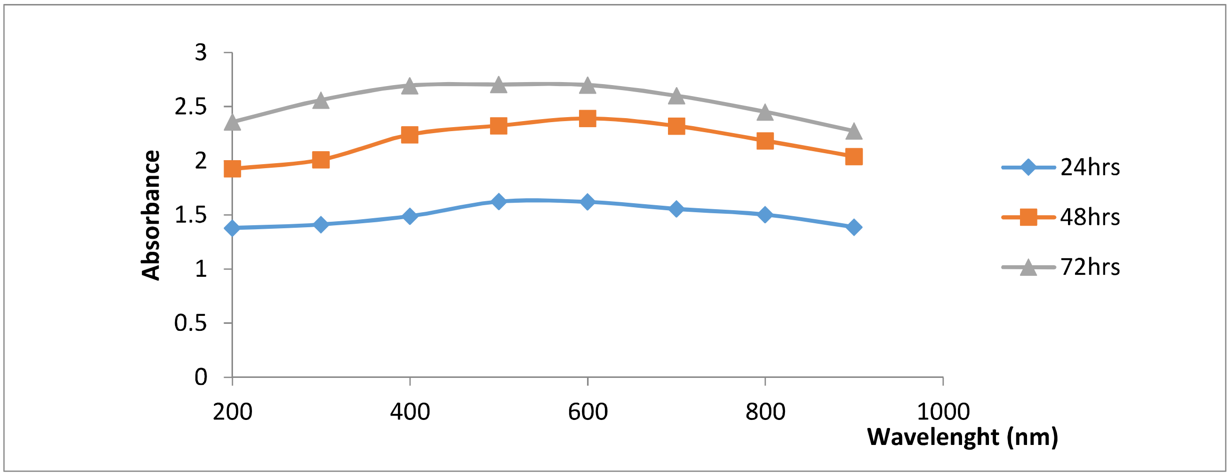

Figure 1: shows UV the spectra of the AgNPs produced using the latex of *Jatropha curcas*.

In Figure 1, at 24 hours and 48 hours the peak was at 500 nm, and at 72 hours there was Surface Plasmon Resonance at 400 nm peak.

Scanning Electronic Microscopy

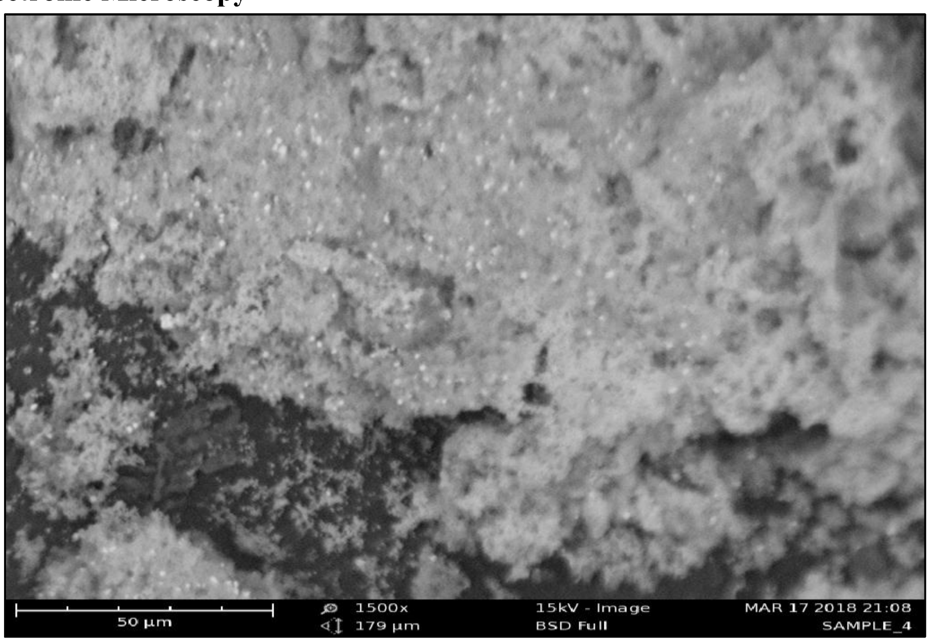

Figure 2: SEM image for AgNPs using *Jatropha curcas* latex white (mag.1500X)

SEM analysis shows high-density AgNPs synthesized by Jatropha curcas latex (Figure 2). It was shown that organic nanofibers are interconnected to each other forming three-dimensional network structures of AgNPs.

Fourier-Transform Infrared Spectra

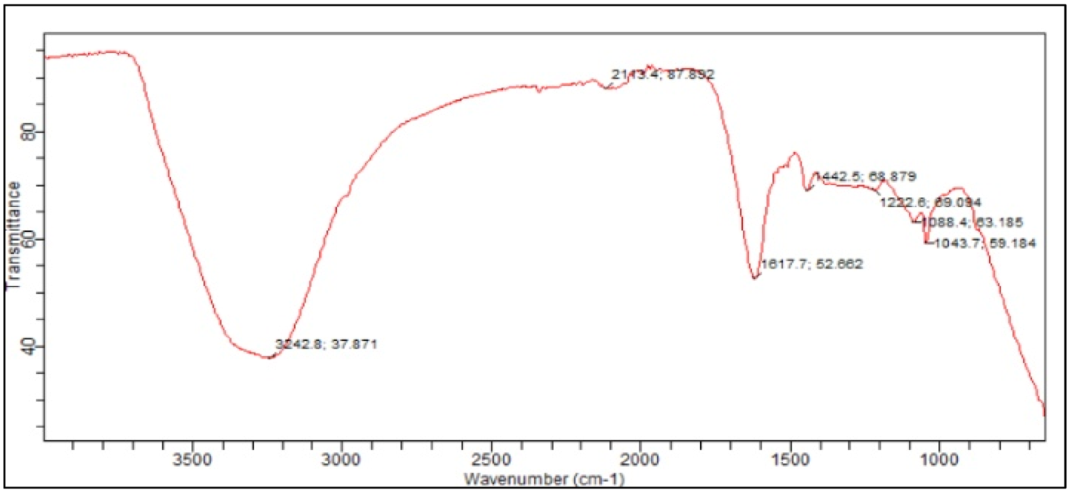

Figure 3, FTIR spectra of *Jatropha curcas* latex.

In Figure 3, Seven peaks were observed which ranged from 3300- 1045 per cm. The peak at 3242 per cm was assigned as – OH stretching in alcohol and phenolic compounds with strong hydrogen bonds. The peak of 2143 per cm is assigned with C≡C stretching in alkynes. The Peak at 1617.7 per cm that is relevant to the C=O bond of the carbonyl group and the stretching vibrations of amides also emerged in this range. The peak at 1442.5 per cm was assigned as P-C with organo-phosphorus (aromatic bond) compounds. The peaks ranged from 1222.8 per cm to 1013.8 per cm stretching and were assigned as C-O with ethers/ aromatics compounds.

DISCUSSION

Nanotechnology is a new form of technology which has great development in various fields. Due to the unique features and applications of the nanoparticles, they are very useful, especially in the field of biotechnology, medical imaging and catalysis.

UV-vis spectra confirmed the synthesis of *J. curcas* nanoparticles as evident from the peak at 600 nm (Figure 1). The UV-vis spectra showed surface plasmon resonance (400nm) at 72hr. The change in colour from milky white to deep brown with time is due to excitation in surface plasmon resonance (**plate 1**). There is no colour change in *J. curcas* latex extract and AgNO3 solution alone, confirming that components from latex extract actually reduced the metallic silver into AgNps.

SEM analysis shows high-density AgNPs synthesized by *jatropha curcas* latex. It was shown that organic nanofibers (crystalline) are interconnected to each other forming three-dimensional network structures of AgNPs.

Organic functional groups like OH, N=O, and C=O linked to the surface of nanoparticles are found by FTIR[17]. FTIR spectra of the latex of Jatropha curcas showed a pattern of spectra which ranged from 3242.8 per cm– 1043.7 per cm. The vibrational bands (FTIR) observed in the Jatropha latex-AgNps indicated the presence of various secondary metabolites such as flavonoids, phenols, glycosides, terpenoids, and tannins which were earlier reported for synthesis and stabilization of nanoparticles[18].

CONCLUSION

This study was able to confirm that silver nanoparticles were produced using *Jatropha curcas* latex, being simple, cost-effective, and secure in production. UV – vis. spectrophotometer and SEM techniques have confirmed the reduction of $AgNO_3$ to AgNps.

FTIR analysis as shown in the study reflected the possible involvement of amines, aromatic groups, -OH in the reduction process and may act as the reducing and capping agents.

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