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SYNTHESIS OF SILVER NANOPARTICLES FROM *LANNEA ACIDA* VIA AQUEOUS AND METHANOLIC LEAF EXTRACT

***Kamal Danazumi, Ahmad Muhammad Sani, Alhassan Kabir Usman and Abdullahi Usman Umar**

Department of Pure and Applied Chemistry, Kaduna State University

*Corresponding authors' email: danazumikamal@gmail.com
ORCID: https://orcid.org/0009-0002-2861-3100

ABSTRACT

The reducing ability of plant extract cost-effectiveness is the major factor to consider in the green synthesis of metal nanoparticles. The present study investigates two different extraction methods for the green synthesis of silver nanoparticles (AgNPs) via aqueous and methanolic Lannea acida leaf extract for the first time. The effect of silver nitrate concentration, and quantity of the silver nitrate (volume) on that of plant extract and studied by UV–Vis spectroscopy and Fourier-transform infrared (FT-IR) spectroscopy. The methanolic extract silver nanoparticles show a remarkable difference compared to silver nanoparticles synthesized from the aqueous extract, this is ascertained that methanol has the potential applications than the silver nanoparticles synthesized from aqueous extract.

Keywords: Silver nanoparticles, Green synthesis, Extraction methods, *Lannea acida*, UV–Vis spectroscopy

INTRODUCTION

Nanomaterials are found as important and keep growing in the field of Nanoscience and Nanotechnology and in recent years researchers have invested much effort in the synthesis and applications of various nanomaterials, due to their potential applications in science and industry. For example, biocompatible nanomaterials are applied directly or they are used to replace natural materials to function or to be in contact with the living systems.(Ghoranneviss et al., 2015). Nanomaterials possess unique properties, owing to their nanoscale dimensions, that can be used to design novel technologies or improve the performance of existing processes. (Manikandan et al., 2019)

Nanoparticles (NP) have been shown to have various useful applications. They are generally synthesized using chemical processes involving hazardous chemicals. Therefore, green synthesis of NPs using natural products can be an environmentally friendly alternative (Joshi et al., 2018)

Nanoparticles made from biological entities have the potential to provide new sources of non-toxic, cost-effective, and environmentally acceptable materials that can be rapidly scaled up and manufactured utilizing a green chemistry technique. While biological entities have been extensively used to produce nanoparticles(Mamuru et al., 2022).

Due to their distinct physical and chemical characteristics, silver and iron oxide metal nanoparticles have drawn the most attention among other nanoparticles for use in electrochemical, bioelectrochemical, and electroanalytical applications. (Ahmed et al., 2016; Ong et al., 2018)

The natural chemical compounds and structurally varied bioactive chemicals found in plants are their reservoirs. The identification of novel biomolecules that the pharmaceutical and agricultural industries can employ directly or as a lead molecule to synthesize more potent chemicals requires the extraction of bioactive components from plants and the quantitative and qualitative assessment of those compounds. (Nasseri et al., 2019)

This paper mostly highlighted the analysis methodologies, which include the extraction methods and the analysis and identifications of bioactive compounds present in the plant extracts through various techniques such as UV vis and FTIR

MATERIALS AND METHODS

Experimental procedures

Fresh leaves of *Lannea acida* were obtained from the Faculty of Earth and Environmental Sciences, Bayero University, Kano. rinsed thoroughly with water to remove dirt and sand particles, then air dried at room temperature for one week to remove moisture and pulverized into a powdered form using mortar and pestle and stored in a closed container for further usage.

Scheme 1: Cold synthesis method

A total of 5g of powdered *Lannea acida* was measured and then macerated with n-hexane 200 ml. The mixture was kept at room temperature for 48 hours, while occasionally shaking and stirring. The solution was filtered using a Whatman number 1 filter paper and collected in an airtight container. The same procedure was repeated using ethyl acetate 200 ml and aqueous methanol (60%) filtered and stored extract for later use.

Alongside 0.02M $AgNO_3$ was prepared by dissolving 3.3974 g of silver nitrate salt into 1000 ml volumetric flask and making it to the mark with distilled water. The solution was properly shaken to allow it to homogenize for at least twelve hours. (Badmapriya and Asharani, 2016). To 10 ml of the extract 10 ml of 0.02M $AgNO_3$ was added, the reduction of metal ions was confirmed by visually observing a color change from light brown solution to dark brown precipitates to indicate the formation of silver nanoparticles, to the same volume of extract 20 and 30 ml of aqueous $AgNO_3$ was added in the ratios of 1:1, 1:2 and 1:3 extract to $AgNO_3$. Filtered, dried at room temperature and preserved for further characterizations of silver nanoparticles (LALC).

Scheme 2: Hot synthesis method

A 5.0 g of powdered *Lannea acida* was weighed and transferred into a 500 ml beaker containing 200 ml deionized water, boiled at 100℃, allowed to cool at room temperature and filtered the extract was stored for further use. To 10ml of the extract 10 ml of 0.02M $AgNO_3$ was added, and the reduction of metal ions was confirmed by visually observing a color change from light brown solution to dark brown precipitates to indicate the formation of silver nanoparticles, to the same volume of extract 20 and 30 ml of aqueous $AgNO_3$

was added in the ratios of 1:1, 1:2 and 1:3 extract to $AgNO_3$. Filtered, dried at room temperature and preserved for further characterizations of silver nanoparticles (LALH). (Baharara et al.,2014)

RESULTS AND DISCUSSION

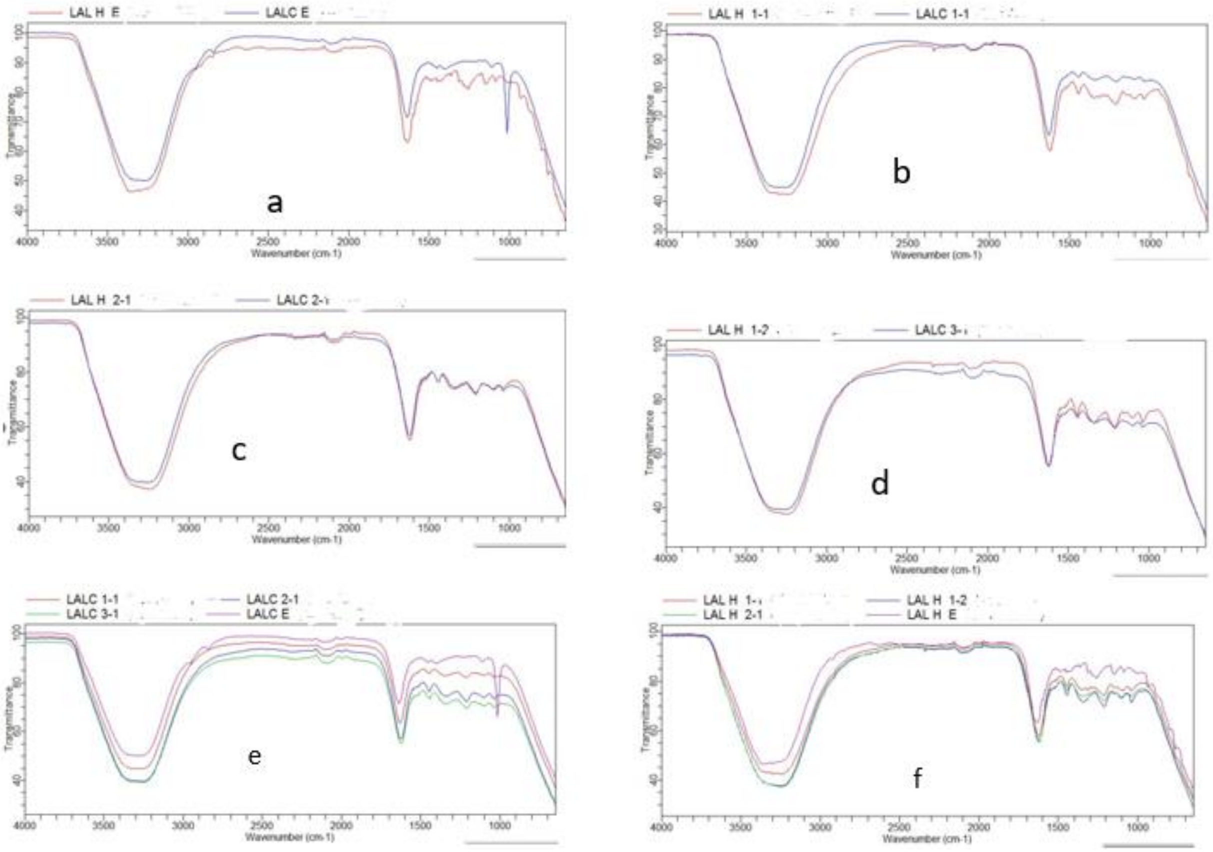

Figure 1 Fourier-transform infrared (FT-IR) spectroscopy obtained from cold and hot extraction method all together in in fig. 1(a-d); red signal stands for hot extraction while blue signal stands for cold extraction method.

Fig. 1(a) obtained from two different extracts without $AgNO_3$. fig. 1(b) stands for extract/ $AgNO_3$ ratio (1:1) extract to $AgNO_3$ ratio. fig. 1(c) stands for1:2 and fig. 1(d) stands for 1:3 extract to $AgNO_3$ ratio.

Fig. 1(e) combined all the signals obtained for cold extraction ranging fron the extract (LALCE) to 1:3 (LALC 1:3) samples. Fig. 1(f) combined all the signals obtained for hot extraction ranging fron the extract (LALHE) to 1:3 (LALH 1:3) samples. This indeed showed the significant of using cold extraction (maceration) and in turn the differences between the two extraction methods.

FTIR analysis of silver nanoparticles was performed in the wavenumber range of 700-4000 cm^{-1}. The graphs obtained from hot synthesis method (LALH) indicate the presence of various chemical groups, 765, 803, 933, 1089, 1149,1216, 1346,1626, 2117,2344 and 3245cm^{-1}absorption bands as 1346,1626, 2117, 2344 and 3245 are the major peaks from hot synthesis method (LALH) and absorption peaks are silver nanoparticles obtained corresponding to C=O vibrations of oxygen, C=C stretching of alkenes (1622 and 1626 cm^{-1}), then C=C stretching of alkenes (2117 cm^{-1}), N-H stretching of nitrogen groups (3245 cm^{-1}), and N-H stretching of aliphatic groups figure 1(a-d). Similar signals also appeared at 1019, 1216, 1346, 1451, 1629, 1640, 2843 and 3264cm^{-1} from the cold synthesis method (LALC). Additionally, the peaks at 1216 and 2843 cm^{-1} are due to strong aromatic C-H bond and 1346 cm^{-1} due to N=O bonds. all these indicate the presence of silver nanoparticles. The presence of a strong absorption band at 1640cm^{-1} is due to C=O of nitrogen group and C=C bond of unsaturated alkenes, the absorption band at 2843cm^{-1} is due to C-H bond of secondary amines. (Anith Jose et al., 2022)

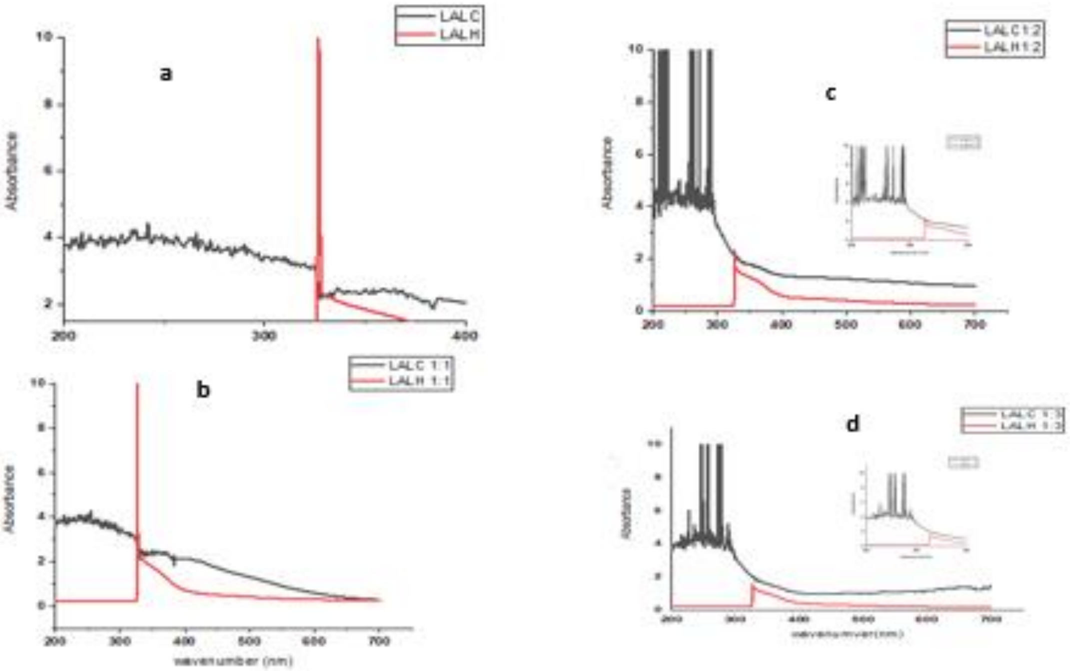

Figure 2. UV vis spectroscopy for LALE & LALC (a), LALC 1:1 & LALH 1:1 (b), LALC 1:2 & LALH 1:2 (c), LALC 1:3 & LALH 1:3(d) extract to $AgNO_3$ ratios.

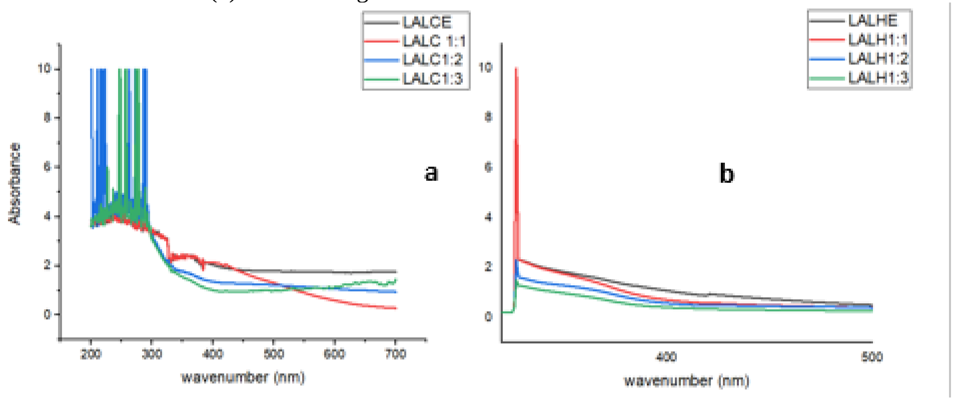

Figure 3. Comparative UV vis spectroscopy for cold synthesis method-LALC(a), and hot synthesis method-LALH(b). showing differences between the two different methods.

The effects of manifested more in 3a, the effect of variation in the quantities of $AgNO_3$, as well as positions of peaks indicating formations of silver nanoparticles also well cleared compared to 3b with a position of a weak signal.

The optical characteristics of silver nanomaterials, including absorption, transmission, reflection, and light emission, are dynamic and can deviate greatly from those of bulk materials. Figure 2b-d (black ink) illustrates the UV absorption spectra of the silver nanoparticle solution, which reveal an absorption peak at 388.27, 440.27 and 421.2 nm in the visible range. The graphs indicate a significant absorption peak for the samples of silver nanoparticles.

For every silver nanoparticle made from *lannea acida*, UV-Vis spectroscopy is obtained and confirms the presence of silver nanoparticles by the peak, which is observed in the 200–700 nm region.

The absorption spectra obtained by UV-Vis spectroscopy are accurate in establishing the existence of silver nanoparticles since these silver nanoparticles, due to the surface plasmon excitation phenomenon in the UV region, present a high absorption peak. The absorption band of 420 nm is typical for silver nanoparticles. The band is approximately 400–450 nm in diameter when the size of the silver nanoparticles is less; however, it can reach up to 495 nm in diameter when the size of the particles grows. The development of bands and photon excitation are significantly influenced by the size of the nanoparticles. The different sizes of the produced silver nanoparticles had a significant impact on the color change of the particles as well. (Anith Jose et al., 2022)

CONCLUSION

Among the two different methods; cold extraction (LALC) and hot extraction (LALH) method, cold extraction gives a better synthesis method looking at the nature of the signals that appeared from the spectrum, and the more the quantity of $AgNO_3$ added to extract the more the silver ions can be reduced and stabilized by *lannea acida* extract to AgNPs, lastly, LALC 3:1ratio gives better silver nanoparticles AgNPs.

RECOMMENDATION

X-ray diffractometry (XRD) and SEM analysis should be carried out to know the actual particle size

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