Materials and its Characterization

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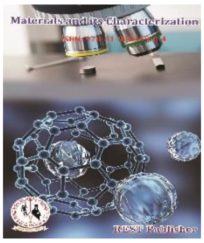

Green synthesis of silver nanoparticles using Mangifera indica leaves and Rose petals extract and their characterization

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Abstract: *Green synthesis of silver nanoparticles using plant extract are considered as eco-friendly method due to it environmentally safe and simple process. It is known that plants are rich in phytochemicals, hence synthesis of silver nanoparticles (Ag NPs) is viable methods. In this paper, we have synthesized silver nanoparticles using Mangifera india leaves and Rose petals extract. The structure of the Ag NPs was confirmed by UV-Vis, FTIR, XRD and SEM-EDAX analysis. From the results and discussion, it is concluded that these extracts can used as natural reducing agent.*

Keywords: *Mangifera indica, Rose petals, Silver nanoparticles, Morphology*

1. INTRODUCTION

Nanotechnology is referred to the term for manufacture, portrayal, manipulation, and application of structures by controlling shape and size at nanoscale (Sarsar et al. 2013). The field of nanotechnology is the most dynamic region of research in material sciences and the synthesis of nanoparticles (NPs) is picking up significantly throughout the world. NPs show totally novel or enhanced properties taking into account particular characteristics, i.e., size (1–100 nm), shape, and structure (Slawson et al. 1992). Ag-NPs have a substantial surface zone which results into noteworthy biochemical reactivity, catalytic activity, and atomic behavior compared with bigger particles having same chemical composition (Xu et al. 2006). In bottom-up approach, chemical reduction is the most general method for the synthesis of Ag-NPs (Chitsazi et al. 2016). Various organic and inorganic reducing agents in aqueous or non-aqueous solutions are used for the reduction of Ag ions, for example, poly-ethylene glycol block copolymers, sodium citrate, Tollen's reagent, Ascorbate, essential hydrogen, NN-dimethyl formamide, and sodium borohydride ($NaBH_4$) (Tran and Le 2013). Capping agents are additionally used for size stabilization of the NPs. One of the greatest advantages of this method is that a substantial number of NPs can be synthesized in a short period of time. During this sort of synthesis, chemicals used are toxic and prompted non-ecofriendly byproducts. This is the reason that leads to biosynthesis of NPs by means of green route that does not use toxic chemicals, and henceforth demonstrating to turn into a developing wanton need to develop environment friendly process. Therefore, the development of green synthesis of Ag-NPs is advancing as a key branch of nanotechnology where the use of biological entities like plant extract or plant biomass, microorganisms for the generation of NPs could be an alternative to chemical and physical methods in an eco-friendly way (Reddy et al. 2012). The advancement of green synthesis over physical and chemical methods are environment friendly, cost-effective, and easily scaled up for vast scale synthesis of NPs, while high-temperature, energy, pressure, and harmful chemicals are not required for green synthesis (Ahmed et al. 2016b). Hence, this review describes the green-inspired synthesis of Ag-NPs that can provide advantage over the physical and chemical methods. Synthesizing nanoparticles using plant extracts offers several advantages compared with other green synthesis methods because plants are eco-friendly and easy to handle (Pallela et al., 2018). Moreover, it offers energy efficiency, low toxicity, high yield, time-cost-effectiveness, and availability. Phytochemicals in plants, such as neo-clerodane flavonol glycosides, ergosterol, iridoid glycosides, phytoecdysones, and other polyphenols, play an essential role in the green synthesis of nanoparticles as reducing, capping, and stabilizing agents (Afreen et al., 2020). Its further reduction to Ag^+ leads to the formation of silver nuclei, resulting in the production of AgNPs. For example, the peel extract of Punica granatum contains kaempferol, flavonoids naringin, and glycosides. All these molecules have OH groups that can reduce Ag^+ ions, leading to the formation of AgNPs. A potential mechanism of producing AgNPs using Tulsi leaf extract revealed that the quercetin found in this plant reacts with Ag^+ ions as the OH groups attach to the carbon atoms of aromatic rings, leading to the reduction of Ag^+ to nanoparticles. Plant extract and $AgNO_3$ concentrations increasing the plant extract concentration in the reaction mixture can increase the absorbance intensity (Ahmed et al., 2016; Anandalakshmi et al., 2016). When using high extract concentrations, biomolecules act as reducing agents and cover the nanoparticle surfaces, preventing them from aggregating and increasing their stability (Khalil et al., 2014). Various plant extracts such as Breynia vitis-idaea leaves (Ruby et al. 2022), Crinum latifolium leaf

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(Vo et al. 2019), Hybanthus enneaspermus whole plant (Suman et al. 2016), Coleus aromaticus leaves (Ramkumar et al. 2016), Amaranthus gangeticus (Kolya et al. 2015), Malpighia emarginata extract (Sherly Arputha Kiruba et al., 2015), Leaf and stem extract of Piper nigrum (Paulkumar et al. 2014), Eclipta prostrate (Rajakumar and Rahuman, 2011) and Acalypha indica leaf (Krishnaraj et al. 2010) are some of the examples for green synthesis of silver nanoparticles using plant extract.

2. MATERIALS AND METHODS

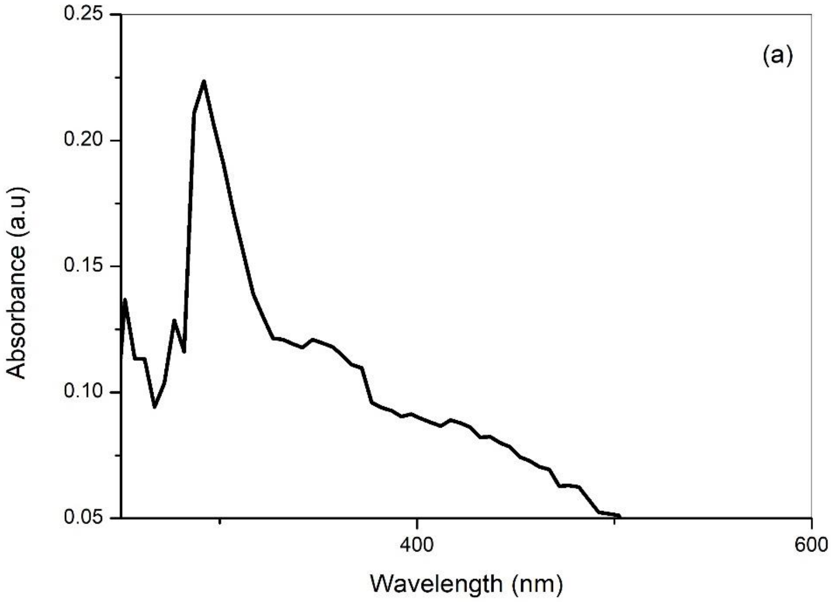
Silver nitrate (AR) grade was purchased from LobaChemie Pvt Ltd, Mumbai. Solutions were prepared in distilled water. Fresh Mangifera indica leaves and Rose flowers were collected in Tiruvannamalai and washed in running tap water followed by distilled water. The leaves were dried in shade and powdered. The powder, 50 g was added to distilled water and boiled for 30 min at 85ºC. The extract was filtered and stored in refrigerator for further application. Mangifera indica leaves and Rose flower extracts used for the synthesis of silver nanoparticles. The green synthesis of silver nanoparticles occurred during the exposure of Mangifera indica leaves and Rose flower extracts to 0.1 M solution of silver nitrate solution. The extract quantity extract used was 10 ml in 50 ml of 0.1 M silver nitrate solution respectively. The colour change in reaction mixture from colourless to light brown was observed, because of the formation of silver nanoparticles which is able to produce the particular colour in the reaction mixtures due to their specific properties. The formation of silver nanoparticles was monitored by visual colour change and simultaneously by UV-Visible spectroscopy. The intensity of the colour increased with increasing dosage of the extract which is due to the excitation of Surface Plasmon Vibrations in the metal nanoparticles. Colour change in mango leaves extract is found to be very rapid. The colour exhibited by metallic nanoparticles is due to the coherent excitation of all the "free" electrons within the conduction band, leading to an in-phase oscillation which is known as Surface Plasmon resonance absorption band.

FIGURE 1. Mango leaves extract before adding silver nitrate solution

Initial characterization of the synthesized Ag NPs was performed using Shimadzu UV 2450, Japan. The identification of functional groups was done using a FT-IR spectrophotometer (JASCO FT-IR 4700). The size, morphology and elemental composition of Af NPs were examined using FE-SEM, EDAX (SIGMA, CARL ZEISS, Germany).

3. RESULTS AND DISCUSSION

UV-Visible spectroscopy is one of the most important techniques to ascertain the formation and stability of the metal nanoparticles in aqueous solution. A comparative study was carried out to investigate the effect of extract concentration on the shape and size dispersity of the silver nanoparticles. By employing the variable volume of extract (10 ml) with 1 ml of 0.1M $AgNO_3$, the influence of the extract concentration on the rate of bioreduction and size of the target product was studied. The amount of the extract is found to play a significant role in size distribution of silver nanoparticles. Figure 1 (a and b) show the UV-Visible absorption spectra of the silver colloids recorded at various time intervals produced by the reduction of 1 mM AgNO3 with 10 ml extract. The absorption spectra recorded for the reaction mixture disclose the production of silver nanoparticles within 10 min. The appearance of a weak plasmon curve indicates the formation of a few nanoparticles formed in the solution. The intensity of the absorption bands increased with the progress of the reaction without any shift in the peak wavelength. Similarly, the spectra were recorded for 20 minutes. The UV-Visible spectrum of Ag NPs (a) and (b) show absorbance at 417 and 418 nm confirmed the formation Ag NPs.



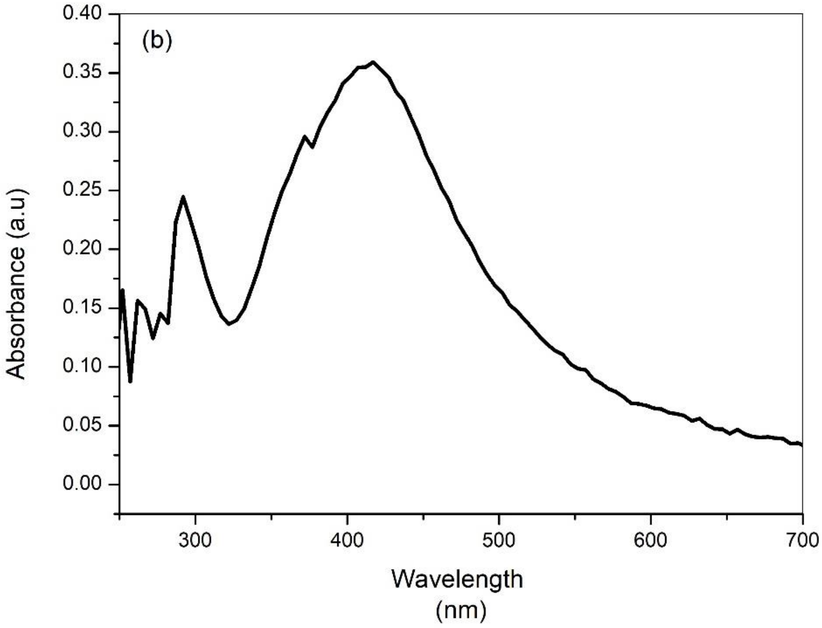


FIGURE 2. UV-Visible spectrum of AgNPs synthesized using mango leaves (a) extract and Rose extract (10 ml) (b).

A number of bands are seen within the region of 400-4000 cm^{-1}. Different functional groups were involved in the reduction of silver ion to silver nanoparticles. FTIR spectra of silver nanoparticles showed medium or strong absorption bands at 3420, 2926, 2370, 1632, 1383, 1226, 1067 and 824 cm^{-1} for mango leaves extract. The peak at 3420 cm^{-1} is assigned to O-H stretching of alcohol and phenol compounds, the presence of peak at 2926 cm^{-1} is assigned to aliphatic C-H stretching in methyl and methylene groups and the peak at 1632 cm^{-1} is due to C=O stretching vibration in carboxylic acid. FTIR spectrum of mango leaves extract is shown in Figure 2 (a and b).

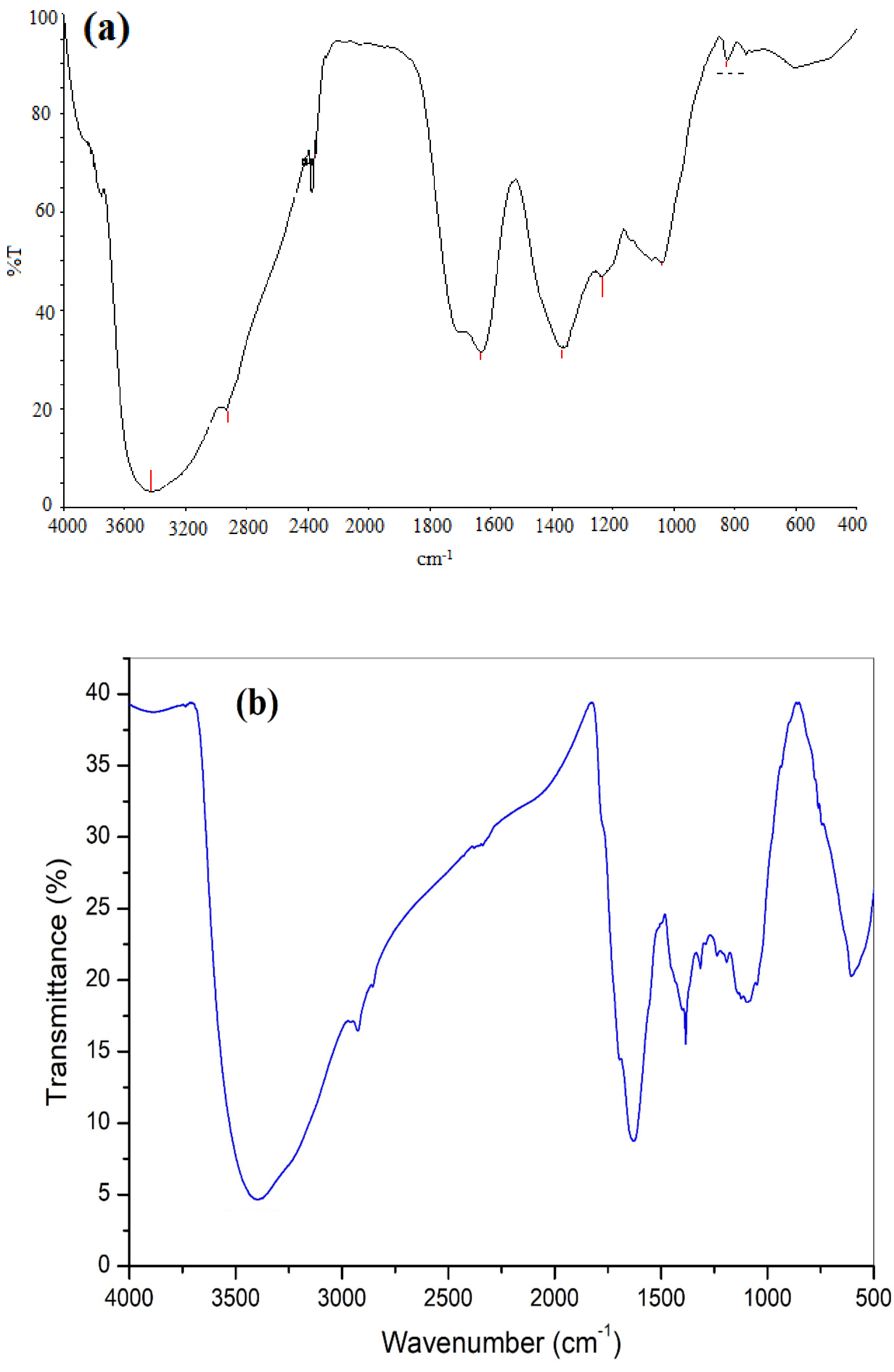


FIGURE 3. FTIR spectra of Ag NPs synthesized using mango leaves (a) and Rose extract (b) for the identification of biomolecules.

The crystalline nature of silver nanoparticles prepared using mango leaves and Rose extract was investigated by XRD pattern is shown in Figure 3 (a and b).

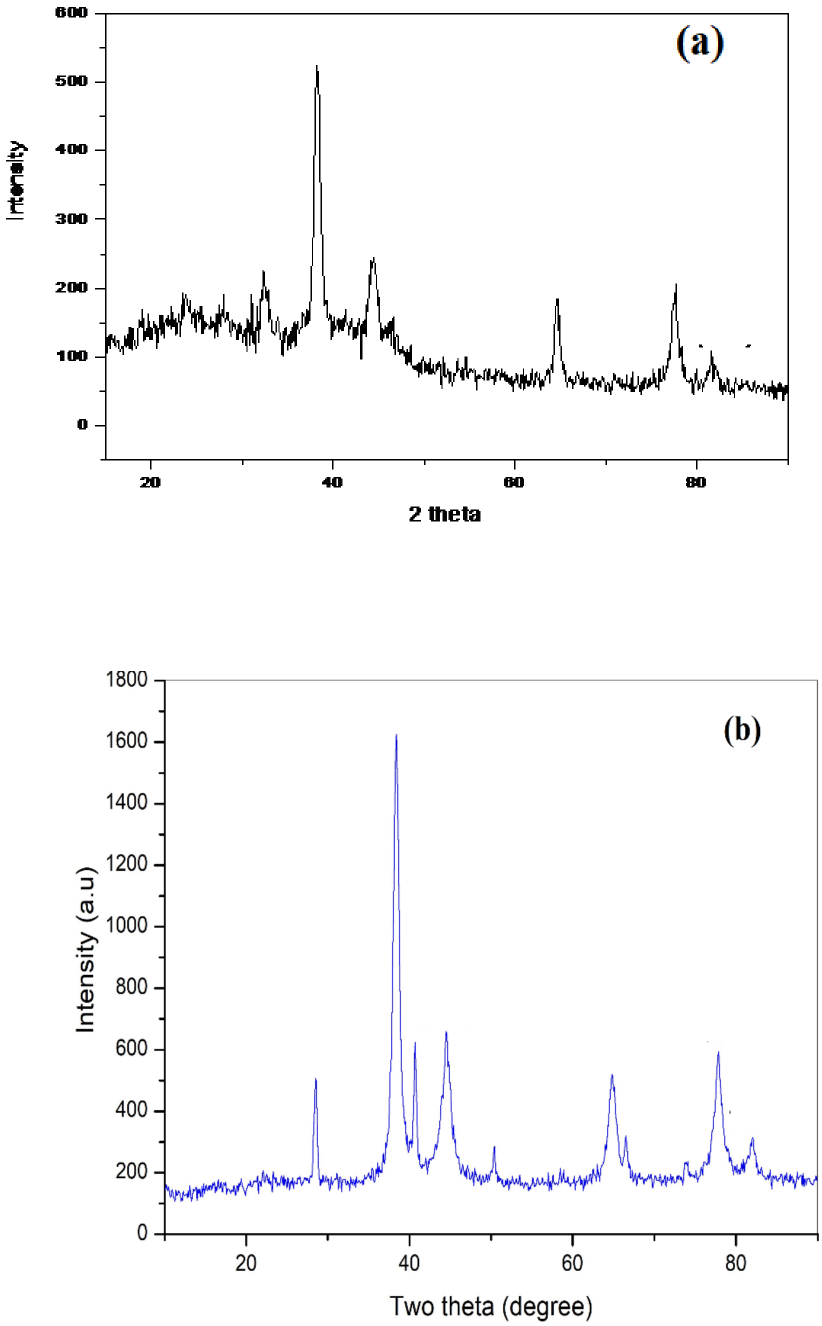


FIGURE 4. XRD pattern of silver nanoparticles synthesized using mango leaves (a) and rose flower extract (b) All the peaks at 2θ values of 38.2, 44.4, 64.6, 77.6 and 81.60 represent (111), (200), (220), (311) and (222) Braggs' reflections of face centered cubic structure of silver, confirms the formation of silver nanoparticles using mango leaves extract which confirms the face-centered cubic structures (JCPDS No. 87-0720) of silver. These indexed peaks are closer to the reported standard data of Joint Committee on Powder Diffraction Standards (JCPDS No. 87-0720) indicating the presence of metallic silver in the face centered cubic lattice. The peak corresponding to the (111) plane is more intense than the other planes. The ratio between the intensity of the (200) and (111) diffraction peaks is much lower than the usual value (111), suggesting that the (111) plane is the predominant orientation. A few unassigned peaks are also noticed in the vicinity of the characteristic peaks. These peaks might have resulted due to the stabilization of the nanoparticles by the capping agent. Intense Bragg reflections suggest the strong X-ray scattering centers in the crystalline phase could be due to capping agents Figures 4 (a and b) show the SEM images of silver nanoparticles synthesized using mango leaves extract. The size of the silver nanoparticles measured is in the range from 13.52 to 41 nm. SEM images have shown individual silver particles as well as a number of aggregates. From the SEM micrograph, it can be observed that, the shape of the silver nanoparticles is spherical and these spherical particles aggregated into large structure. The nanoparticles are not in direct contact within the aggregates, indicating stabilization of the nanoparticles by a capping agent. The presence of secondary materials capping with the silver nanoparticles may be assigned to bio-organic compounds from leaf extracts.

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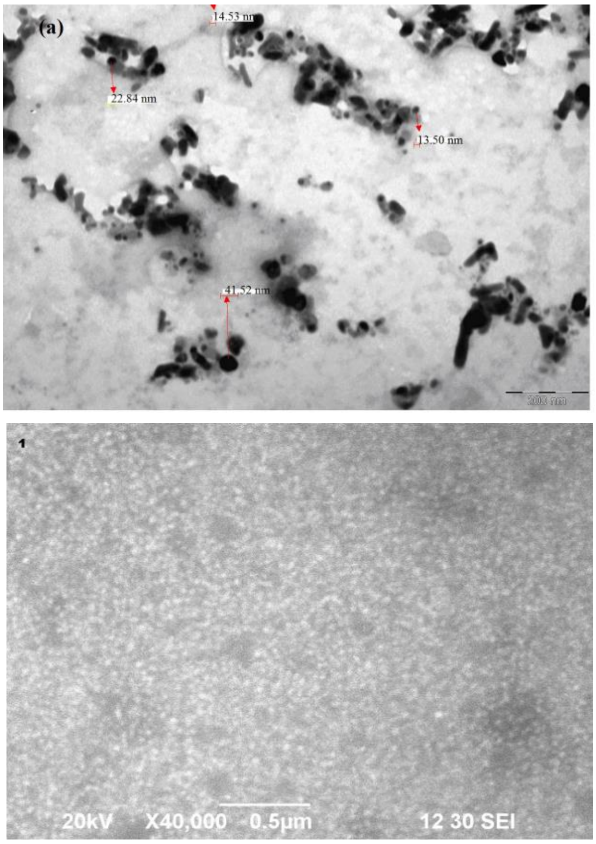

FIGURE 5. (A) SEM images of silver nanoparticles synthesized using 1 mM silver nitrate extract with 10 ml of mango leaves extract. It is believed that Mangifera indica leaves and Rose petals are rich in Polyphenols, flavonoids, and other phytochemicals, which react with silver nitrate to produce silver nanoparticles.

4. CONCLUSION

UV-Visible study reveals the formation of silver nanoparticles using Mangifera indica leaves extract. FTIR spectrum of the Mangifera indica leaves confirmed the presence of phytochemicals. XRD spectrum confirmed the crystalline structure of the silver nanoparticles. SEM analysis confirmed the formation of spherical particles. From the results and discussion, it is concluded that Mangifera indica leaves extract can be used as a natural reducing agent for the synthesis of silver nanoparticles.

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