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Eco-friendly synthesis, optical and morphological studies of silver nanoplates using Moringa Oleifera Gum extract

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Abstract

The work reported the easiest and cheapest way of achieving silver nanoplates (Ag NPs) using aqueous Moringa Oleifera gum extract as a nanoplate growth medium at room temperature. This synthetic method involved the formation of Ag NPs using Moringa Oleifera gum extract as reducing and nanoparticles surface stabilizing agent. The aqueous Ag+ ions were reduced while treating with the aqueous solution of Moringa Oleifera gum extract at room temperature as well as at boiling temperature of aqueous solution. Thus obtained Ag NPs from room temperature and at boiling condition were characterized using UV-visible, Fourier transform infrared (FT-IR) spectroscopies and the morphology studies of Ag NPs were confirmed by scanning electron microscopy (SEM) with energy dispersive X-ray diffraction spectroscopy (EDS) technique. UV-vis spectral studies revealed the characteristic surface plasmon resonance of Ag nanostructures and SEM with EDS study confirmed the Ag NPs formation with nanoplate morphologies.

Keywords: Silver nanoplates, Moringa Oleifera Gum extract, surface plasmon resonance

1 Introduction

Silver nanostructures with various dimensions are very impressive to the chemists as they show size and shape dependent optical and catalytic activities [1]. Among silver nanostructures, silver nanoplates are seem to be very unique in optical behaviour and show wide applications in SERS activity[2]. So far, there are many reports in the literature where wide usage of chemicals such as surfactant, Ag seed growth solution, reducing agent were utilized to generate silver nanoplates through wet chemical approach[3]. These reagents and starting components involved are highly inappropriate to use them in biological applications and hazardous to the environment. But the synthetic route which is based on naturally available biomass materials provides alternative and best route of achieving Ag nanoplates in a better yield than physicochemical methods[4]. There are many reports showing the formation of silver nanospheres using Moringa Oleifera leaf extract[5], and other microorganisms[6]. In present report, a simplest method for the generation of silver nanoplates using the extract of Moringa Oleifera Gum for the first time where the above extract alone is used as reducing and surface stabilizing agent. None of the hazardous chemicals are involved throughout the synthetic process. Additionally, the entire synthetic work is benign to the environment and hazardous free because the aqueous medium is used in all synthetic stages. In previous reports, even at room temperature, Ag nanoplates formation require the presence of surfactant molecules[7]. Further, this work clearly expands the inplane dipole plasmon band of Ag nanoplates and is observed at 740 nm in all reaction conditions. Additionally,this work showed that, by adjusting the concentration of Moringa Oleifera Gum extract with constant volume of Ag^{+} ions in the reaction medium, the lateral dimensions of Ag nanoplates could be controlled. These Ag nanoplates may find important applications in the field of SERS platform[8].

In this work, iron oxide is prepared from novel sonication method. The aim of this study is to reveal the structural, morphological vibrational and optical properties of the material. The chemical analysis was performed with XRD (X-Ray Diffraction), FTIR (Fourier Transform Infrared Spectrometer), SEM (Scanning Electron Microscope) and UV-Visible analysis.

2 Experimental

Materials and methods

Silver nitrate (>99.9%), trisodium citrate dehydrate (99%) were received from Alfa Aesar. Moringa olefiera crude gum was collected near village area. Double distilled water was used throughout all experimental work.

Preparation of Moringa Oleifira gum extract

To prepare Moringa gum extract, 2.0 g of finely powdered crude gum was dispersed in 100 ml of water and stored over night (~12 hours). Then, the above solution was used to prepare gum extract. After overnight, visible impurities such as dry dust particles of wood particles and insoluble part of gum were removed by normal filtration using Whatman No.1 filter paper. Invisible micro-particles were also removed from gum extract by using centrifugation process at 8000 rpm. Thus obtained Moringa Oleifera gum extract was stored at room temperature and used for

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experimental work. The gum extract was prepared weekly once freshly, following the above procedure.

Synthesis of Ag NPs at room temperature

The aqueous solution of purified gum extract in various volumes was introduced into a vial containing 5 ml of $AgNO_3$ (1mM) aqueous solution at once and allowed to react for about one minute at room temperature. During this process, the colour of the reaction mixture was noted and monitored the changes periodically using UV-vis spectroscopy. The resulting Ag colloidal solution was stored at room temperature for further characterization.

In order to check the reduction rate of Moringa Oleifera gum extract, various volumes of the gum extract were added in to the aqueous solution of $AgNO_3$ and the rate of AgNPs formation was noted. From these studies, we came to observe the optimum amount of gum extract required to reduce Ag+ ions present in the whole of the solution.

Synthesis of Ag nanoparticles by Moringa Oleifera gum extract reduction method

To synthesize Ag nanoparticles, 50 ml of freshly prepared 1mM aqueous $AgNO_3$ solution was taken in 250 ml round bottom flask and fitted with condenser, and then it was kept over water bath at constant stirring along with heating condition. The temperature of the reaction medium was maintained at 80^oC. At this time, 10 ml of Moringa Olefira gum extract was added at once to the reaction mixture. After the addition of the Moringa Oleifira gum extract, 10-15 minutes heating was continued and then the reaction mixture was cooled to the room temperature. The resulting colloidal Ag nanoparticle solution was stored at room temperature and used for experimental studies.

3 Results and Discussion

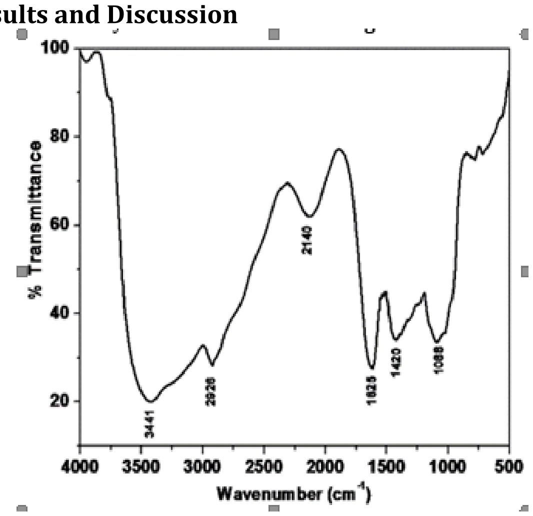


Figure 1. FTIR spectrum of crude Moringa Olifera crude gum.

The FT-IR spectrum of crude Moringa Oleifera Gum is shown in the fig. 1. This spectrum contains a broad band at 3441cm-1 which corresponds to O-H stretching. Here –OH bonded group may be alcohol, acid or aldehyde functional groups. There is another peak at 2926 cm-1 indicates sp3 hybridised C-H stretching from bioorganic molecules. The medium peak at 2140 cm-1 indicates a –C=C- stretching. The sharp peak at 1625 cm-1 indicates N-H functional group stretching. The broad band at 1088 cm-1 assigned to C-O stretching, this indicates the presence of carbonyl group in Moringa Oleifera gum. This FTIR spectrum confirmed the availability of various bioactive organic molecules with different functional groups present in the crude M. Oleifira gum.

UV-vis study of Ag NPs at room temperature

The reduction of Ag^+ ions into Ag^oNPs takes place while reacting with Moringa gum extract. Immediate contact of Moringa Oleifera gum extract with aqueous Ag^+ ion led to the colour change from pale yellow to dark brown colour within 2 minutes at room temperature. It indicated that the formation of AgNPs using Moringa Oleifera gum extract and the formation of AgNPs confirmed by recording UV-vis spectra. The peak due to the Surface Plasmon Resonance (SPR) from AgNPs surface was observed at 420 nm. The rate of colour change depending upon the concentration of Moringa Oleifera gum extract. The formation of AgNPs was observed at 5:3 v/v ratio (1mM $AgNO_3$: gum extract) solution.

In another case, 5ml of 1mM $AgNO_3$ solution in 25ml vials and then added 1ml of gum extract into the glass vials, the process was repeated for three different concentrations. In each case, the volume of gum extract volume was increased by 2ml, 3ml respectively. Therefore, we were synthesised AgNPs colloids in different concentration. In 5:1 v/v ratio, the formation of AgNPs was observed in slower rate. The colour changing process was noticed after 2 hrs in this ratio. But, in case of 5:2 ratio, the formation of AgNPs was identified visually within 10 minutes, because, the colour change was observed from pale yellow to dark brown in colour. In 5:3 ratio, the colour change was immediate and achieved brown coloured AgNP colloidal solution. Therefore, from the above observation and UV-vis spectra studies, the surface plasman resonance peak at 420 nm, 740 nm were noted in all cases. But, the optimum volume (ratio) of Moringa Oleifera gum extract for AgNPs formation was found to be 5:2 ratio.The intensity of AgNPs absorption band increased while increasing the Moringa gum extract volume in the reaction mixture. But, the colour change depends on the reduction rate of Ag+ to Ag^o during the formation of AgNPs. This was evident from the fig. 2.

UV-Vis absorbance study of Ag nanoparticles

The formation of Ag nanoparticles was observed at higher temperature and during this process the colour change was from pale yellow to light brown at 80^oC. The colour change was noticed for a period of 2 hours. The colour change of AgNPs and due to the excitation of Surface Plasmon electrons in the Ag nanoparticles surface. This reduction process was confirmed by the absorption peak at 428 nm in UV-vis spectrum. In this bulk method, silver nitrate and gum extract solution in the ratio of 5:1. The reaction was carried out continuously till 2 hours, after the completion of 2 hours Ag nanoparticles formed effectively.

The colour of the solution was changed from pale yellow to dark brown. The formation AgNPs was confirmed by the surface plasman resonance peak of AgNPs at 428 nm (Fig. 3.).

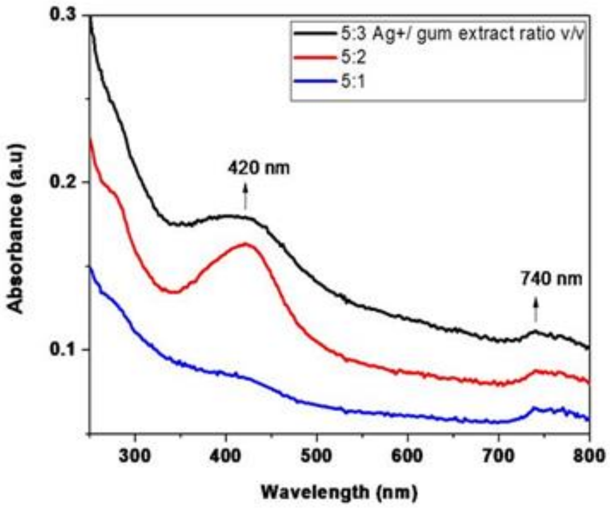


Figure 2. UV-vis spectra of Ag nanoplates at room temperature with different Ag^{+}/M.Olifera gum extract (5:1 v/v-blue, 5:2 v/v-red, 5:3 v/v-black line).

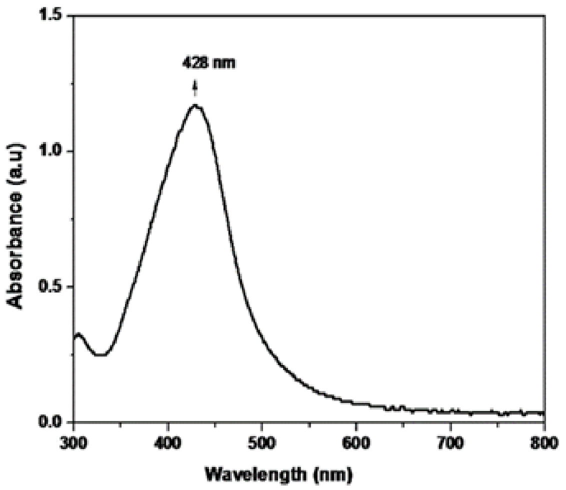
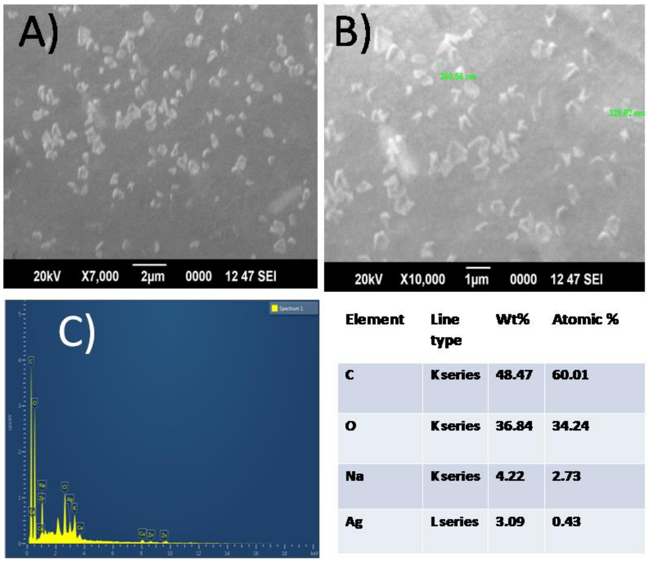


Figure 3. UV-vis spectrum of Ag nanoparticles synthesized using M. Olefira gum extract reduction method.

Morphology studies of AgNPs

The scanning electron microscopy was utilized to identify the morphological features of the AgNPs, were showed in the fig. 4., which confirmed the shape of AgNPs was in nanoscale but some portions of AgNPs were obtained at microscale size. This might be due to the solvent evaporation induced aggregation during sample preparation. Therefore. the size of the AgNPs was observed around at 360 nm and 328 nm. From the morphological studies, the poly-dispersity nature of Ag NPs was confirmed in this synthetic methodology.This synthetic route confirmed the reducing ability of M.Oleifira gum extract.



Element	Line type	Wt%	Atomic %
C	Kseries	48.47	60.01
O	Kseries	36.84	34.24
Na	Kseries	4.22	2.73
Ag	Lseries	3.09	0.43

Figure 4. (A,B) Scanning electron microscopic images of Ag nanoplates synthesized using M.Oleifera gum extract at room temperature, (C)EDX Profile of Ag nanoplates and elemental composition table of Ag nanoplates.

4 Conclusions

The formation of Ag nanostructures were studied at various experimental conditions and found to be effective for eco-friendly synthesis of Ag nanostructures using Moringa oleifera gum extract. Thus synthesized AgNPs from the greener method was confirmed by UV-visible spectral analysis. The AgNPs surface was stabilized through the various functional groups present in organic molecules available in Moringa oleifera gum extract, and identified by using FTIR and SEM-EDX techniques. The SEM analysis with EDX showed the morphological feature of the formed AgNPs and showed the polydispersity nature in shape and size between 320-360 nm in range. This AgNPs are ideal substrate materials for SERS studies.

References

[1] M. Maillard, S. Giorgio and M.-P. Pileni, Adv. Mater. 14, (2002) 1084.
[2] R. Xu and L. Yan, IOP Conf. Ser.: Mater. Sci. Eng. 678 (2019) 12007.
[3] S. Chen and D. L. Carroll, J. Phys. Chem. B 108, (2004) 5500.
[4] A. J. Haes and R. P. Van Duyne J. Am. Chem. Soc. 124, (2002) 10596.
[5] R. Sathyavathi, M. Bala Murali Krishna and D. Narayana Rao J. Nanosci. Nanotechnol. 11 (2011) 2031.
[6] B. Nair and T. Pradeep Crystal Growth and Design 2 (2002) 293.
[7] Q. Zhang, Y. Hu, S. Guo, J. Goebl and Y. Yin Nano Lett. 10 (2010) 5037.
[8] J. Zhang, X. Li, X. Sun and Y. Li J. Phys. Chem. B 109 (2005) 12544.
[9] A. Toma and S. Deyno IJP 1(2014) 222.