Available at www.ijcasonline.com ISSN 2349 – 0594

International Journal of Modern Chemistry and Applied Science

International Journal of Modern Chemistry and Applied Science 2016, 3(1), 306-308

Green synthesis of silver nano particles and study of catalytic activity

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Abstract: Silver nanoparticles (AgNPs) were synthesized through green route using syzigium cumini leaf extract. Syzigium cumini reduces the diabetic levels, improves immunity and bone strength, improves the hemoglobin levels, and treats infections. Leaves of the tree are good for digestive system and help to prevent cancer. Leaf extract acts as both reducing and stabilizing agent. The synthesized nano particles were characterized using UV-visible spectroscopy, X-ray diffraction analysis and Scanning Electron Microscopy. The prepared AgNPs were investigated for their catalytic activity. The results show a good catalytic activity of AgNPs on the reduction of para nitro phenol (4-NP) to para amino phenol (4-AP).

Key words: Green route, Silver nanoparticles, X-ray diffraction, Scanning Electron Microscopy, Catalytic activity.

1. Introduction

Nowadays, synthesis of metal Nanoparticles (NPs) is one of the fast growing areas due to physical, chemical, biological applications of NPs in all areas. Noble metals such as silver, gold, copper exhibit different applications like drug delivery, cancer detection, catalysis and antibacterial activity. Chemical synthesis of NPS involves toxic solvents and is very expensive. On contrary the green synthesis is easy, eco-friendly and very cheap[1,2]. Plant extract provides a good alternative source for the synthesis of NPs. Among plant extracts, Syzigium cumini fruits, leafs, bark is very important in medicinal area. Syzigium cumini reduces the diabetic levels, improves immunity and bone strength, improves the hemoglobin levels, and treats infections. Leaves of the tree are good for digestive system and help to prevent cancer[3,4]. Preparation of many analgesic and antipyretic drugs (paracetamol, phenacitin etc) needs 4 amino phenol as an intermediate. 4-amino phenol can be obtained by the reduction of 4-nitrophenol. The chemical synthesis for the conversion of 4NP to 4-AP involves the use of many toxic chemicals[5,6]. Therefore, there is a need for an alternative eco-friendly method for the conversion of 4NP to 4AP. Present study reports the synthesis of silver nanoparticles using syzigium cumini leaf extract and their catalytic activity has been investigated in reduction of 4NP to 4AP.

2. Materials and Methods

2.1. Materials

Silver nitrate, $NABH_4$, Para nitro phenol, syzigium cumini leaves that were collected from Osmania university botanical garden, Telangana are required for the synthesis of AgNps and investigating their catalytic activity.

2.2. Preparation of leaf extract

The fresh syzigium cumini plant leaves were washed several times with running tap water and then distilled water. The leaves were kept under shade and dried for seven days. Then, the leaves were crushed and ground in to fine powder in a Mortar and Pestle. 10 grams of leaf powder was weighed and boiled in 100 ml double distilled water in a glass beaker for 15minutes at 60^0 and then the extract was filtered through whatman filter paper no.1. The filtrate is the leaf extract and was used as a reducing and stabilizing agent for further studies.

2.3. Synthesis of silver nanoparticles

30 ml of 3mM aqueous solution of silver nitrate was taken in Beaker and 2.0 ml of syzigium cumini leaf extract was added at 50^0 C and the samples were collected for every 10min, 20min, 30 min, 60min, 120 min, 180min, 1, 2, 3…. 30 Days. A control setup was maintained for fixing the temperature.

2.4. Characterization

To confirm the formation of AgNps and their crystallinity, UV–vis spectral analysis and XRD analysis were carried out respectively. To determine the morphology of synthesized silver nanoparticles using leaf extract, the Scanning electron microscopic (SEM) analysis was carried out.

2.5. Catalytic activity on p-nitro phenol

The reduction of 4-NP TO 4-AP was done in the presence of sodium boro hydride and silver Nano particles as catalyst. 1.9 ml of 4NP was taken and 0.2m NABH4 was added to it in a cuvette. An immediate color change from light yellow to light green was observed. Then, 50micro lit. of prepared 3mM silver nanoparticles solution was added to the above solution. The reaction was spectro photo metrically monitored in the wavelength range 200-800 nm with different time intervals.

3. Results and discussion

3.1. UV-VIS Analysis

The formation and stability of nanoparticles in aqueous solution was determined by UV-vis spectroscopy. It was observed that the light yellow colored leaf extract solution changes to brown red color within 10minutes due to the formation of stable silver nano particles. The UV-vis spectra of AgNPs were recorded at different time intervals and are shown in figure 1. The absorption peaks are observed at10min, 20min, 30 min, 60min, 120min, 180min, 1, 2, 3…30 Days respectively (fig.1). It is clear from the spectra that

the SPR peak of AgNPs was observed at 439-441nm. As the reaction time was increased, the intensity of SPR peak also increased indicating the conversion of silver ions into AgNPs. However the UV-vis spectra recorded after 3 days showed that there was no increase in the absorption which confirmed that the reaction completed.

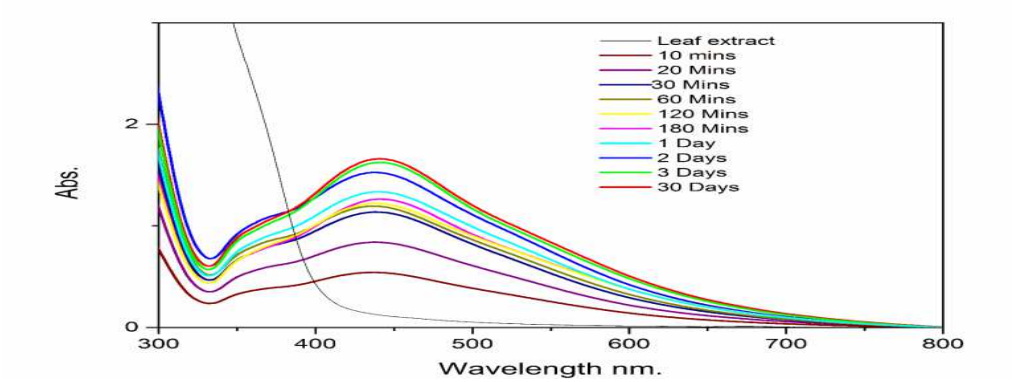

Fig.1. The UV-VIS Spectra of Ag nanaoparticles

3.2. XRD analysis

XRD Spectrum of synthesized AgNPs (fig.2) shows the peaks at 2 θ degree of 38.2, 44.4, 64.6, 77.5 that can be attributed to the (111) (200) (220) and (311) crystalline planes of face centered cubic crystalline structure of AgNps respectively. The average crystallite size of the AgNps was found to be 12.4nm as calculated by using Debye-Scherer formula

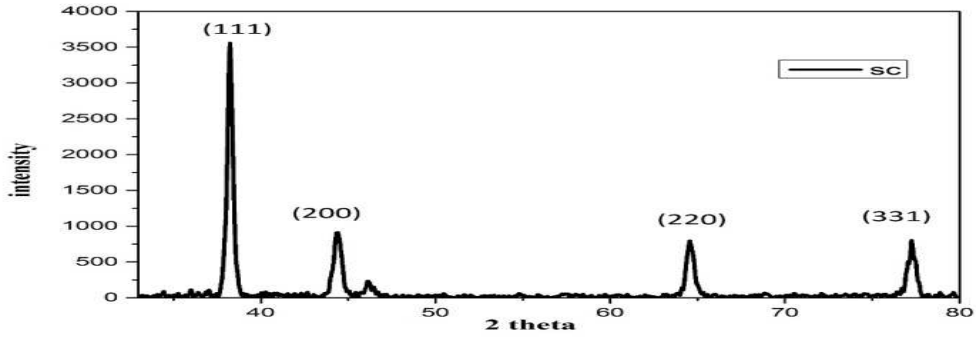

Fig .2. XRD patterns of silver nanoparticles stabilized in syzigium cumini leaf extract.

3.3. SEM Analysis

SEM analysis determines the size and shape of the silver Nanoparticles. The formation of silver Nanoparticles in the SEM image (fig 4) shows that the nanoparticles have spherical shape.

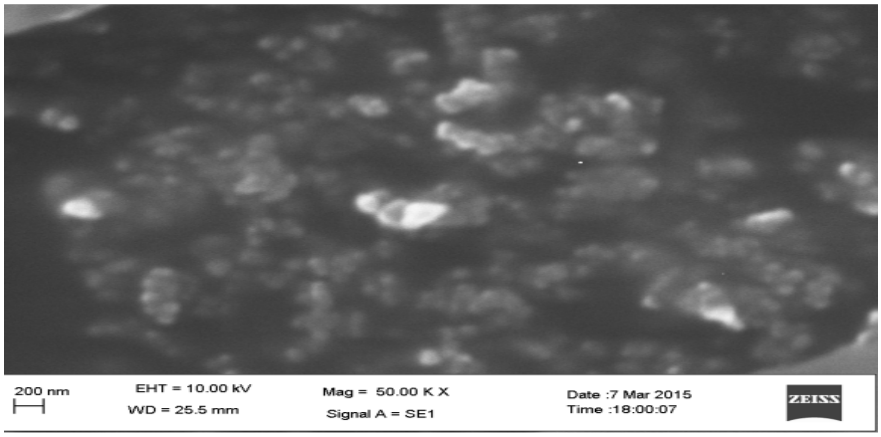

Fig.3. SEM image of silver nanoparticles stabilized in syzigium cumini leaf extract.

3.4. Catalytic activity of AgNPs

Catalytic activity of silver nanoparticles in reduction of 4NP to 4AP was explained with the help of sodium borohydride. In this experiment 1.9ml of 0.2mM 4 NP was taken in a quartz cuvette. 4 NP shows its characteristic absorption peak at 322nm shown by (i) in figure 5. After the addition of $NABH_4$, the solution immediately changed from light yellow to intense yellow and the absorption peak was observed at 400 nm, indicating the formation of para nitro phenolate ion shown by (ii) in figure 5. In the absence of AgNps the phenolate ion peak was unchanged. AgNps solution was added to phenolate ion and placed in UV-Vis spectrophotometer. The peak of phenolate ion was slowly decreased. The reaction was observed for every five minutes. A decrease in the intensity of the peak was observed and a new peak was observed at 296 nm shown by (iii) in figure 5. It clearly indicates the formation of 4-amino phenol (4-AP) without any byproduct.

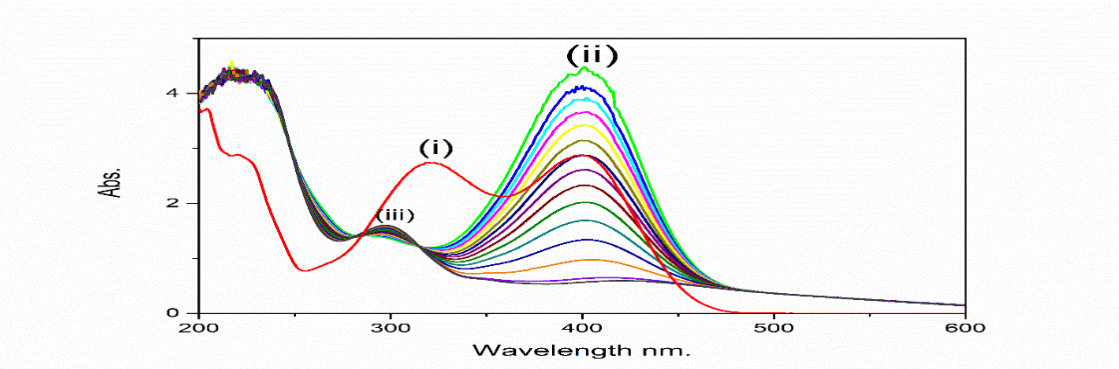

Fig.4. UV-VIS spectra recorded during the reduction of 4 NP with NABH4 catalysed by Ag NPs. i) 4 NP .ii) reduction of nitrophenolate ion with time interval of 5 mins. iii) 4 AP

4. Conclusion

Syzigium cumini is an efficient source for the synthesis of silver nanoparticles. Syzigium cumini acts as both reducing agent and stabilizer. The synthesized silver nanoparticles were characterized by various techniques which confirm the formation of stable AgNps. The green synthesized AgNps have shown good catalytic activity on the reduction of para nitro phenol (4-NP) to para amino phenol (4-AP).

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