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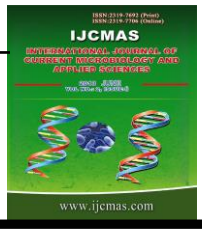


Original Research Article

Green Synthesis of Silver Nanoparticles by Leaf Extracts from Medicinal Plants

N. Mamatha[1] and E. Keshamma[2*]

[1]Department of Botany, K. G. F. First Grade College, Oorgaum, K. G. F., Karnataka, India
[2]Department of Biochemistry, Maharani's Science College for Women, Palace Road, Bengaluru, Karnataka, India
Corresponding author

A B S T R A C T

Nanoparticles synthesized using variety of hazardous chemical methods which are not environmentally friendly. Hence in the present study we aimed for green synthesis of silver nanoparticles from leaf extracts of four medicinal plants namely *Adhatoda vasica, Rosmarinus officinalis, Evolvulus alsinoides,* and *Gymnema sylvestre*. Fresh leaves of *Adhatoda vasica, Rosmarinus officinalis, Evolvulus alsinoides,* and *Gymnema sylvestre* (20 g) was weighed and transferred to 500 mL flask containing 100 mL of methanol, mixed well, and boiled for 5 min. The extract obtained was filtered through Whatman No. 1 filter paper and the filtrate was collected in 250 mL Erlenmeyer flask for further use. To synthesize silver nanoparticles, 5 mL of leaf extracts of *Adhatoda vasica, Rosmarinus officinalis, Evolvulus alsinoides,* and *Gymnema sylvestre were* mixed with 50 mL of an aqueous 1 mM solution of silver nitrate ($AgNO_3$) and stirred for 10 min at 30°C. Reduction occurs rapidly as indicated by a reddish-brown *colors* after 40 mins indicating the formation of the silver nanoparticles. The silver nanoparticles obtained were purified by centrifuging at 10,000 rpm for 20 mins and dispersing the pellets obtained in deionized water three times to remove water soluble. UV-visible spectrophotometer readings were taken at every 30 mins of intervals up to 2hrs within range of 400-480nm. This study findings delineated that silver nanoparticles synthesized from leaf extracts of medicinal plants namely *Adhatoda vasica, Rosmarinus officinalis, Evolvulus alsinoides,* and *Gymnema sylvestre* were ranged of 5-50 nm in size.

Keywords

Green synthesis, Silver nanoparticles, Medicinal plants, Leaf extracts, Methanol.

Introduction

Natural methodologies utilizing microorganisms and plants or plant extracts for metal nanoparticle synthesis have been recommended as important options in contrast to chemical methods (Kasthuri *et al.,* 2009). In the previous decade there has been a noticeable increment in the field of manufacture of nanoparticles with controlled morphologies and exceptional highlights making it a broad zone of research. The amalgamation of nanoparticles with

command over molecule size, shape and crystalline nature has been one of the fundamental targets in science that could be utilized for potential applications, for example, bio-medical, biosensor, catalyst for bacterial biotoxin end and lower cost electrode (Antonyraj *et al.*, 2013; Neville *et al.*, 2009; Staniland, 2007).

Distinctive synthetic techniques have been utilized for the preparation of nanoparticles with various morphology and size. In spite of the fact that these techniques have brought about high-quality nanoparticles yet at the same time a key comprehension of improved manufacturing process is required which could be explored at the industrial and business level to have better fabricated, enduring, cleaner, more secure and more smarter items, for example, home appliances, communication technology, medicines, transportation, agriculture and industries.

Along these lines, the fundamental center is to develop nanoparticles utilizing naturally favourable methodologies. These give answers for growing challenges identified with natural issues (Antonyraj *et al.*, 2013; Neville *et al.*, 2009; Staniland, 2007).

A significant part of biosynthesis of nanoparticles is the utilization of plant concentrate to the biosynthesis reactions. Amalgamation of semicircular silver nanoparticles utilized a decontaminated apiin compound, extracted from henna leaf at ambient conditions (Kasthuri *et al.*, 2009). Plants have various reducing agents, for example, polyphenols and flavonoids etc…and are responsible for the reductions of Ag^+ particles. These polyphenols and flavonoids are utilized as antimicrobial and antioxidant agents by the plants to shield themselves from different pathological conditions (Gorinstein *et al.*, 2001; Anagnostopoulou *et al.*, 2005).

Hence in the present study we aimed for green synthesis of nanoparticles from leaf extracts of four medicinal plants namely *Adhatoda vasica* (Figure 1), *Rosmarinus officinalis* (Figure 2), *Evolvulus alsinoides* (Figure 3), and *Gymnema sylvestre* (Figure 4).

Materials and Methods

Collection of Plant Materials

The leaves of *Adhatoda vasica, Rosmarinus officinalis, Evolvulus alsinoides,* and *Gymnema sylvestre* were collected in and around district headquarter places of Karnataka.

Preparation of Leaf Extract

Fresh leaves of *Adhatoda vasica, Rosmarinus officinalis, Evolvulus alsinoides, and Gymnema sylvestre* were finely cut (20 g) and was weighed and transferred to 500 mL flask containing 100 mL of methanol, mixed well, and boiled for 5 min. The extract obtained was filtered through Whatman No. 1 filter paper and the filtrate was collected in 250 mL Erlenmeyer flask and stored at 4°C for further use.

Synthesis of Silver Nanoparticles (NPs) Using the Leaf Extract

To synthesize silver nanoparticles, 5 mL of leaf extracts of *Adhatoda vasica, Rosmarinus officinalis, Evolvulus alsinoides, and Gymnema sylvestre* were mixed with 50 mL of an aqueous 1mM solution of silver nitrate ($AgNO_3$) and

stirred for 10 min at 30°C. Reduction occurs rapidly as indicated by a reddish-brown colors after 40 mins indicating the formation of the silver nanoparticles.

The silver nanoparticles obtained were purified by centrifuging at 10,000 rpm for 20 mins and dispersing the pellets obtained in deionized water three times to remove water soluble. UV-visible spectrophotometer readings were taken at every 30 mins of intervals up to 2hrs within range of 400- 480 nm.

Scanning Electron Microscopic (SEM) Analysis

SEM analysis was done using Inspect S 50 machine. Thin films of the sample were prepared on a carbon coated copper grid by just dropping a very small amount of the sample on the grid.

Results and Discussion

The silver nanoparticles (NPs) of leaf extract of *Adhatoda vasica* synthesized using aqueous solution of silver nitrate was measured atevery 30 mins of intervals up to 2hrs within range of 400-480nm using UV-visible spectrophotometer was represented in Figure 5.

The silver NPs of leaf extract of *Rosmarinus officinalis* synthesized using aqueous solution of silver nitrate was measured at every 30 mins of intervals up to 2hrs within range of 400-480 nm using UV-visible spectrophotometer was represented in Figure 6.

The silver NPs of leaf extract of *Evolvulus alsinoides* synthesized using aqueous solution of silver nitrate was measured at every 30 mins of intervals up to 2hrs within range of 400-480 nm using UV-visible spectrophotometer was represented in Figure 7. The silver NPs of leaf extract of *Gymnema sylvestre* synthesized using aqueous solution of silver nitrate was measured at every 30 mins of intervals up to 2 hrs within range of 400-480 nm using UV-visible spectrophotometer was represented in Figure 8.

The scanning electron microscope (SEM) images of silver NPs synthesized from *Rosemary officinalis* and *Adhatoda vasica* were illustrated in Figure 9A and Figure 9B respectively.

Nanotechnology is one of the growing areas of research in the life sciences especially biotechnology to improve the human health.

For the delivery of therapeutic agents and other activities against different diseases, synthesis of stable and versatile silver nanoparticles (AgNPs) depends on the size and shape. Nanoparticles are prepared by using variety of hazardous chemical methods which are not environmentally friendly.

Our study reported, green synthesis of silver NPs from leaf extracts of four medicinal plants namely *Adhatoda vasica, Rosmarinus officinalis, Evolvulus alsinoides*, and *Gymnema sylvestre*.

Literature reports suggested that the absorption of wavelength could be used to depict the estimated nanoparticles size.

Hence, in our study hypothetically estimated size of silver NPs synthesized from leaf extracts of medicinal plants namely *Adhatoda vasica, Rosmarinus officinalis, Evolvulus alsinoides,* and *Gymnema sylvestre* were ranged of 5-50 nm in size.

Figure.1 Showing *Adhatoda vasica* plant

Figure.2 Showing *Rosmarinus officinalis* plant

Figure.3 Showing *Rosmarinus officinalis* plant

Figure.4 Showing *Gymnema sylvestre* plant

Figure.5 UV-Vis spectrophotometer readings of *Adhatoda vasica* silver NPs

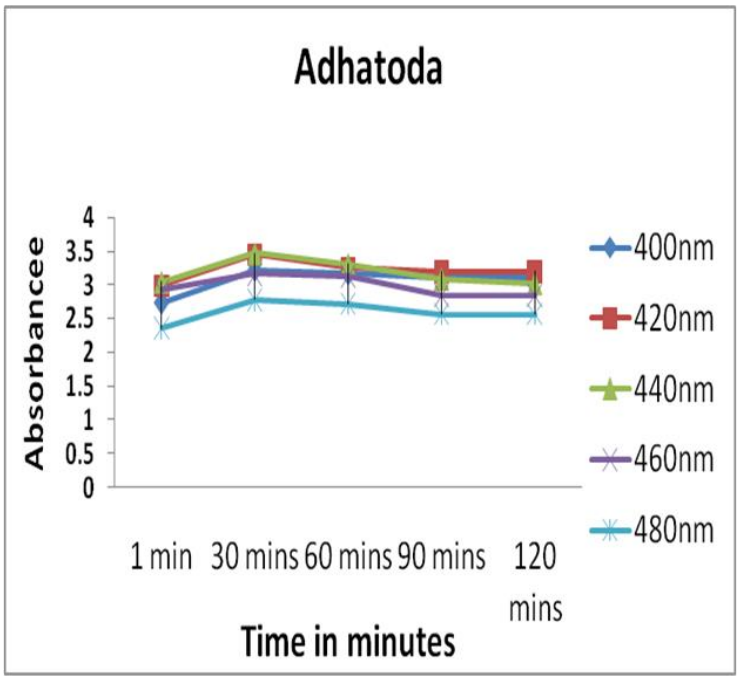


Figure.6 UV-Vis spectrophotometer readings of *Rosmarinus officinalis* silver NPs

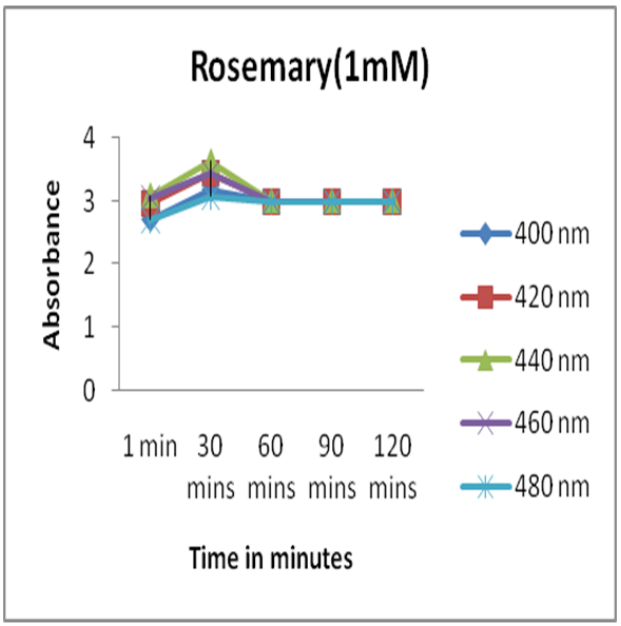


Figure.7 UV-Vis spectrophotometer readings of *Evolvulus alsinoides* silver NPs

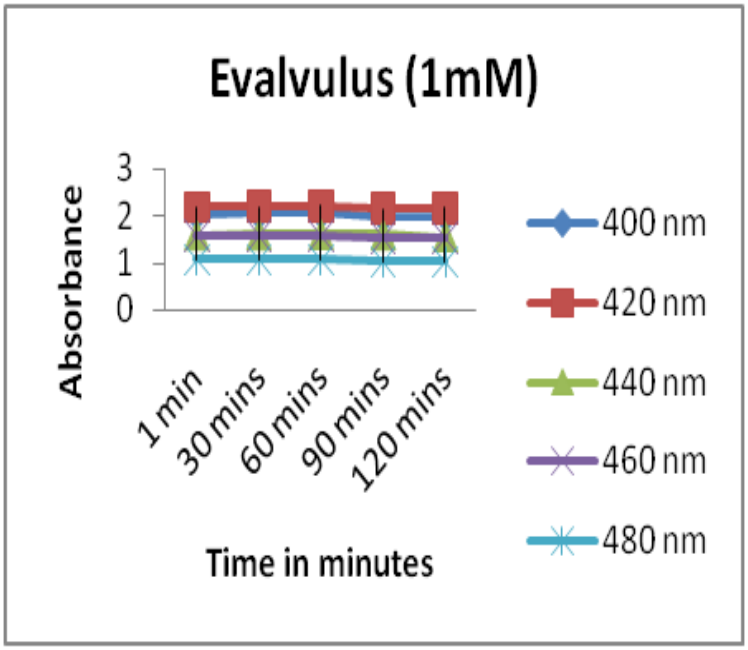


Figure.8 UV-Vis spectrophotometer readings of *Gymnema sylvestre* silver NPs

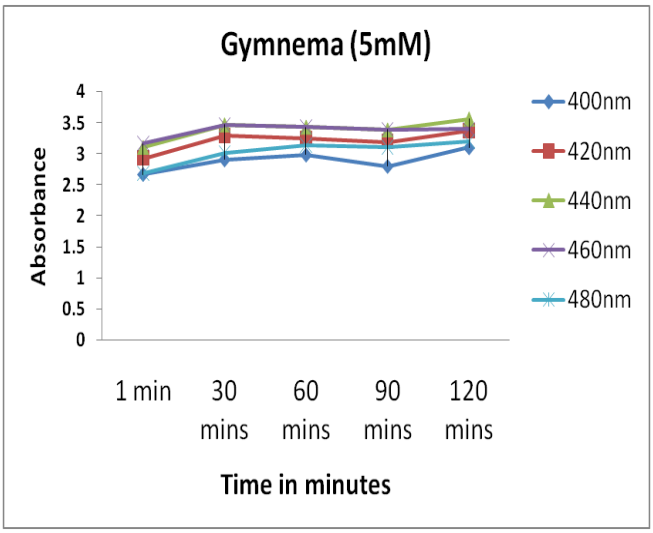


Figure.9A SEM images of silver NPs synthesized from *Rosemary officinalis*

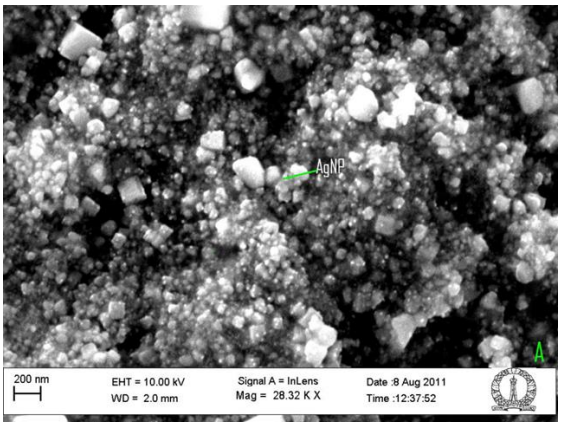
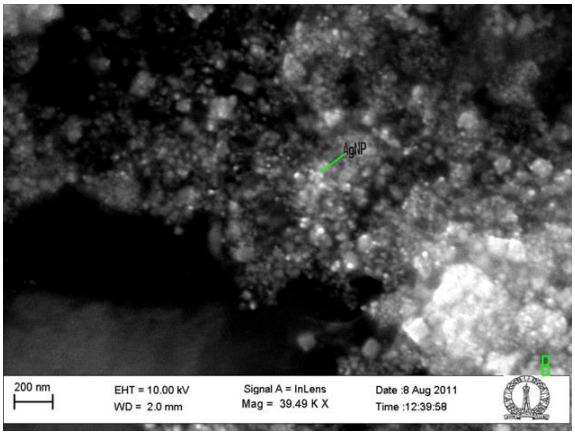


Figure.9B SEM images of silver NPs synthesized from *Adhatoda vasica*



Absorption spectra was recorded maximum at 420 nm in our study. According to Caroling *et al.,* (2013) noble metal silver shows its characteristic absorbance in the range of 410-430 nm, and reported that that phytochemical polyol components, flavonoids and terpenoids plays pivotal role in reduction of silver ions Caroling *et al.,* (2013).

In conclusion, silver nanoparticles synthesized from leaf extracts of four medicinal plants namely *Adhatoda vasica, Rosmarinus officinalis, Evolvulus alsinoides,* and *Gymnema sylvestre* were ranged of 5-50 nm in size.

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