



Green bio-synthesis of Silver Nanoparticles Using *Ziziphora tenuior* L Water Extract

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Abstract

Different biological methods are gaining recognition for the production of silver nanoparticles (Ag-NPs) due to their multiple applications. The use of plants in the synthesis of nanoparticles emerges as a cost effective and eco-friendly approach. In the present study, the synthesis of silver nanoparticles by using *Ziziphora tenuior* L of water extraction was carried out. For this purpose the water extract of *Ziziphora tenuior* L is used as the reducing agent. By addition of silver nitrate to this extract at room temperature, the color of the extract changed from pale yellow to dark brown, which showed the formation of silver nanoparticles. The characteristics of the obtained silver nanoparticles were studied using different methods, which including; ultraviolet-visible spectroscopy (UV-Vis), powder X-ray diffraction (XRD), scanning electron microscopy (SEM). *Ziziphora tenuior* L was found to display strong potential for the synthesis of silver nanoparticles by rapid reduction of silver ions (Ag^+ to Ag^0).

Keywords: Green bio-synthesis, Silver nanoparticles, *Ziziphora tenuior* L, X-ray; Eco-friendly.

Introduction

One of the important aspects of nanotechnology is the production of nanoparticles different in shape, size and physico-chemical properties. Many researchers have reported biosynthesis of silver nanoparticles using plant materials [1]. Nanotechnology is a principally attractive area of research related with production

of nanoparticles of variable sizes, shapes, chemical compositions, dispersity and their possible application for human being benefits. Creation, manipulation and utilization of metallic nanoparticles, because of reduction of materials dimensions, affect the physical properties and results in displaying extraordinary thermal, optical and electronic

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properties of nonmaterial. Green synthesis of nanoparticles is an eco-friendly method and uses natural solvent.

The green biosynthesis and characterization of silver nanoparticles using *Achillea wilhelmsii* Pharmaceutical plant aqueous extract was reported [2]. The green synthesis of silver nanoparticles using methanolic extract of *Vitex Negundo* L leaves and *Callicarpa maingayi* stem bark were also reported [3,4]. In another study Bio-synthesis of Ag-NPs from silver nitrate solution using water extract of *Myrmecodia pendan* (Sarang Semut plant) at room temperature was successfully carried out. [5,6]. Also biological synthesis of gold nanoparticles produced by the reduction of HAuCl_4 using citrus fruits (Citrus limon, Citrus reticulata and Citrus sinensis) water extract was successfully carried out [6]. In our previous work, the synthesis and antibacterial effects of silver nanoparticles on a polyamide (nylon 6, 6) by interfacial synthesis technique were also evaluated [7]. Ag NPs were successfully synthesized under moderate temperature (45 °C) at different stirring times of reaction. The formation of Ag NPs was confirmed in the UV-visible absorption spectra, which showed the SPR band characteristics of Ag NPs in the range of 412–437 nm. The XRD results confirmed that the Ag NPs possessed a face-centered cubic crystal structure. Also gold nanoparticles (Au-NPs) were synthesized using of the

brown marine algae *Sargassum muticum* (*S. muticum*) aqueous extract as both a reluctant and a capping agent. Many synthesis methods have been applied to prepare Ag NPs; chemical reduction in aqueous and non-aqueous media, in soft matrices, and in solid matrices (e.g., mesoporous silicate) [8–11], by applying physical processes/various types of irradiation [12–14] and electrochemical processes [15], in emulsion systems [16]. The Ag NPs are widely used as photo-catalysts [17], catalysts [18], antibacterial [19], biosensor [20], bio imaging and in surface-enhanced Raman spectroscopy [21]. In the present study, the synthesis and characterization of silver nanoparticles is reported. Ag-NPs were prepared using silver nitrate and aqueous extract of *Ziziphora tenuior* L as reducing agent and stabilizer.

Experimental

Materials

Plant of the *Ziziphora tenuior* L from the Sabalan region of Iran were collected then were washed and dried at the shade. AgNO_3 (99.80%) were purchased from Merck. All the solutions were prepared with double distilled water.

Preparing the water extract of *Ziziphora tenuior* L

10g of the ground *Ziziphora tenuior* L were extracted with 100 ml double distilled water, with boiling the mixture for 10 minutes in

a water bath. The mixture was filtered and centrifuged at 3000 rpm for 10 minutes to remove any proteins from extract.

Synthesis of silver nanoparticles

A volume of 100 ml of 0.01 M AgNO₃ solution reacted with 20 ml water extract of *Ziziphora tenuior L* at room temperature (25°C) for 48 hours with vigorous stirring. The color of the solution changed from pale yellow to dark brown, which showed the formation of silver nanoparticles.

Characterization Methods and Instruments

The structure of the Ag-NPs was studied using the X-ray diffraction (XRD, Inel, EQUINX

3000). The SEM was performed using a Ziess ΣIGMA VP instrument to study the morphology of Ag-NPs. The UV-visible spectra were recorded over the 200-800 nm rang with a UV Bio-TEK UV-visible spectrophotometer.

Results and discussion

Photograph of Ziziphora tenuior L and Ag-NPs

In Figure 1 the formation of Ag-NPs synthesized using *Ziziphora tenuior L* water extract is shown. By addition of silver nitrate to the water extract at room temperature, the color of the extract changed from pale yellow to dark brown during the reaction, which showed the synthesis of Ag-NPs.

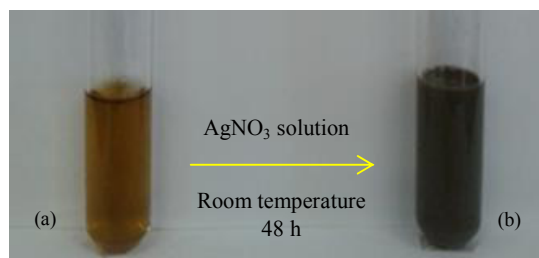


Figure 1. Photograph of (a) *Ziziphora tenuior L* and (b) Ag-NPs synthesized.

Ultraviolet-visible spectroscopy (UV-Vis)

Figure 2 absorption spectra of Ag-NPs synthesized is shown. The formation of Ag-

NPs was confirmed by a maximum absorption peak at 501 nm.

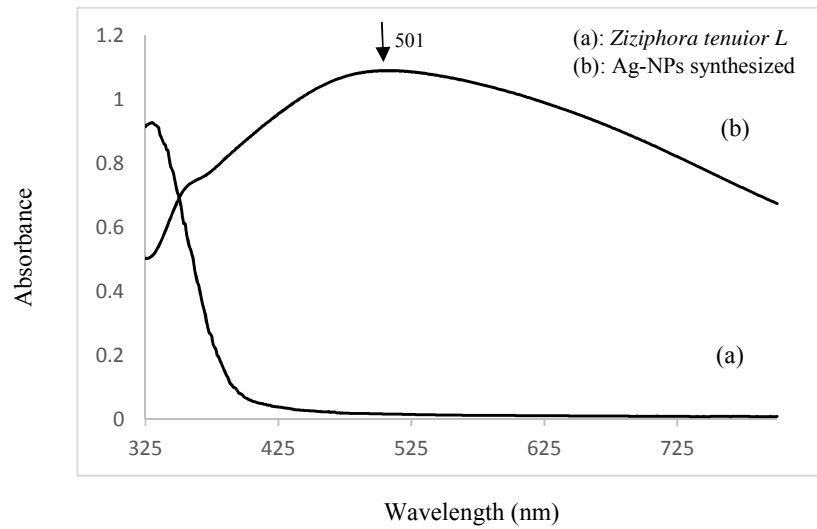


Figure 2. UV-Vis absorption spectra of (a) *Ziziphora tenuior L* and (b) Ag-NPs synthesized.

SEM and TEM micrographs

Figure 3 SEM image of Ag-NPs synthesized using *Ziziphora tenuior L* water extract is shown, which shows the homogenous

formation of Ag⁰ particles and there is no agglomeration. Also the Ag-NPs, confirms the existence of small spherical nanoparticles.

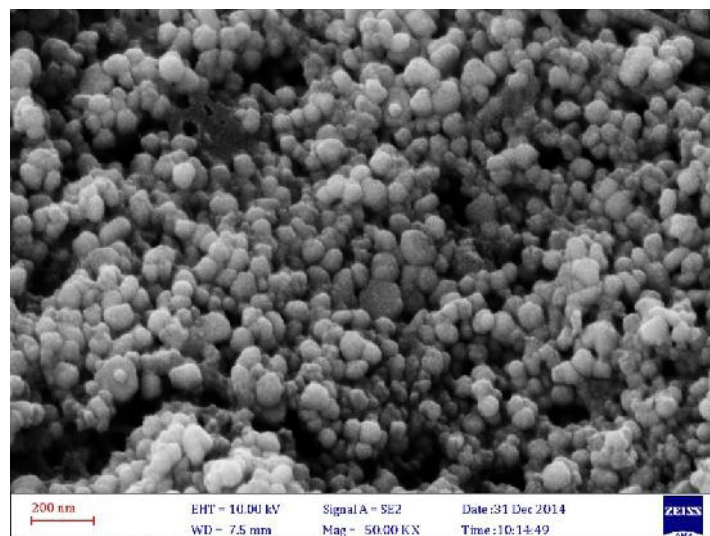


Figure 3. SEM image of Ag/ *Ziziphora tenuior L* after 48 hours.

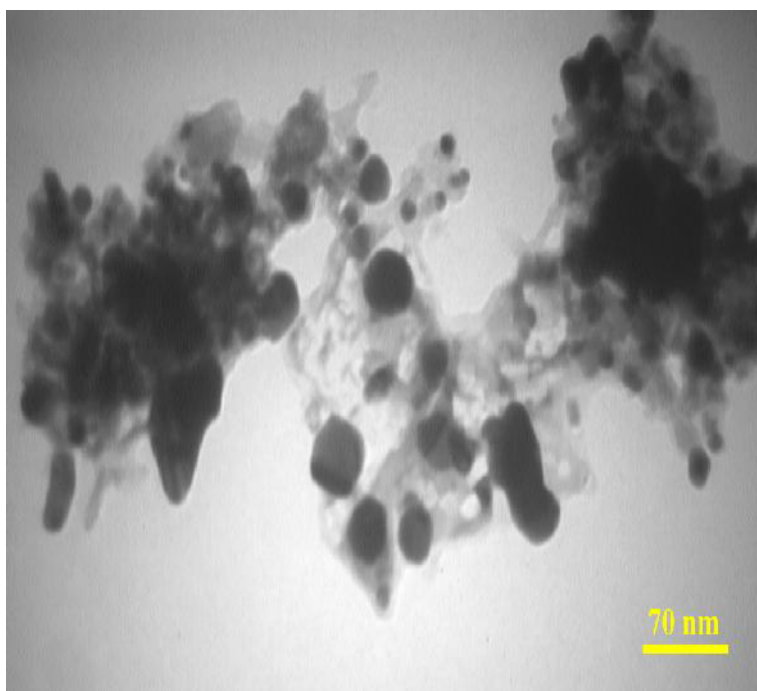


Figure 4. TEM images of silver nanoparticles.

Figure 4 shows the TEM images of the Ag nanoparticles produced. The Ag nanoparticles were formed on 23 nm in average. The organics present in the bark were believed to be the agents responsible for reducing the Ag^+ to Ag^0 . Most of the nanoparticles were roughly circular in shape with smooth edges.

Powder X-ray diffraction (XRD)

In Figure 5 XRD patterns of Ag-NPs

synthesized using *Ziziphora tenuior L* water extract is shown. The XRD patterns of Ag-NPs indicated that the structure of silver nanoparticles is face-centered cubic (fcc). In addition, the silver nanoparticles had peaks at 2θ of 38.22, 44.17, 64.48 and 77.23 could be attributed to the 111, 200, 220 and 311 crystallographic planes of the face-centered cubic (fcc) silver crystals, respectively.

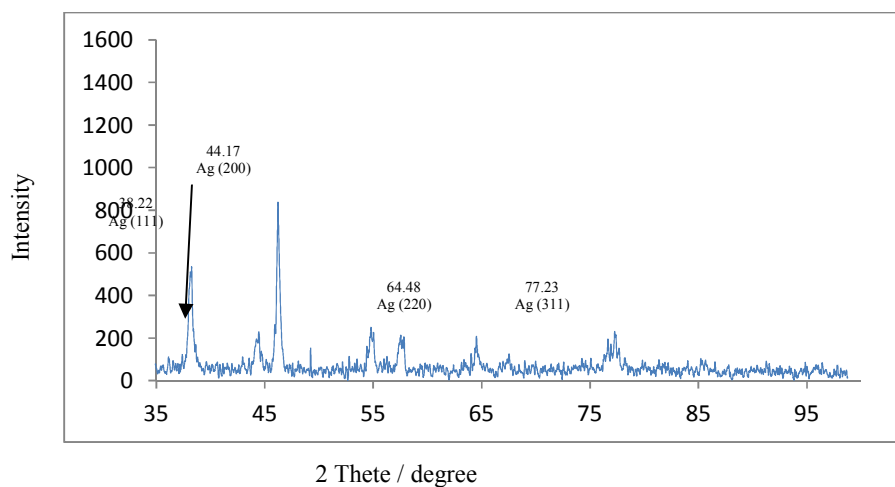


Figure 5. XRD patterns of Silver nanoparticles synthesized in *Ziziphora tenuior L* for determination of silver crystals after 48 hours.

Conclusion

According to results, silver nanoparticles spherical shapes were synthesized using water extract of *Ziziphora tenuior L*. silver nanoparticles by UV-Visible, SEM and XRD were characterized. The results suggested that *Ziziphora tenuior L* plays an important role in the reduction and stabilization of silver to silver nanoparticles.

Acknowledgments

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