JOURNAL OF PURE AND APPLIED MICROBIOLOGY, May 2014. Vol. **8**(Spl. Edn. 1), p. 313-316

Green and Facile Approach for Synthesis and Characterization of Silver Nanoparticles using Coriander (*Coriandrum sativum*) Leaf Extract

Sobhy M. Yakout[1,2]*, Ahmed A. Abdeltawab[3,4], Ashraf A. Mostafa[5] and Sherif, H. Abd-Alrahman[1,6]

[1]Biochemistry Department, College of Science, King Saud University, P.O. Box 2455, Riyadh 11451, Kingdom of Saudi Arabia.
[2]Hot Laboratories Center, Atomic Energy Authority, P.O. Box 13759, Cairo, Egypt.
[3]Chemistry Department, College of Science, King Saud University, P.O. Box, 2455, Riyadh 11451, Kingdom of Saudi Arabia.
[4]Chemical Engineering Departments, Tabbin Institute for Metallurgical Studies, Cairo 11413, Egypt.
[5]Botany and Microbiology Department, College of Science, King Saud University, Riyadh, Kingdom of Saudi Arabia.
[6]Pesticides Residues and Environmental Pollution Deptartment, Central Agricultural Pesticide Laboratory, Agricultural Research Center, Giza 12618, Egypt.

(Received: 10 April 2014; accepted: 16 May 2014)

A facile and eco-friendly method for the preparation of Silver nanoparticles (AgNPs) has been developed based on bioreduction of silver nitrate precursors with *Coriandrum sativum* **leaf extract in aqueous environment. The effect of reaction time, and AgNPs formation mechanism has been investigated. The formation of AgNPs was observed by the change of color from colorless to dark brown by the addition of silver nitrate into leaves extract. It was observed that use of** *Coriandrum sativum* **leaf extract makes convenient method for the synthesis of silver nanoparticles and can reduce silver ions into silver nanoparticles within one hour of reaction time without using any harsh conditions. Silver nanoparticles so prepared were characterized by using UV–visible spectroscopy. This process of synthesis creates new opportunities in process development for the synthesis of AgNPs**

Key words: Silver Nanoparticles, Coriander, UV–vis.

Coriander (*Coriandrum sativum* L.) is a well-known herb widely used as a pharmacy and food industries[2]. This plant is widely distributed and mainly cultivated for its seeds which are used for different purposes such as food, drugs, cosmetics, perfumery and medicinal uses. It is native to the Mediterranean and Middle Eastern regions and has been known in Asian countries for thousands of years[3] The seeds of coriander were found in the ancient Egyptian tomb of Ramses the Second. The Egyptians called this herb the ‘‘spice of happiness”, probably because it was considered to be an aphrodisiac[4] It was used for cooking and for children’s digestive upset and diarrhea.

Silver nanoparticles (AgNPs) have drawn intensive interest in recent years due to the low-cost, high-efficiency, unique optical and electronic properties which lead to potential applications in industrial fields such as catalyst (Bhatte, Tambade *et al*. 2010), antimicrobial agents (Musarrat, Dwivedi *et al*. 2011), conductive coating and sensors (Kosmala, Wright *et al*. 2011). Currently, a large number of physical, chemical, biological, and hybrid methods are available to synthesize different types of nanoparticles (Mahdavi, Ahmad *et al*. 2013). Though physical and chemical methods are more popular for nanoparticle synthesis, the use

* To whom all correspondence should be addressed.
Tel.: +966558448693; Fax: +96614675931;
E-mail: sobhy.yakout@gmail.com

of toxic compounds limits their applications. To overcome the problem of toxicity in synthesis, safe eco-friendly green methods have a major role for producing nanoparticles (Arockiya Aarthi Rajathi, Parthiban *et al*. 2012). Several methods have been used for the green biosynthesis of NPs using various biological materials as reducing agents such as microorganisms, marine organisms, micro-fluids, and plant extracts (Shameli, Ahmad *et al*. 2012). The bio-green method of synthesizing nanoparticles using either microorganisms or extracts of medicinal plants holds unique attention among researchers. It is an economic, eco-friendly and simple method in the synthesis route (Raveendran, Fu *et al*. 2003). Synthesis of nanoparticles using microorganisms (Thakkar, Mhatre *et al*. 2010) consume more time for the maintenance of microorganisms whereas the plant extract mediated methods require less processing time. Plant extracts, are relatively easy to handle, readily available, low cost, and have been well explored for the green synthesis of other nanomaterials (Khan, Khan *et al*. 2013). Moreover, the biologically active molecules involved in the green synthesis of NPs act as functionalizing ligands, making these NPs more suitable for biomedical applications (Azizi, Namvar *et al*. 2013).

Hence, the present study was designed to prepare AgNPs using bio-green method with aqueous extract of Coriander bioreducing agent of Ag + to Ag to synthesize the silver nanoparticles. The formed AgNPs were characterized using ultraviolet-visible spectroscopy. Understanding of the in situ particle stabilization mechanism are focused in this study.

MATERIALS AND METHODS

The fresh plant leaves (Fig. 1) were washed several times with running tap water, and then with distilled water. 20 g of leaves were weighed and boiled for 15 min in 100 ml Milli-Q water and then the extracts were filtered through Whatman filter paper No. 1. The filtered extract was stored in refrigerator at 4^{o}C. This extracts were used as reducing as well as stabilizing agent.

The synthesis of nanoparticles by bio-green method was carried by adding 10 ml of Coriander aqueous extract (Fig. 1ba) to 50 ml of 1 mM silver nitrate solution and kept for incubation at room temperature for 2 h. The overall reaction process was carried out in dark to avoid unnecessary photochemical reactions. The color change of the silver nitrate solution from colorless to brownish yellow was observed by naked eye (Fig. 1c) and the bio reduced sample component was confirmed by UV–Visible spectroscopy. The obtained Coriander AgNPs were purified through repeated centrifugation at 11,500 rpm for 20 min and washed with distilled water. The Coriander AgNPs were collected and redispersed in deionized water for characterization.

The formation of AgNPs from silver ions at different time intervals was monitored by measuring theUV–visible spectra of the respective solutions after diluting it 20 times with deionized water. The spectrum was recorded by using UV-1700Shimadzu UV–Visible spectrophotometer from 300 nm to600 nm. The deionized water was used as the blank.

RESULTS AND DISCUSSION

Silver nanoparticle preparation and characterization

The characterization and measurements of the AgNPs produced by the green reduction method using the Coriander extract are presented. The effects of the reaction time, mechanism of the formation of the AgNPs and the influence of the essential functional groups involved in reducing the silver ions to nanoparticles, have been considered, and are discussed in the following sections.

Formation of AgNPs from 1 mM solution of silver nitrate and *C. collinus* filtrate can be easily visualized by the color change of the mixture which is turned from green to yellowish brown color as showen in Fig. 2 It is well known that AgNPs shows a yellowish brown color in aqueous solution; this color arises from excitation of surface plasmon vibrations in the metal nanoparticles[24,25] it is due to collective oscillation of free electrons present in the reduced AgNPs[39]. Suchvisual observations on a change in biomass color due to the synthesis of gold nanoparticles have been reported earlier(Ahmad, Mukherjee *et al*. 2003).

UV–visspectroscopy is usually the first technique which is used in characterization of metallic nanoparticles because of surface plasmonresonance (SPR) phenomenon (Smitha, Philip *et al*. 2009).Fig. 3 shows the UV–vis absorption spectra of the Ag nanoparticles at different time intervals. Typical AgNPs having λmax values which are in the visible range of 400–500 nm (Sastry, Mayyaa *et al*. 1997). The absorption peak of obtained AgNPs is centered around 410–430 nm. This observation clearly indicates the successful reduction of Ag using Coriander extract. Surface Plasmon peak observed confirms the influence of aqueous Coriander leaf extract in reducing Ag+ ions to Ag NPs from aqueous $AgNO_3$ solution.The formation of AgNPs was found to increase with reaction time. The broad spectra formed at short time indicate the presence of particles with a broad size distribution. There isa slight shift in the peak towards shorter wavelength with time observed. This shift may be attributed to slight modification in the size and shape of nanoparticles (Raghunandan Bedre, Mahesh *et al*. 2011). From the figure it isobserved that the absorption peak becomes sharp as the time increases. This indicates the formation of the poly dispersed AgNPs initially that become mono-dispersed spherical nanoparticles with increasing reaction time. Thus from the results itcan be inferred that at room temperature the mixing time is an important factor in determining the size distribution of silver nanoparticles.

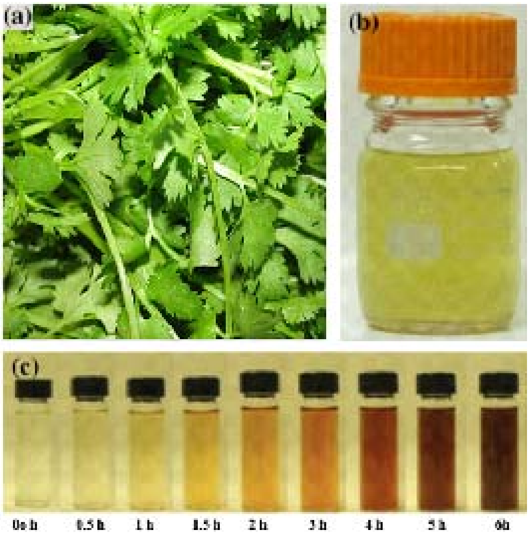

Fig. 1. Photograph of (a) Coriander leaves (b) Coriander leaves extract, and (c) the appearance of the reaction mixtures as a function of time.

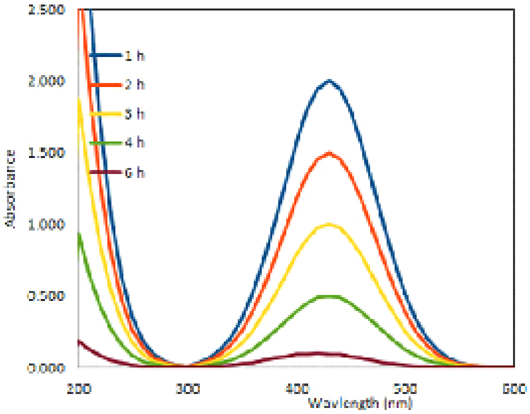

Fig. 2. UV- vis spectra of AgNPssynthesized by Coriander leaves at different time intervals

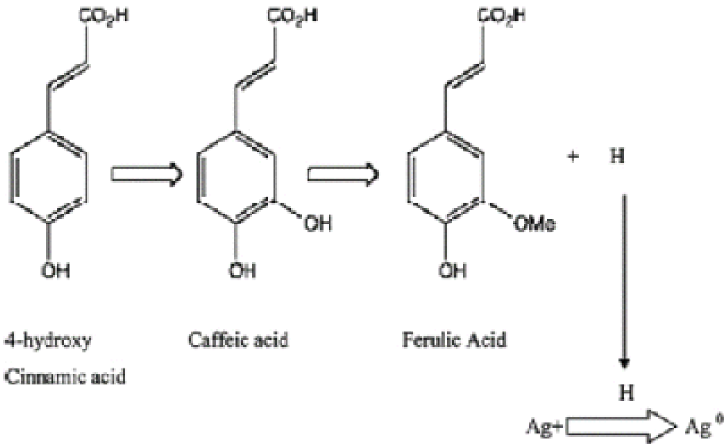

Fig. 3. possible mechanism for silver nanoparticle formation.(Ashokkumar, Ravi *et al*. 2014)

Mechanism of the formation of silver nanoparticle

Spinach leaves, containing several active components, including flavonoids, exhibit antioxidative, antiproliferative, and antiinflammatory properties in biological systems. Spinach extracts have been demonstrated to exert numerous beneficial effects, such as chemo- and central nervous system protection and anticancer and antiagingfunctions. The bioactive compounds like alkaloids, flavanoids, tannias, ascorbic acid and phenolic compounds are present in plant. Phenolic acids are large family of secondary metabolites having hydroxyl benzoic or hydroxyl cinnamic structures. It has been reported that they possess hydroxyl and carbonyl groups which are able to bind to metals[36]. Phenolic compounds may inactivate ions by chelating. According to Morgan *et al*., this chelating ability of phenolic compounds is probably related to the high nucleophilic character of the aromatic rings rather than to specify chelating groups within the molecule[37].

CONCLUSION

The present study introduced a simple, fast and economical biological procedure to synthesize Ag nanoparticles using Coriander leaves extract. Plant extract was used as a reducing and capping agents. The characterization of Ag+ ions exposed to this plant extracts by UV-vis techniques confirm the reduction of silver ions to silver nanoparticles. The presence of phenolic compounds may be the key factors for the formation of silver nanoparticles. Biological synthesized AgNPs could be of immense use in the medical field for their efficient antimicrobial function

ACKNOWLEDGMENTS

The Authors extend their appreciation to the Deanship of Scientific Research at King Saud University for funding the work through the research group project No RGP-VPP-184.

REFERENCES

1. Ahmad, A., P. Mukherjee, *et al*. Colloids Surf. B: *Biointerfaces,* 2003; **28**: 313–318.
2. Arockiya Aarthi Rajathi, F., C. Parthiban, *et al*. "Biosynthesis of antibacterial gold nanoparticles using brown alga, *Stoechospermum marginatum* (kützing). ." Spectrochim. Acta Part A *Mol. Biomol. Spectrosc*.2012; **99**: 166–173.
3. Ashokkumar, S., S. Ravi, *et al*. "Synthesis, characterization and catalytic activity of silver nanoparticles using *Tribulus terrestris* leaf extract." Spectrochimica Acta Part A: *Molecular and Biomolecular Spectroscopy,* 2014; **121**: 88–93.
4. Azizi, S., F. Namvar, *et al*. "Biosynthesis of Silver Nanoparticles Using Brown Marine Macroalga, *Sargassum muticum* Aqueous Extract." *Materials*, 2013; **6**: 5942-5950.
5. Balantrapu, K. and D. Goia "Silver nanoparticles for printable electronics and biological applications." *J Mater Res,* 2009; **24**(9): 2828-2836.
6. Bhatte, K., P. Tambade, *et al*. " Silver nanoparticles as an efficient, heterogeneous and recyclable catalyst for synthesis of â enaminones. ." *Catal Comm*, 2010; **11**: 1233–1237.
7. Khan, M., M. Khan, *et al*. "Green synthesis of silver nanoparticles mediated by *Pulicaria glutinosa* extract. ." *Int. J. Nanomed*.**,** 2013; **8**: 1507–1516.
8. Kosmala, R., R. Wright, *et al. Chem. Phys.,* 2011; **129:** 1075–1080.
9. Mahdavi, M., M. B. Ahmad, *et al*. "Synthesis, surface modification and characterisation of biocompatible magnetic iron oxide nanoparticles for biomedical applications. ." *Molecules,* 2013; **18**: 7533–7548.
10. Musarrat, J., S. Dwivedi, *et al*. Bioresour. *Technol*., 2011; **101:** 8872–8876.
11. Raghunandan Bedre, D., D. Mahesh, *et al. J. Nanopart. Res.*2011; **13**: 2021–2028.
12. Raveendran, P., J. Fu, *et al. J Am Chem Soc*, 2003; **125**: 13940–11394.
13. Sastry, M., K. S. Mayyaa, *et al*. " pH dependent changes in the optical properties of carboxylic acid derivatized silver colloid particles. ." *Colloids Surf. A,* 1997; **127**: 221–228.
14. Shameli, K., M. B. Ahmad, *et al*. "Green biosynthesis of silver nanoparticles using *Curcuma longa* tuber powder. ." *Int. J. Nanomed.,*2012; 7: 5603–5610.
15. Smitha, S. L., D. Philip, *et al*. *Spectrochim. Acta A* **,** 2009; **74**: 735–739.
16. Thakkar, K. N., S. S. Mhatre, *et al*. "Biological synthesis of metallic nanoparticles." *Nanomedicine,* 2010; **6**: 257-262.