American Journal of Advanced Drug Delivery

www.ajadd.co.uk

Original Article

Biological Synthesis of Gold and Silver Nanoparticles by *Nitraria schoberi* Fruits

Majid Sharifi Rad[1, 2], Javad Sharifi Rad[3, 4]*, Gholam Ali Heshmati[2], Abdolhossein Miri[3,4] and Dhrubo Jyoti Sen[5]

[1]Department of Range and Watershed Management, Faculty of Natural Resources, University of Zabol, Iran
[2]Department of Rangeland Science, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan 49138–15739, Iran
[3]Zabol Medicinal Plants Research Center, Zabol University of Medical Sciences, P.O. Box 61615-585 Zabol, Iran
[4]Department of Pharmacognosy, Faculty of Pharmacy, Zabol University of Medical Sciences, P.O. Box 61615-585 Zabol, Iran
[5]Department of Pharmaceutical Chemistry, Shri Sarvajanik Pharmacy College, Gujarat Technological University, Arvind Baug, Mehsana-384001, Gujarat, India

Date of Receipt- 18/06/2013
Date of Revision- 20/06/2013
Date of Acceptance- 29/06/2013

Address for Correspondence
Zabol Medicinal Plants Research Center, Zabol University of Medical Sciences, P.O. Box 61615-585 Zabol, Iran & Department of Pharmacognosy, Faculty of Pharmacy, Zabol University of Medical Sciences, P.O. Box 61615-585 Zabol, Iran

E-mail:
javad.sharifirad@gmail.com

ABSTRACT

Biological synthesis of nanoparticles by the use of natural solvents and it's natural protecting method was compared with physical and chemical methods. Among of biological synthesis of nanoparticles methods, using of plant and particularly medical plants are more important. Synthesis of silver and gold nanoparticles may be influenced directly or indirectly by phytochemicals in plants such as flavonoids, diosgenin and phenolics compounds. In this study the extracts of dry fruit was used for biological synthesis of gold and silver nanoparticles as a reducing agent. Salt of these elements was added to extract with 1mM concentration and the reaction was performed at room temperature. Change color in plant extract after its reaction with gold and silver salts and peak absorption in 550 and 450nm for gold and silver respectively using spectrophotometer showed that gold and silver nanoparticles was produced. Then size and morphology of these nanoparticles was determined by electronic microscope. The shape of particles was circle and the average particle size was 20-30 and 70-100nm for gold and silver respectively.

Keywords: Gold nanoparticles, Silver nanoparticles, UV-VIS spectra, FSEM, *Nitraria schoberi* .

INTRODUCTION

The nanotechnology field is one of the most active areas of research in modern materials science. Nanotechnology is an attractive research field because the use of nanoparticles due to particular physicochemical characteristics is increasing in the various sciences. Nanoparticles demonstrate completely new or improved properties based on special characteristics such as size, morphology and distribution. New applications of nanoparticles are emerging rapidly (Jahn, 1999; Murphy, 2008).[1,2] Today, synthesis of nanoparticles has significant growth in many countries especially in Iran. Nanoparticles have much usage in industry, agriculture, pharmaceutical and medicine Sciences (Kim *et al*., 2004; Sperling *et al*., 2008).[3,4] Nanoparticles show important role in different aspects such as drug delivery, antimicrobial activities, diagnosis and tissue engineering (Malabadi *et al*., 2012; Sharma *et al.*, 2007; Song and Kim, 2009; Gardea-Torresdey *et al*., 2002, 2003).[5-9] The use of environmentally benign materials such as plant leaf extract (Parashar *et al*., 2009),[10] bacteria (Saifuddin *et al*., 2009),[11] fungi (Bhainsa and D'Souza 2006)[12] and enzymes (Willner *et al*., 2007)[13] for the synthesis of nanoparticles suggest many benefits of eco-friendliness and compatibility for pharmaceutical and other biomedical usages as they do not use toxic chemicals for the synthesis protocol. The chemical and physical methods are common method for nanoparticles synthesis. These methods are often expensive, time consuming and difficult. The methods of chemical synthesis lead to appearance of some toxic chemical absorbed on the surface that may have adverse effect in the medical applications. The use of microorganisms such as bacteria, fungus and or macro organisms such as plant and algae can be an appropriate alternative method for nanoparticles synthesis (Malabadi *et al*., 2012; Geethalakshmi and Sarada, 2010).[6-14] These methods provide promotion over chemical and physical method as it is cost effective, environment friendly, easily scaled up for large scale synthesis and in these methods there is no need to use energy, high pressure, temperature and toxic chemicals.

Nitraria schoberi is a medical plant from Zygophyllaceae family. The leaves, fruits and seeds of this species are often used in folklore medicine as an antispasmodic. It has several classes of secondary metabolites including flavonoids derivatives, fatty acids, alkaloids and sterols (Tulyaganov and Allaberdiev, 2003; Hadj *et al*., 2011; Suo and Wang, 2010).[15-17] The previous studies showed that the fruits of *Nitraria schoberi* are a source for phenolic compounds (Senejoux et al., 2011).[18]

The aim of this study is a simple, rapid and green biosynthetic method using *Nitraria schoberi* plant has been investigated for synthesis gold and silver nanoparticles.

MATERIALS AND METHODS

Plant Material

In this study, the fruits of *Nitraria schoberi* plants (Figure-1) were used to make the aqueous extract. The fresh fruits of *Nitraria schoberi* plants were collected from Hamoon international wetland, Zabol, Iran. All fruits were thoroughly washed in distilled water for three times and they were placed in an oven at 75°C for 48hours. 20grams of dried fruits were boiled in an Erlenmeyer flask with 100mL of sterile distilled water for 10min. Fruit broth was sterilized by filtration (0.45µm) and kept at 4°C for further experiment.

Synthesis of silver and gold nanoparticles

In this step, 20mL of broth was added to 20mL of 1mM aqueous gold salt ($HAuCl_4$) and silver salt ($AgNO_3$) solutions and incubated at room temperature. The color change of extract from light yellow to dark purple about gold and from light yellow to brown or black about silver indicated the synthesis of gold and silver nanoparticles respectively (Figure-2).

RESULTS & DISCUSSION

Spectrophotometry analysis by UV-VIS spectrophotometer

Approximately 150µL of solution derived from interaction between plant extract and gold and silver salts were prepared at 1ml volume and in the range of 450-640nm wavelength was investigated by spectrophotometer. Absorption peak was 550 and 450nm for gold and silver respectively that represents the synthesis of gold and silver nanoparticles. (Figure-3)

Determination of the morphology and size of nanoparticles by field emission scanning electron microscopy (FESEM)

For this purpose, derived deposit from the interaction was centrifuged for three times at a speed of 13,000rpm. The resulting deposit was photographed by scanning electron microscopy (Figure-4). The reduction of gold and silver ions and fruit extract lead to the formation of nanoparticles at room temperature. The formations of gold and silver nanoparticles as well as their morphological dimensions by FESEM study demonstrated that average size of nanoparticles were 30 and 40 nm for gold and silver nanoparticles respectively. The shapes for both for gold and silver nanoparticles were spherical and irregular (Figure-4). Synthesis of silver and gold nanoparticles may be influenced directly or indirectly by phytochemicals in plants such as flavonoids, diosgenin and phenolic compounds. As a result of reactions of *Nitraria schoberi* fruit extract that include reducing agents such as alkaloids, tannins, flavonoids, enzymes and other reducing factors with solution salts at room temperature, the gold and silver ion reduced and their electrical charge became zero and finally the gold and silver nanoparticles were produced.

CONCLUSION

The synthesis of nanoparticles by plant is of great interest due to eco-friendliness, economic prospects, feasibility and wide range of applications in nanomedicine, catalysis medicine, nano-optoelectronics, etc. It is a new and emerging area of research in the scientific world, where day-by-day developments is noted in warranting a bright future for this field. This new method is rapid time scales for biosynthesis of metallic nanoparticles using environmentally benign natural resources as an alternative to chemical synthesis protocols as reductant for synthesizing silver and gold nanoparticles. nanoparticles. in the future, it would be significant to know the precise mechanism of biosynthesis and to technologically engineer the nanoparticles with the aim of attaining better control shape, over size and whole monodispersivity.

Electronic configuration of the two metals are:

$_{79}Au^{197}$=[Xe] $4f^{14}$ $5d^{10}$ $6s^1$=2, 8, 18, 32, 18, 1

$_{47}Ag^{108}$=[Kr] $4d^{10}$ $5s^1$=2, 8, 18, 18, 1

Both of the metals are in the class of transition elements having one valence electron in outermost shell (orbit). Valency of gold: Au^{+1} and Au^{+3} and for silver: Ag^{+1}. Metal ions are produced by reducing action by phytoconstituents into nanoparticles. Since gold produce two cations so the λmax in UV-VIS range shows the peak nearly 540nm whereas silver produce one cation so λmax in

UV-VIS range shows the peak nearly 460nm by the nanoparticles produced by phytoconstituents. (Figure-3).

ACKNOWLEDGEMENTS

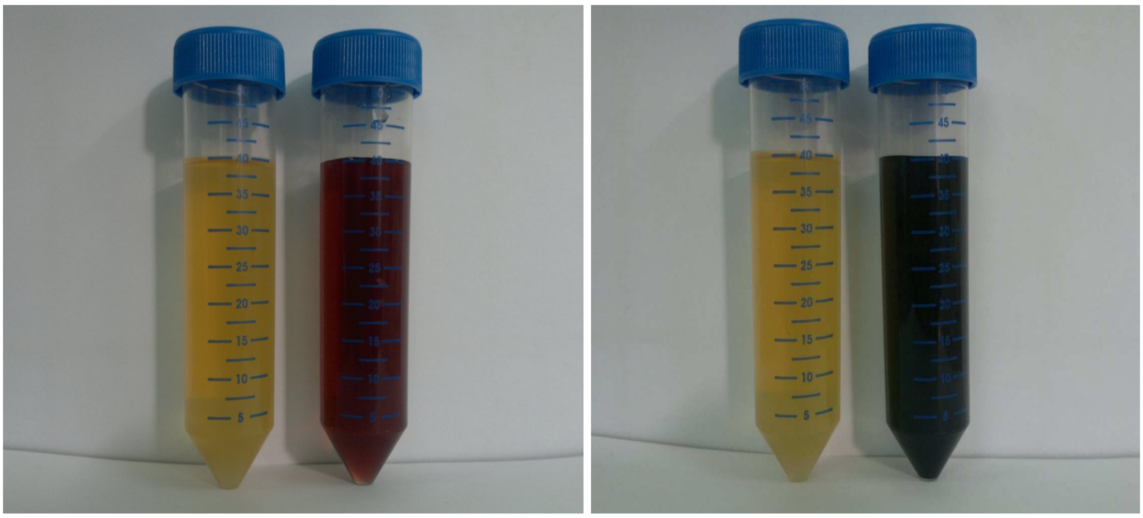
The authors are very grateful to department of rangeland science, Gorgan University of agriculture science and natural resources for financial support and our sincere thanks to Mrs. Maryam Rahdar for providing the guidance, encouragement and valuable suggestions during the various stages in research work.

REFERENCES

1. Jahn W. Chemical aspects of the use of gold clusters in structural biology. *J. Struct. Biol.*; 127: 106-112, **1999**.
2. Murphy CJ. Sustainability as a Design Criterion in Nanoparticle Synthesis and Applications. *J. Mater. Chem.*; 18: 2173-2176, **2008**.
3. Kim F, Connor S, Song H, Kuykendall T, Yang P. Platonic Gold Nanocrystals. *Angew. Chem.*; 116: 3759–3763, **2004**.
4. Sperling RA, Gil PR, Zhang F, Zanella M, Parak WJ. Biological applications of gold nanoparticles. *Chem. Soc. Rev.*; 37: 1896-1908, **2008**.
5. Malabadi RB, Meti NT, Mulgund GS, Nataraja K, Kumar SV. Synthesis of silver nanoparticles from *in vitro* derived plants and callus cultures of *Costus speciosus* (Koen.); Assessment of antibacterial activity. *Research Plant Biol.*; 2: 32-42, **2012**.
6. Sharma NC, Sahi SV, Nath S, Parsons JG, Gardea-Torresdey JL, Pal T. Synthesis of plant-mediated gold nanoparticles and catalytic role of biomatrix-embedded nanomaterials. *Environ. Sci. Technol.*; 41(14): 5137-5142, **2007**.
7. Song JY, Kim BS. Rapid biological synthesis of silver nanoparticles using plant leaf extracts. *Bioprocess Biosyst. Eng.*; 32: 79-84, **2009**.
8. Gardea-Torresdey JL, Parsons JG, Gomez E, Peralta-Videa J, Troiani HE, Santiago P, Jose- Yacaman M. Formation and growth of Au nanoparticles inside live *Alfalfa* plants. *Nano Letters.*; 2: 397-401, **2002**.
9. Gardea-Torresdey L, Gomez E, Peralta-Videa JR, Parsons JG, Troiani H, Jose-Yacaman M. Alfalfa spouts: a natural source for the synthesis of silver nanoparticles. *Langmuir.*; 19: 1357-1361, **2003**.
10. Parashar UK, Saxena SP, Srivastava A. Bio inspired synthesis of silver nanoparticles. *Dig. J. Nanomater Bios.*; 4(1): 159- 166, **2009**.
11. Saifuddin N, Wong CW, Yasimura AN. Rapid biosynthesis of silver nanoparticles using culture supernatant of bacteria with microwave irradiation. *E- J. Chem.*; 6(1): 61-70, **2009**.
12. Bhainsa KC, D'Souza SF. Extracellular biosynthesis of silver nanoparticles using the fungus *Aspergillus fumigatus*. *Colloids Surf. B.*; 47(2): 160-164, **2006**.
13. Willner I, Baron R, Willner B. Integrated nanoparticle-biomolecule systems for bio sensing and bio- electronics. *Biosens. Bioelectron.*; 22: 1841-1852, **2007**.
14. Geethalakshmi R, Sarada DVL. Synthesis of plant-mediated silver nanoparticles using *Trianthema decandra* extract and evaluation of their anti-microbial activities. *Int. J. Eng. Sci. Tech.*; 2(5): 970-975, **2010**.
15. Tulyaganov TS, Allaberdiev FK. Alkaloids from plants of the Nitraria genus. Structure of sibiridine. *Chem. Nat. Comp.*; 39: 292-293, **2003**.
16. Hadj SJ, Chevalot I, Harscoat-Schiavo C, Paris C, Fick M, Humeau C. Biological activities of flavonoids from *Nitraria retusa* (Forssk.) Asch. and their acylated derivatives. *Food Chem.*; 124: 486-494, **2011**.
17. Suo Y, Wang L. Extraction of *Nitraria tangutorum* seed lipid using different extraction methods and analysis of its fatty acids by HPLC fluorescence detection and on-line MS identification. *Eur. J. Lipid. Sci. Technol.*; 112: 390-399, **2010**.
18. Senejoux F, Girard C, Aisa HA, Bakri M, Kerram P, Berthelot A, Bévalot F, Demougeot C. Vasorelaxant and

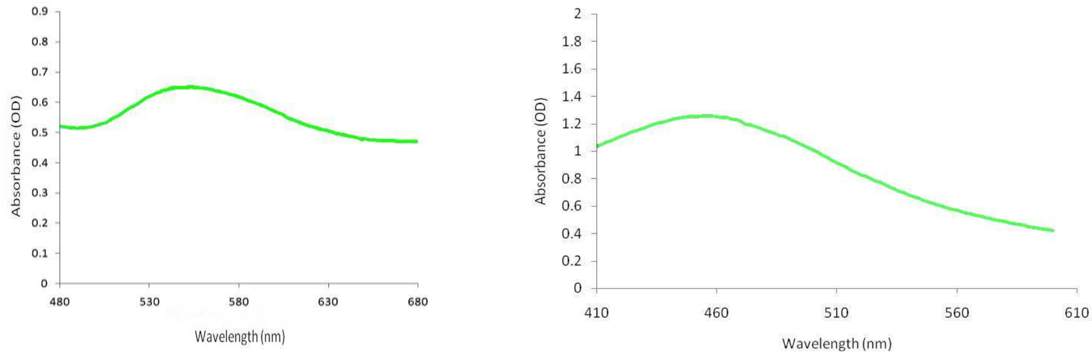
hypotensive effects of a hydroalcoholic extract from the fruits of *Nitraria sibirica* Pall. (Nitrariaceae). *J. Ethnopharmacol.*; 141(2): 629-34, **2011**.

Figure.1. **Fruit of *Nitraria schoberi* plant**



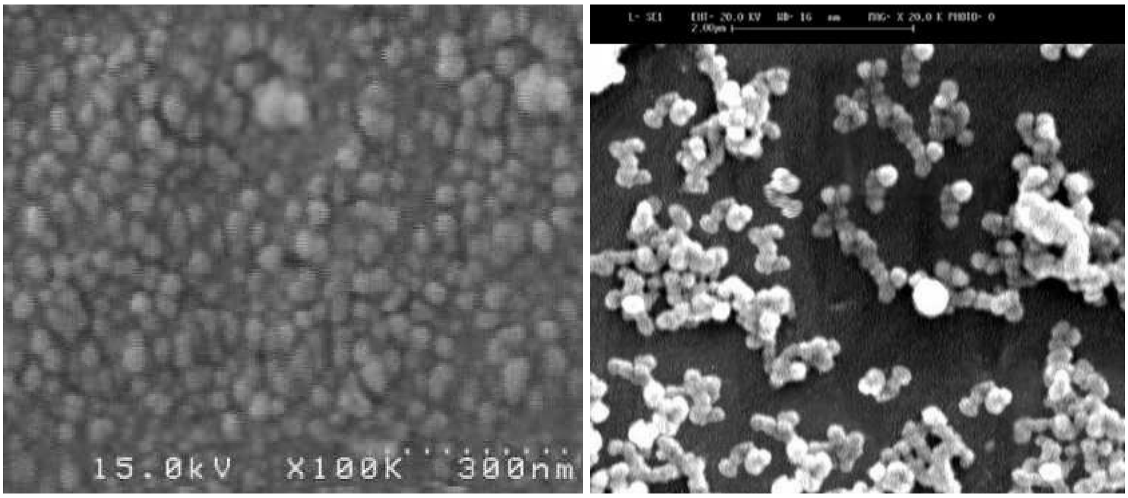
Gold Nanoparticles **Silver Nanoparticles**

Figure.2. **The change color of *Nitraria schoberi* fruit extract resulting synthesis of gold and silver nanoparticles**



Gold Nanoparticles **Silver Nanoparticles**

Figure.3. **UV-VIS absorption spectra for gold and silver nanoparticles**



Gold Nanoparticles **Silver Nanoparticles**

Figure.4. **FSEM images of gold nanoparticles**