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Original Research

Synthesis of silver nanoparticle using *Portulaca oleracea* L. extracts

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Abstract

Objective(s): To evaluate the influences of aqueous extracts of plant parts (stem, leaves, and root) of *Portulaca oleracea* L. on bioformation of silver nanoparticles (AgNPs).
Materials and Methods: Synthesis of silver nanoparticles by different plant part extracts of *Portulaca oleracea* L. was carried out and formation of nanoparticles were confirmed and evaluated using UV-Visible spectroscopy and AFM.
Results: The plant extracts exposed with silver nitrate showed gradual change in color of the extract from yellow to dark brown. Different silver nanoperticles were formed using extracts of different plant parts.
Conclusion: It seems that the plant parts differ in their ability to act as a reducing and capping agent.

Keywords: Nanoparticles, Plant part, *Portulaca oleracea*, Silver

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Introduction

Today, most studies in the field of nanoparticles (NPs) are conducted on heavy metals such as Ag, Pt, Pd and Au. Metal NPs are used extensively in different areas such as catalyst, biological detection probes, electronic, and medicine (1).With the expansion of NPs applications, new ways for synthesis of metal NPs are considered among which NPs of Ag are more efficient, as their anti-microbial effects play a significant role in the domain of biology and medicine (2). There are different methods for the synthesis of silver NPs, such as reduction of solvent, chemical and photochemical reaction in reverse cycles, and thermal decomposition of Ag components (3). Most of these methods are dangerous, because they use toxic and hazardous solvent or high pressure and temperature, thus they are harmful for ecology and natural environment.

Therefore, finding new synthesis methods for Ag NPs which are harmless for natural environment and are economic is necessary.

Expanding processes for synthesizing NPs which are friendly to the environment namely using microorganisms, fungus and plants are also useful for reducing waste materials on natural environment.

These methods are called green synthesis of NPs (4). The success of green synthesis in comparison with other physical and chemical methods is due to its compatibility with nature, easy application and capability of doing synthesis in large scale, without using high pressure, high temperature, high energy and poisonous chemicals (5).

Biosynthesis of metal NPs by plant extract is the best nature-friendly method. Application of several plant aerial part extracts such as alfalfa and *Aloe vera* are already reported (6, 7).

It was reported that active biological compounds in the plant extract such as proteins, polysaccharides, vitamins and polyphenols are responsible for reduction of metal ions to the metal particles (8). Based on the reported research, polyols and water soluble heterocyclic complexes are responsible for the reduction of silver ions and stability of NPs (8).

In line with the pervious researches on rapid synthesis of silver nanoparticle by fresh leaves water extract of porslan (*Portulaca oleracea*) from the family of Portulacaceae (9), different part of dried *P. oleracea* was selected for investigating the formation of silver NPs.

Different part of this plant has different active compounds, such as phenolic acids, oxalic, malic, ascorbic acid, soluble carbohydrates, tannin, omega-3, flavonoids and alkaloids (10).

Moreover it is rich in proteins, amino acids, and glycosides.

Each part of the plant is rich source of compounds which are known as good reducing agents for silver ion (10). The influence of plant part extract (stem, leaves, and root) on particle size of silver NPs is the aim of this research.

Materials and Methods

Plant part extracts

The *P. oleracea* seeds were obtained from Nikanbazr Company, Isfahan, Iran.

The plants were prepared by cultivation of the seeds and harvested in full flowering stage.

The plant roots, stems and leaves were separately dried at room temperature. 5 grams of powdered leaves, stems and roots were mixed with 100 ml distillated water and poured in to 300 ml volume flasks.

This mixture was boiled for 5 minutes. After decantation, solution was kept at 4ºC.

Silver NPs formation with extracts of Portulaca oleracea L.

10 ml of the extracts of each plant parts was added into 190 ml of 10^{-3} M $AgNO_3$. The formation of Ag NPs was investigated through monitoring color change of the

solution from yellow to dark brown and using Nano ZetaSizer and UV- visible spectrophotometer in wavelength between 350-800 nm (11).
Then AFM was applied for morphological examination and particles size measurements (12).

Results

The extract obtained from root, leaves and stem of dried *Portulaca oleracea* in the presence of clear solution of 10^{-3}M $AgNO_3$, showed color change from yellow to dark brown after 1-2 hours at room temperature.
This seems to indicate the formation Ag NPs (Figure 1). Reduction of the silver ion to silver NPs during exposure to the plant leaf extracts could be followed by color change and thus UV-vis spectro-scopy.
Figures 2-4 show the analysis of the particle size of NPs obtained by Nano ZetaSizer from different parts of the plant. Figures 5-8 are AFM images of NPs formed with 5% plant broth and 1 mM $AgNO_3$ solution.
It is shown that relatively spherical NPs are formed with average diameter of about 136-175 nm based on plant part used.In order to screen plant with high production capability of silver NPs, different plant part extracts were compared for their ability to synthesize silver NPs synthesis.As shown in Figure 2-4, the particle size formed was the highest for stem extract and the lowest for leave extracts.

Discussion

The different plant part extracts of Portulaca oleracea were able to form silver NPs with different particle size and shape in vitro.As presented in Figures 2-7, there are differences on AgNPs formationability according to plant part used.

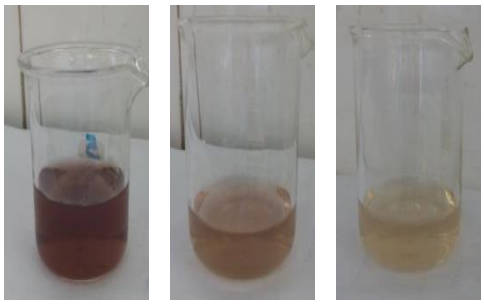

Figure 1. The color changing of leave extract mixed with AgNO3 solution within 2 hours.

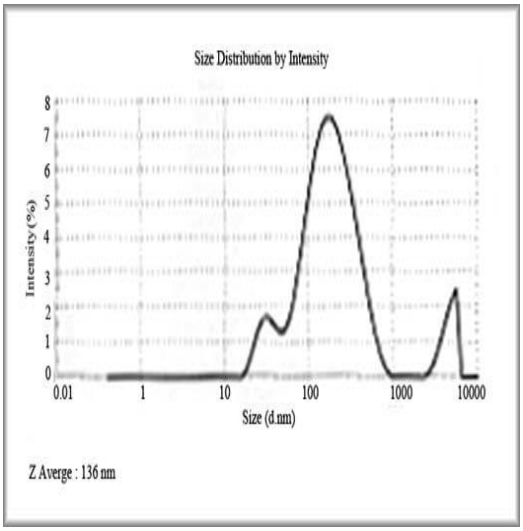

Figure 2. The size of silver nanoparticles obtained from stem of *Portulaca oleracea.L.*

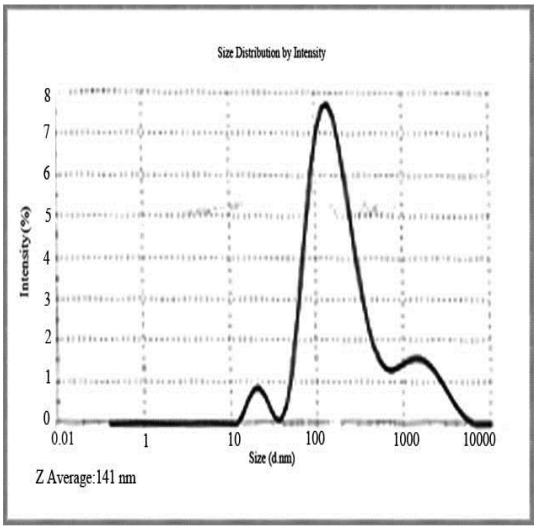

Figure 3. The size of silver nano particles obtained From leaves of *Portulaca oleracea.L.*

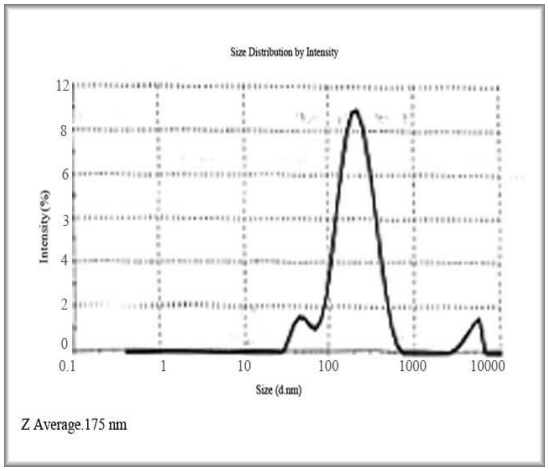

Figure 4. The size of silver nano particles obtained from root of *Portulaca oleracea.L.*

It was reported that the fresh leaves aqueous extract of the plant synthesized silver nanoparticles with particle size less than 60 nm (9).

But the dried leaves in current study produce silver NP with the size of 136 nm which may related to change in leaves compositions such as enzymes over drying.

As presented on Figs. 2-4, the plant part extract form nanoparticles with different sizes; 146 nm, 136 nm, and 175 nm for root, leave, and stem extracts, respectively. The mechanism of biological synthesis of NPs is not fully understood.

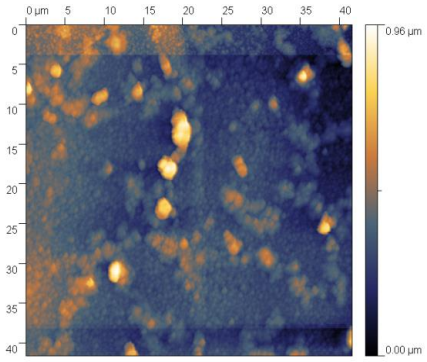

Figure 5. The AFM images of silver nanoparticles in leaves extract of *Portulaca oleracea.L.*

Gold NPs were synthesized extracellularly by the *Tamarindus indica*. It was reported that the reduction occurred due to release of reductase enzyme into the solution (13).

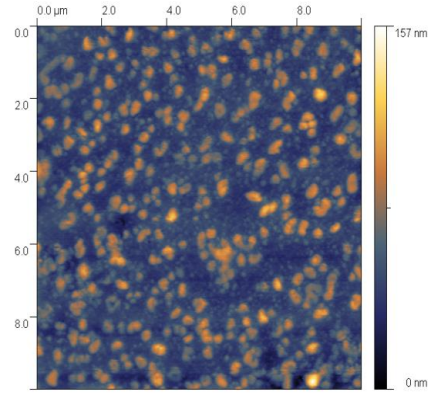

Figure 6. The AFM images of silver nanoparticles in root extract of *Portulaca oleracea.L.*

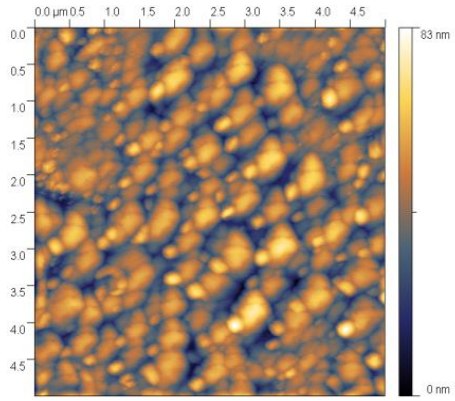

Figure 7. The AFM images of silver nanoparticles in stem extract of *Portulaca oleracea.L.*

Cinnamomum camphora has also been revealed to fabricate Au and Ag NPs. It is believed that terpenoids are active molecules stabilizing the NPs and reaction of the metal ions is possibly facilitated by terpenoids broth (14). Studies on the fruit extract of *Emblica officinalis* indicated that the proteins played a reducing and controlling role during the formation of silver NPs in the solutions (15). Bioreduction activity of leaf extracts of *Helianthus annus*, *Basella alba*, and *Saccharum officinarum* resulted in the fabrication of Ag NPs in which *Helianthus annus* was found to exhibit strong potential for quick reduction of Ag ions (16). The polyol components and the water soluble heterocyclic components are mainly res-ponsible for reduction of Ag+ as well as stabilization of NPs. It seems that the basis of all metal NPs synthesis methods is the

reduction of metal ions by reduction agents. *Portulaca oleracea* stem, leave, and root contains different quantity of phenols, flavonoids, carbohydrates, alkaloids, triterpens, phenolic acids, ascorbic, malic, citric and oxalic acids (17).

Flavonoids are responsible for antioxidant activity in plant (18). It seems that water soluble carbohydrates such as fructose/froctan, amino acids such as glotamic acid, alanin, and phenylalanin which are found differently in plant parts are responsible for reduction and stability of Ag NPs (11, 19).

The presence of polyol and soluble heterocyclic complexes are necessary for reduction of Ag ions and stability of Ag NPs (8).

Also quality and quantity of polysaccharides exist in different plant parts are effective factors in biosynthesis and stability of NPs.

The exact mechanism for the fabrication of NPs in biological resources is still being investigated and several possible ways have been proposed (20, 21).

Several studies still need to be executed to understand the effect of parameters regarding the influences of many and different constituents available in stem, leave, and root for phytofabrication of AgNPs by *P. oleracea* extracts.

Most published date available on the green Ag NPs biosynthesis ability of plant leaf extract (22-27), however, there are several reports on stem, fruit extract as well (15, 28).

Rich compounds occurrence in different parts of *P. oleracea* that are able to reduce Ag ions and help the stability of NPs, short reaction time, rapid growth of the plant in different environmental conditions, will justify the value of using root, leaves, and stem of the plant.

Meanwhile, different size Ag NPs obtains is among the beneficial goals of the present method to evaluate and compare the sliver biosynthesis ability of each plant part separately.

Conclusion

Rich compounds occurrence in different parts of P. oleracea that are able to reduce Ag ions and help the stability of NPs, short reaction time, rapid growth of the plant in different plant parts, will justify the value of using root, leaves, and stem of the plant.

Meanwhile, different size AgNPs obtains is among the beneficial goals of the present method to evaluate and compare the sliver biosynthesis ability of each plant part separately.

Acknowledgments

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