Plant extract: safe way for fabrication silver nanoparticles

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Abstract. A safe approach for fabrication silver nanoparticles has established. In this approach a grape fruit peel extract was employed to serve as a capping agent to reduce the aggregation process of Ag nanoparticles. The formation of Ag nanocrystal was confirmed by the color change from yellow to brownish red after 24-hour incubation. The red shift of SPR band position (~455 nm) compared to the bulk silver (420 nm) indicates the formation of silver nanoparticles. The size and morphology of Ag nanoparticles were characterized by scanning electron microscopy. The SEM images revealed that the prepared Ag nanoparticles have a diameter of 50-70 nm, while the cubic-like shapes are dominated. Fourier Transform Infrared Spectroscopy (FT-IR) was employed to characterize the prepared Ag nanoparticles.

Keywords: Silver nanoparticles, fruit peel extract, capping agent, SEM and SPR absorption band.

1. Introduction

Silver nanoparticles have attracted the attention of many researchers during the last decades because these particles possess significant applications in antibacterial coatings\(^1,2\) and medical diagnoses.\(^3\) Furthermore, the antimicrobial property\(^4\) of silver nanoparticles opens the door to use them in many products such as in cosmetics and clothing.\(^5\)

The high electrical conductivity of silver metal (compared with gold, copper and other metals) makes it an excellent candidate for the conductive inks manufacturing.\(^6\) In addition, silver nanoparticles have a high surface plasmon resonance (SPR), which is the ability of the valence electrons to oscillate at the Ag nanoparticles surface. If they
resonance with a suitable light, the absorption band appears in the region of 400-600 nm of the UV-Vis spectrum depending on the size, the shape and the chemical composition of the prepared nanoparticles. This unique property offers an opportunity to use silver nanoparticles in numerous applications in surface enhanced fluorescence, optics and Raman spectroscopy.7,8

Although several chemical and physical approaches have been proposed and employed to fabricate silver nanoparticles such as metal reduction, electrochemical, Sol-gel methods, chemical vapor deposition, photochemical and Light-assisted methods,9-12 most of these methods employed reducing reagents, toxic solvents and chemical stabilizers,13,14 which may cause some biological risks and hazard effects on environment.

Therefore, in this report we used the peel extraction from Grapefruit (citrus paradise) to synthesis silver particles. This approach could be considered as an alternative way to prepare metal nanoparticle rather than using chemical and physical approaches. It depends on the plant photochemicals as a natural capping agents and stabilizers so, it is eco-friendly, cheap and easy method. The formation of silver nanoparticles is confirmed from the SPR absorption band of Ag and the scanning electron microscope (SEM) morphologies.

2. Methodology

In order to prepare the fruit peel extraction, Grapefruit was purchased from the local market. It was rinsed several times with tap water then distilled water and peeled. The fruit peels were cut into small parts and dried under the sun light for two days, then crashed into a fine powder. All the glass wares were rinsed with deionized water and dried in the hot air oven. Six grams of the fruit powder was dissolved in 60 ml deionized water. The mixture was boiled for 6 minutes at 80 °C before filtration (whatmann No. 1 filter paper was used).

The extract then stored in the fridge (~4 °C) to use it in the fabrication process of silver nanoparticles. 1 mM of silver nitrate solution was prepared by dissolving 0.0169 g into 100 ml deionized water and stored in a dark container for further use.
To fabricate silver nanoparticles, 6 ml of the fruit extract was mixed with 80 ml of silver nitrate then the mixture was kept for a night at room temperature. The solution, which contains Ag nanoparticles, was then centrifuged at 4000 rpm for 20 minutes and dried before characterizing with the UV-vis spectrometer, FT-IR and SEM.

3. Results and discussion

There is a notable change in the color from yellow to brownish red after incubating the prepared mixture overnight as shown in Figure 1(a and b). This change could confirm the formation of Ag nanoparticles because of the reduction process of Ag⁺ ion to Ag⁰ nanoparticle where the fruit peel extract serves as a reducing agent and capping agent to reduce silver ion to silver nanoparticles and to minimize the aggregation process of silver nanoparticles, alternatively. This result is quite similar to the early works done by Gurunathan and Shahverdi.¹⁵,¹⁶

![Figure 1](image)

**Figure 1** (a) Yellow color solution composed of grapefruit peel extract and silver nitrate after mixing immediately, (b) brownish red color solution after 24-hour incubation for the mixed solution at room temperature.

To provide more evidence for the formation of silver particles, UV-Vis absorption spectrum was recorded using UV-1800 series Shimadzu spectrophotometer. The surface
plasmon resonance (SPR) absorption band of the prepared solution is found to be ~455 nm as shown in Figure 2. This red shift (compared to the SPR band of silver metal at 420 nm) is attributed to the fabrication of silver nanoparticles in the presence of grape fruit peel extract. Our finding is in agreement with the UV-Vis absorption band of Ag nanoparticles prepared from banana peel extraction by Alvakonda Narayanamma (λ = 454.07 nm).\textsuperscript{17}

![Figure 2 UV-Vis absorption spectrum of Ag nanoparticles formed by using grape fruit peel extract as a reducing agent. The red arrow at ~ 455 nm indexes the SPR absorption band of the prepared Ag nanoparticles.](image)

The morphology of the prepared silver nanoparticles was studied using scanning electron microscope (SEM). It is clear that silver nanoparticles obtained from grape fruit peel extract possess different shapes but the dominated ones are cubic-like structure (see Figure 3). In term of size, these particles have size of 50 -70 nm roughly. Silver nanocrystals with size range between 50-100 nm is fundamental for several optical applications as these particles have the ability to enhance the signal by scattering the light due to their SPR.\textsuperscript{18}
Figure 3 Scanning electron microscope (SEM) image shows the shape and size of Ag nanoparticles prepared from the grape fruit peel extract.

The FT-IR measurements were carried out to know the biomolecules that are responsible for the reduction process of silver ion to silver nanoparticles using grape fruit peel extraction. Figure 4 shows a significant peak at 3419.9 cm\(^{-1}\) which could be assigned to the stretching of primary amine.\(^{19}\) A small shoulder appeared at 2949.26 cm\(^{-1}\) which may attributed to the stretching of secondary amine. However, the band observed at 1629.90 cm\(^{-1}\) may correspond to their vibrations. The peak centred at 1411.94 cm\(^{-1}\) which are assigned to the C-N stretching vibrations of aromatic groups.\(^{20}\)
4. Conclusion

Silver nanoparticles have been prepared successfully using environment-friendly approach. This approach relies on the use of plant photochemicals as a natural capping and reducing agents for synthesis Ag nanoparticles, which may lead to use these particles in the medical, pharmaceutical and biological field. UV-Visible spectrometer, FTIR and scanning electron microscopy have been used to confirm the fabrication process of silver nanoparticles.
5. References

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