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Green Synthesis of Silver Nanoparticles from *Astragalus Lagopoides* L. Leaves

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A B S T R A C T

Natural products have gained great interest due to their broad spectrum of biological activities. In this study, silver nanoparticles (AgNPs) were synthesized using *Astragalus lagopoides* L. by green approach. The structure of AgNPs was elucidated by spectroscopic techniques. UV-Vis spectrum presented the maximum absorption of AgNPs at 419 nm. The crystal structure of AgNPs was assigned as face centered cubic by X-ray diffraction (XRD) pattern. Scanning electron microscope (SEM) established morphology of AgNPs with an average size of 36.4 nm. *A. lagopoides* included the bioactive compounds, So, AgNPs capped by these compounds could be valuable substances for food and pharmaceutical applications.

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Introduction

Medicinal plants play a significant role in drug development due to their biological activities (Dede et al., 2019, Erenler et al., 2019, Genç et al., 2019, Yaman et al., 2021). The advances in chromatography and spectroscopy in 19th century enabled the isolation and identification of bioactive compounds in the plants. Hence, plants became the focus of science, and many scientific studies were carried out to find the bioactive compounds that could be used in medicines (Elmastas et al., 2018, Erenler et al., 2018, Guzel et al., 2017, Karan et al., 2018a, Karan et al 2018b, Newman & Cragg 2007, Yildiz et al., 2017).

Nanotechnology is developing as a significant discipline of science with its various applications such as in pharmaceuticals, textile agriculture, catalysis, sensors, mechanics, optics, electronics, biomedicine (Ali et al., 2020, Karan et al., 2022, Sahin Yaglioglu et al., 2022).

Recently there has been a great interest in green synthesis of nanoparticles from plants (Alomar et al., 2020). The capping and stabilizing the metal by bioactive compounds could enhance biocompatibility. Metal and metal oxide nanoparticles are believed as the highly suitable materials owing to their distinctive physical properties such as significant surface area to volume ratio, controlled morphology, smaller size, and light absorption properties (Erenler & Dag 2022). These properties enable them to be used in many areas such as biosensor, optoelectronics, and biomedicine (Burlacu et al., 2019).

The physical and chemical techniques have been used mostly for synthesis of nanoparticles (Geetha et al., 2013). However, these techniques require high energy, toxic chemicals, and harsh reaction conditions. The main drawback of these techniques is that the biocompatibility of nanoparticles is compromised due to the use of toxic chemicals in the synthetic stage (de Souza et al., 2019). Plant-based green approach has many advantages such as one-pot synthesis, robustness, low cost, and environmental friendliness, as well as the use of natural compounds from plants as reducing agents (Genc 2021). Therefore, the synthesis of nanoparticles using green approach, particularly plant-based techniques, is an alternative to these conventional procedures (Genc et al., 2021).

Astragalus L. genus belonging to the Fabaceae family has nearly 3000 species distributed mainly North America, Europe and Asia (Podlech 2008). Some species of this genus have been used as a folk medicine to treat various diseases such as gastric ulcer, bronchitis, hypertension, diabetes, gynaecological ailments (Benchadi et al., 2013). *Astragalus* species include the significant bioactive compounds such as saponins, flavonoids (Li-Xian et al., 1986, Yahara et al., 2000).

Herein, AgNPs were synthesized by eco-friendly, cheap, easy, and scale up manner. The structure of AgNPs was elucidated by spectroscopic techniques.

Plant Material

A. lagopoides was collected from Van region and taxonomic identification was carried out after comparison with the sample deposited at the Herbarium (13747) by Prof.Dr. Fevzi Özgökçe, Yüzüncü Yıl University, Van, Turkey.

Green Synthesis of Silver Nanoparticles

A. lagopoides leaves (10 g) were washed, dried, and powdered then heated in deionized water (100 mL) at 45°C for 2 hours. After double filtration with ordinary filter paper and Whatman (Grade 1) filter paper, the extract solution was treated with the deionized water solution of silver nitrate (0.35 M, 100 mL) for 2 h at 65°C. After the centrifugation of mixture at 5000 rpm for 15 min, the desired product was formed washed, and dried by lyophilisation (Erenler et al., 2021)

Characterisation of Nanostructures

The synthesized AgNPs were characterised by spectroscopic techniques. UV-Vis (UV-2600) spectrophotometer was used to reveal the maximum absorption of AgNPs. Empyrean, Malvern Panalytical diffractometer was utilized for X-ray diffraction (XRD) analysis to determine the crystal structure of AgNPs. Quanta Feg450 was used for scanning electron microscope (SEM) analysis to reveal the morphology of AgNPs (Gecer et al., 2022).

Results and discussion

UV-Vis Analysis

A. lagopoides leaves were used for synthesis of silver nanoparticles. The colour change of reaction mixture proved the formation of AgNPs. The maximum absorption at 419 nm verified the structure (Figure 1A). The reduction of Ag^{+1} ions was occurred by the molecules in *A. lagopoides* leaves. The silver nanostructures were formed by the redox reaction of *A. lagopoides* leaves solution with silver nitrate solution (Alomar et al., 2020).

X-ray Diffraction

XRD pattern indicated the crystal structure of synthesized nanoparticles. The diffraction peaks at 38.14°, 44.29°, 64.48° and 77.34° correspond to facets 111, 200, 220 and 311 of the face centered cubic crystal structure, respectively (Beyene et al., 2017) (Figure 1C) (Aravinthan et al., 2015).

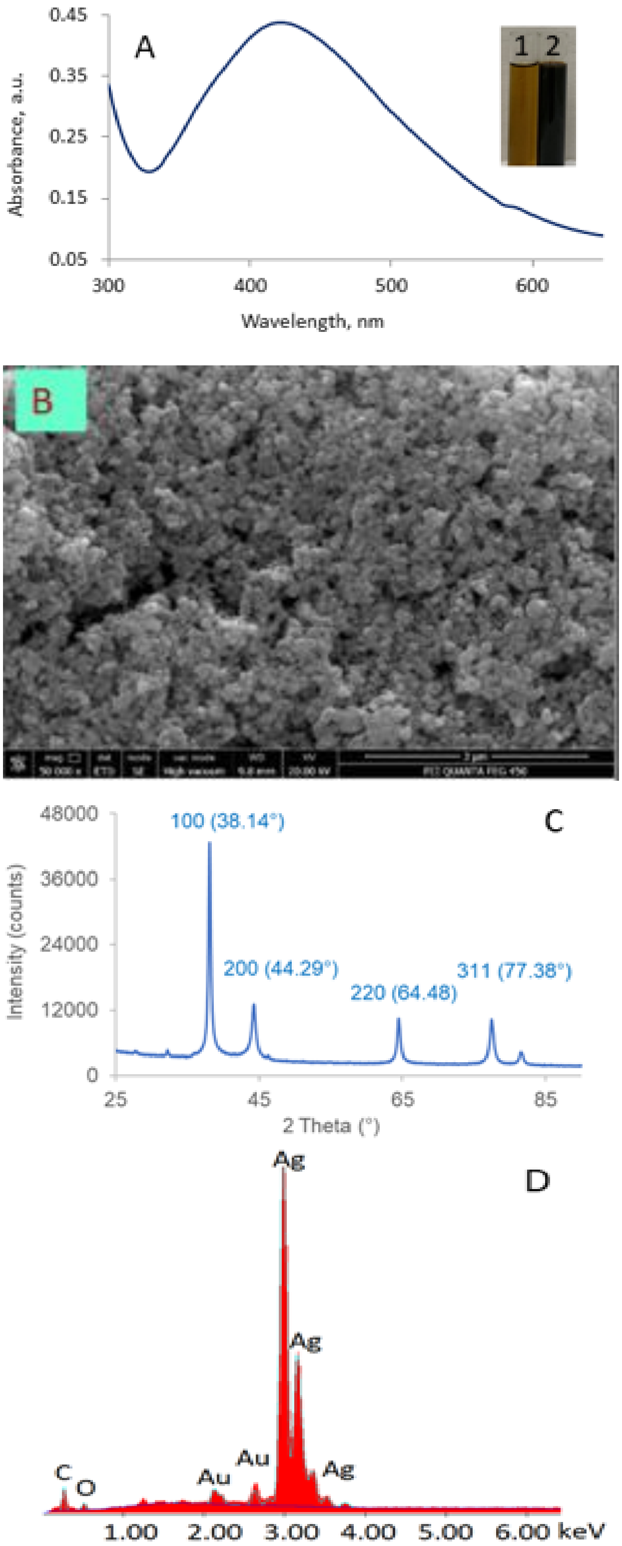

Figure 1. UV-Vis spectrum (A), extract solution (1) and AgNPs solution (2). SEM image (B). XRD spectrum (C). EDX spectrum (D).

Scanning Electron Microscope Analysis

SEM analysis displayed the morphology of nanoparticles (Figure 1B). Formation of nanoparticles was also confirmed by the energy disperse analysis (EDX). The strong peaks around 3 and 3.4 keV in EDX spectrum supported the structure of nanoparticles (Figure 1D). The average particle size was calculated as 36.4 nm (Bachheti et al., 2020).

Conclusion

The synthesis of AgNPs using *A. lagopoides* by cheap, eco-friendly, one-pot and scale-up method was achieved. The structure of the green synthesized silver nanoparticle was elucidated by extensive spectroscopic study such as UV-Vis, XRD, SEM, and EDX techniques. The spectroscopic study showed the formation of well-dispersed, spherical, nanoparticles with an average size of 36.4 nm. *A lagopoides* contains significant bioactive compounds. Hence, nanoparticles capped and stabilized by the corresponding compounds could be a promising material for food and pharmaceutical industries.

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