Green Synthesis, Characterization and Stabilization of Nanoparticles Silver with *Thuja Orientalis* Extract

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**Abstract**

Green synthesis represents an eco-friendly alternative to the environment by minimizing the use of chemical reagents and reduces temperature and pressure conditions. *Thuja orientalis* has a wide medical use because it contains a large amount of compounds derived and was decided to use for the synthesis of nanoparticles. Leaf extract was obtained and characterized by Infrared Spectroscopy Fourier Transform (FTIR) observed carboxyl groups (-C=O), hydroxyl (-OH) and aromatic amines (-NH), then proceeded to the synthesis of nanoparticles, using AgNO₃ as precursor at a concentration of 15 mg L⁻¹, obtaining AgNPs was verified by observing the Ultraviolet-visible Spectroscopy (UV-Visible) absorbance characteristic plasmon between 410-420 nm which reveals the reduction of silver ions (Ag⁺) into metallic silver (Ag₀), the aqueous solution was characterized by scanning electron microscopy (SEM) nanometric sizes observed. The particles obtained were stable for 4 months in aqueous solution, where the characteristic plasmon absorbance was observed by UV-visible spectroscopy for this time.

**Keywords**

Green synthesis; *Thuja orientalis*; Silver; Nanoparticles

**Introduction**

Nanomaterials may provide solutions to technological and environmental challenges in the areas of solar energy conversion, catalysis, medicine, and water treatment [1]. The noble metals, especially silver and gold, have attracted great attention due to their innumerable applications in various branches of science, namely catalysis, photonics, photography, chemical sensing, and most importantly, in the medicinal field antimicrobial agents [2].

It is a dioic tree, the female cone is whitish or rose pale and later bluish-green, with tips well marked and open like spikes, each one of synonomy. It is an evergreen coniferous tree, used in landscape, his cup is narrow in its early years and increases as ages, the general shape is conic and the branches have a laminar form [11]. The branches are fan-like in it is final extreme and upwardly disposed. Branches and leaves have a flat form. The leaves are squamiforms, it means, everyone are like a squama, disposed one on other in an alternated way, they are imbricated. The leaves have a well-marked tip disposed in opposite way. Towards the tip, every branch changes from deep green to green yellowish color.

It is a tree distributed spread widely in Japan, China and Korea [10], this it belongs to the family of Cupressaceae, Subfamily Cupressaceae, and genera *Platycladus* have a big quantity of synonymy. It is an evergreen coniferous tree, used in landscape, his cup is narrow in its early years and increases as ages, the general shape is conic and the branches have a laminar form [11]. The branches are fan-like in it is final extreme and upwardly disposed. Branches and leaves have a flat form. The leaves are squamiforms, it means, everyone are like a squama, disposed one on other in an alternated way, they are imbricated. The leaves have a well-marked tip disposed in opposite way. Towards the tip, every branch changes from deep green to green yellowish color.

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them are a squama and have 6-8 of flattened oval form, are thick and provided with an apical hook, the cone is dehiscent when becomes to maturity then it becomes brownish-tan. Every cone has about 6 seeds, ovoid-trigonoidas and is released generally wingless [11]. The leaves have essential oils which are used in traditional medicine as antifungic, bactericide and other properties such as treatment of cancer, eradicate parasitic worms, and many others. Normally the oil is toxic, mainly for the presence of α-thujone. The other compounds of the leaves are; rhodoxanthin, amentoflavone, hinokiflavone, quercetin, myricetin, carotene, xanthophylls and ascorbic acid [12].

Materials and Methods

Materials

All the chemicals and reagents used in this study were of analytical grade. All glass wares were washed in dilute HNO₃ acid and rinsed thoroughly with distilled water prior to use and dried.

Sample collection

Thuja orientalis, the specimen is relatively common as it is used as ornamental shrub, previously the work of taxonomic identification of the species was once defined, and we proceeded to the selection of leaves to obtain the extract. The main parameters to consider for collection are: young leaves, in good condition, with no evidence of disease or pests. They were then washed with tap water and then with deionized water, then were weighed and the leaves were cut into thin parts removing the stems.

Obtaining the extract

Was weighed 5 g of finely chopped leaves into a flask with 100 mL of deionized water and brought to a temperature of 80-85°C, the mouth of the flask was capped to prevent evaporation losses, plant sample remained a period of 15 minutes, this time completion was removed and allowed to cool for 5 minutes, the mixture was filtered with whatman 40 filter paper and stored in amber bottles at low temperature for subsequent use.

Synthesis of AgNPs

AgNPs synthesis was performed with 50 mL of Thuja orientalis extract at a temperature of 80°C with constant stirring, adding 10 mL of AgNO₃ at different time intervals for each of the concentrations (1, 10 and 15 ppm), UV-vis spectroscopy to corroborate obtaining AgNPs was used, changes in the different variables (temperature, stirring, coloration change) were recorded, the synthesis was completed within 30 minutes from being started, a change was observed to be yellow to amber as shown in Figure 1, the samples were refrigerated for later analysis.

Characterization techniques

The leaf extract Thuja orientalis was characterized by Infrared spectroscopy Fourier transform (FTIR) to identify key functional groups of biomolecules present, the synthesis of silver nanoparticles visual observations of color changes were made during the development of the synthesis, then samples were analyzed by spectroscopy Ultraviolet-visible (UV-Vis) to determine the absorbance characteristic plasmon of the nanoparticles, then the nanoparticles obtained were characterized by scanning electron microscopy (SEM) to determine morphologies and sizes of the particles present in the solution.

Results and Discussion

FTIR spectroscopy

The sample for FTIR analysis was prepared with chloroform extract, the analysis results are shown in Figure 2, where major functional groups present in the extract were identified and associated with the following wavelengths at 2432 cm⁻¹ for NH- and OH groups at 2921 cm⁻¹ for -CH₂-, at 2851 cm⁻¹ CH=CH₂ and O in 2347 cm⁻¹ is attributed to O=C-ÖH at 2065 cm⁻¹ was associated with CO-ÇRN₂ in 1773 cm⁻¹ for C=OR, in 1635 cm⁻¹ and HC=CH-NH₂ in 1463 cm⁻¹ for CH₃ and -CH₂- in 1377 cm⁻¹ for O-CO-CH₃ at 1315 cm⁻¹ for C=O-Φ-OH and NH, in 1057 cm⁻¹ to C-OH groups at 873 cm⁻¹ is attributed to SO, at 762 cm⁻¹ for -NH₂ and -NH-, and finally 538 cm⁻¹ is attributed to C-Cl.

UV-visible Spectroscopy

At the time that a molecule absorbs UV-Vis radiation, the absorbed energy excites electrons from lower energy orbitals to orbitals of higher energy. The UV-Vis maximum absorption occurs at a given wavelength characteristic of the molecular structure can be determined and a graph of intensity versus wavelength absorption. The position and shape of the surface plasmon band depends on the size and shape of the particles, because if these increase, the absorption band tends to shift towards longer wavelengths with higher [13] sizes. The AgNPs have absorbance at a characteristic wavelength between 300 and 800 nm [14], greater absorbance within the range of 460 and 540 nm are attributed to sizes of 10 to 30 nm [15].

Figure 1: Difference in color between the extract before and after performing the synthesis. A) Extract, B) after adding 10 mL of 10 ppm AgNO₃ in a time of 30 minutes.

Figure 2: FTIR Spectrum of the leaf extract Thuja orientalis.
The results obtained for the synthesis with AgNO₃ to 1, 10 and 15 ppm with the extract are shown in Figure 3, 4 and 5, where the maximum plasmon absorbance varies between 403 and 425 nm.

For synthesis with AgNO₃ to 1 ppm, a gradual increase in absorbance ranging from 0.04 to 0.15 units, because the increase in absorbance is minor to observed, this in a small amount of nanoparticles obtained is attributed since the plasmon absorbance appears in length range characteristic wave, reported in the literature for silver nanoparticles. After four months of having made the synthesis, the samples were reanalyzed, the results show that for the times 1 and 2, no longer the plasmon characteristic absorbance seen, this might be due to the agglomeration of nanoparticles in the solution.

In Figure 4, the results of synthesis are shown in AgNPs a solution of AgNO₃ at 10 ppm. The results observed in the plasmon absorption between 403 and 425 nm at the time of synthesis, are attributed to the particles of nanometric size according to that reported in the literature; after 4 months of having made the synthesis, the evolution of nanoparticles in solution was analyzed, results shown in Figure B, and found that the absorbance remains with nanometric sizes, it is noteworthy that by this time small precipitates in the solution began to be observed, so plasmon absorbance between 409 and 420 nm which is attributed to nanometer-sized particles can be seen. Furthermore, when the same solution was analyzed four months after synthesis as seen in Figure B, there was an increase in absorbance which can be attributed to the continuous solution reacting and plasmon absorbance are observed between 415 and 420 nanometers, which shows that the synthesized nanoparticles remain stable, it is noteworthy that no precipitates are present in the flasks.

In Figure 5, the results of synthesis are shown AgNPs with a solution of AgNO₃ at 15 ppm. The results observed in the plasmon absorption between 403 and 415 nm at the time of synthesis, are attributed to the particles of nanometric size according to that reported in the literature; after 4 months of having made the synthesis, the evolution of nanoparticles in solution was analyzed, results shown in Figure B, and found that the absorbance remains with nanometric sizes, it is noteworthy that by this time small precipitates in the solution began to be observed, so plasmon absorbance between 409 and 420 nm which is attributed to nanometer-sized particles can be seen. Furthermore, when the same solution was analyzed four months after synthesis as seen in Figure B, there was an increase in absorbance which can be attributed to the continuous solution reacting and plasmon absorbance are observed between 415 and 420 nanometers, which shows that the synthesized nanoparticles remain stable, it is noteworthy that no precipitates are present in the flasks.

In Figure 3, the results of synthesis with AgNO₃ to 1, 10 and 15 ppm with the extract are shown. A) At the time of synthesis, B) Analysis obtained 4 months after having performed the synthesis.
it had to be filtered to be analyzed, precipitation is attributed to the agglomeration of nanoparticles.

**SEM characterization**

To determine the morphology of the synthesized AgNPs sample, they were observed with scanning electron microscopy. The sample analyzed for scanning electron microscopy, in which the synthesis was 10 ppm of AgNO₃ was used, the microscopy analysis were performed 40 days after the synthesis, and those samples that showed no precipitates, the results are shown in Figure 6.

In micrograph spherical shapes of nanoparticles, some particle sizes of 100 nm are observed, the solutions are analyzed that showed no precipitates, the greater sizes observed 100 nanometers are attributed to agglomeration of the nanoparticles obtained, since these remained in solution, since the time between the synthesis and characterization by microscopy time it was about 4 months.

**Conclusions**

The synthesis by green chemistry AgNPS present satisfactory results for the species *Thuja orientalis*, so it is enhanced as a species for this type of synthesis, for which the data obtained by UV-visible spectroscopy showed the typical plasmon absorbance for silver nanoparticles (between 403 and 420 nm) sizes at the synthesis are in the nanometer range; the obtained nanoparticles tend to agglomerate, but observed by SEM showed spherical morphologies within the range of 100 to 200 nm, these sizes may vary significantly since the sizes depend on the type of mechanism used for the synthesis, precursors and conditions reaction.

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References


