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Research Article

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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 $AgNO_3$ 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 (Ag^{0}), 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]. Colloidal silver is of particular interest because of its distinctive properties, such as good conductivity, chemical stability, catalytic and antibacterial activity. Generally, metal nanoparticles can be prepared and stabilized by chemical, physical and biological methods; the chemical approach, such as chemical reduction, electrochemical techniques, photochemical reduction [1] and pyrolysis and physical methods, such as Arc-discharge and physical vapor condensation (PVC) [3].

Most of the chemical methods used for the synthesis of nanoparticles are too expensive and also involve the use of toxic, hazardous chemicals that are responsible for various biological risks. This enhances the growing need to develop environmentally friendly processes through green synthesis and other biological approaches. Sometimes the synthesis of nanoparticles using various plants and their extracts can be advantageous over other biological synthesis processes which involve the very complex procedures of maintaining microbial cultures [4]. Many of such experiments have already been started such as the synthesis of various metal nanoparticles using fungi like *Fusariumoxy sporum* [5], *Penicillium sp* [6]. But, synthesis of nanoparticles using plant extracts is the most adopted method of green, eco-friendly production of nanoparticles and it also has a special advantage that the plants are widely distributed, easily available, much safer to handle and act as a source of several metabolites [7]. There have also been several experiments performed on the synthesis of silver nanoparticles using medicinal plants.

With the advent of advance technologies and improved scientific knowledge, a way for research and development has been paved in the field of herbal and medicinal plant biology towards intersection of nanotechnology. One such interference is employing plants in synthesis of nanoparticles. The possibilities of employing plants in the synthesis of nanoparticles have burgeoning interest as an important source against reliable and environmentally benign method of metallic nanoparticles synthesis and it is characterization [8].

Studies have shown that the size, morphology, stability and properties (chemical and physical) of the metal nanoparticles are strongly influenced by the experimental conditions, the kinetics of interaction of metal ions with reducing agents, and adsorption processes of stabilizing agent with metal nanoparticles. Hence, the design of a synthesis method in which the size, morphology, stability and properties are controlled has become a major field of interest [9].

Taxonomy and chemical constituents of *Thuja orientalis*

Thuja orientalis 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.

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

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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 HNO_3 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 $AgNO_3$ 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 -CH_2-, at 2851 cm^{-1} CH=CH_2 and O in 2347 cm^{-1} is attributed to O=C-OH at 2065 cm^{-1} was associated with CO-CRN_2 in 1773 cm^{-1} for C=OR, in 1635 cm^{-1} and HC=CH-NH_2, in 1463 cm^{-1} for CH_2 and -CH_3- in 1377 cm^{-1} for O-CO-CH_2, 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 -NH_2 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].

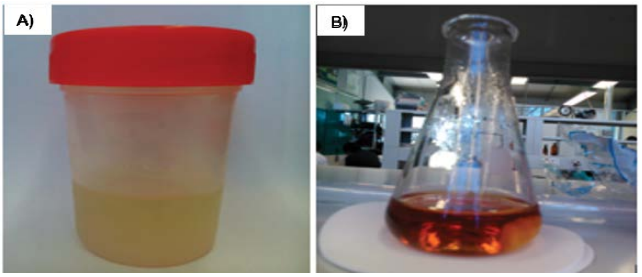

Figure 1: Difference in color between the extract before and after performing the synthesis. A) Extract, B) after adding 10 mL of 10 ppm AgNO3 in a time of 30 minutes.

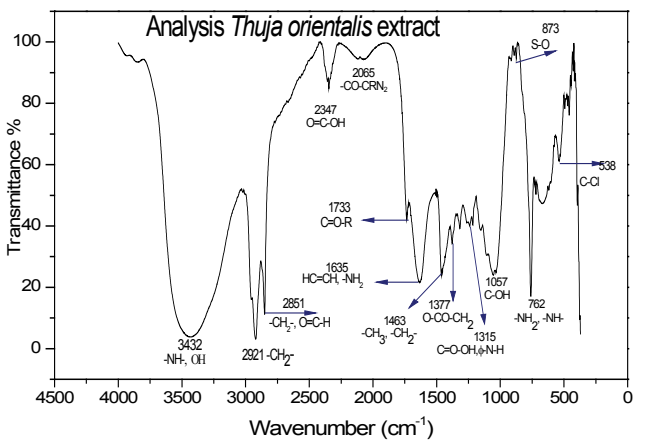

Figure 2: FTIR Spectrum of the leaf extract *Thuja orientalis.*

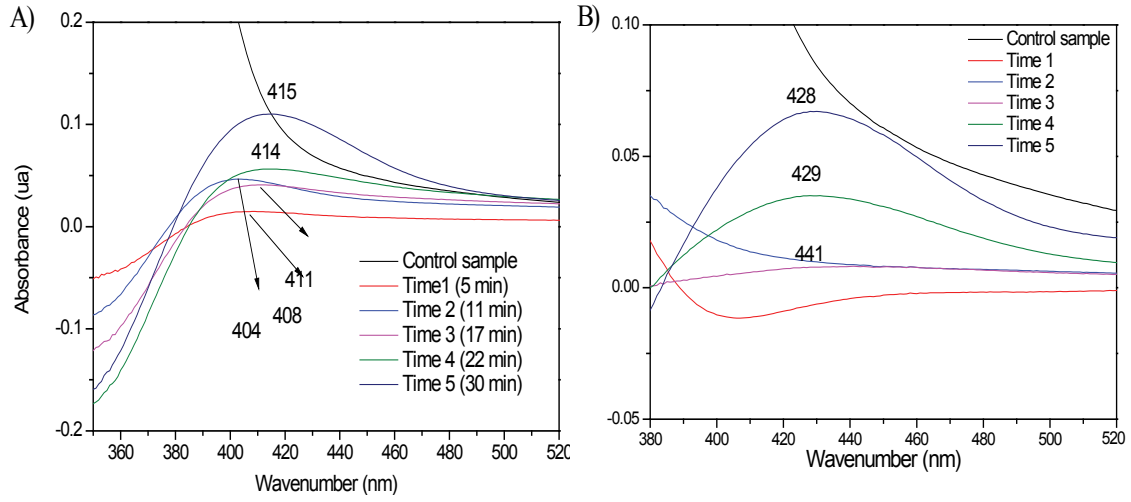

Figure 3: Surface plasmon spectra after the addition of different concentration of metal ion silver with 10 mL of $AgNO_3$ to 1 ppm, A) At the time of synthesis, B) Analysis obtained 4 months after having performed the synthesis.

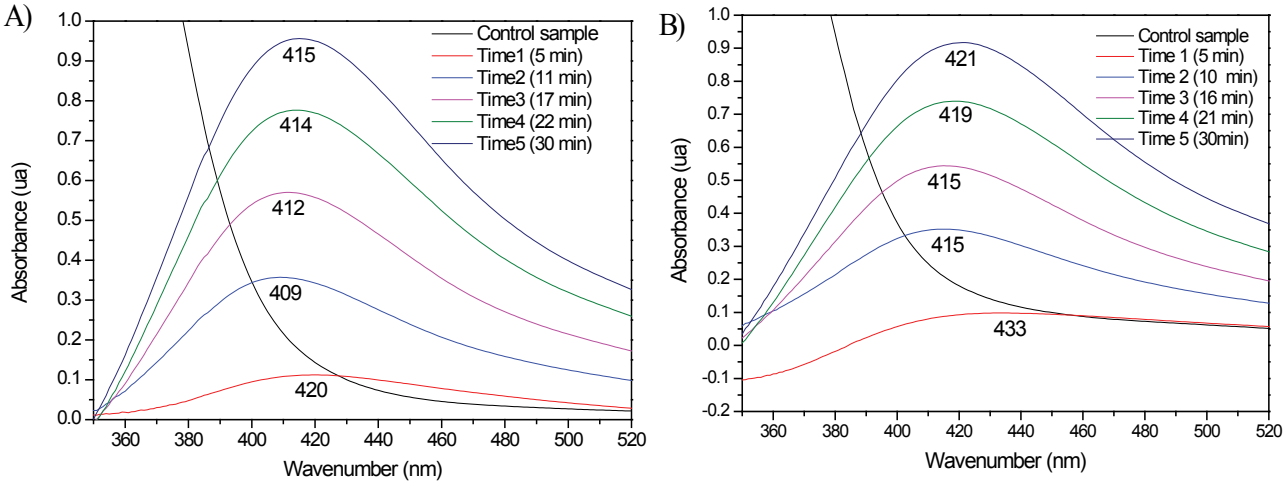

Figure 4: Surface plasmon spectra at different concentration metal ion concentration with 10 mL of 10 ppm $AgNO_3$, A) At the time of synthesis, B) Results obtained 4 months after completing the synthesis.

The results obtained for the synthesis with $AgNO_3$ to 1, 10 and 15 ppm with the extract are shown in Figure 3, 4 and 5, where the maximum plasmon absorbance varies ranges between 403 and 425 nm.

For synthesis with $AgNO_3$ 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 to 10 ppm of $AgNO_3$

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 it being cooling 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 $AgNO_3$ at15 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

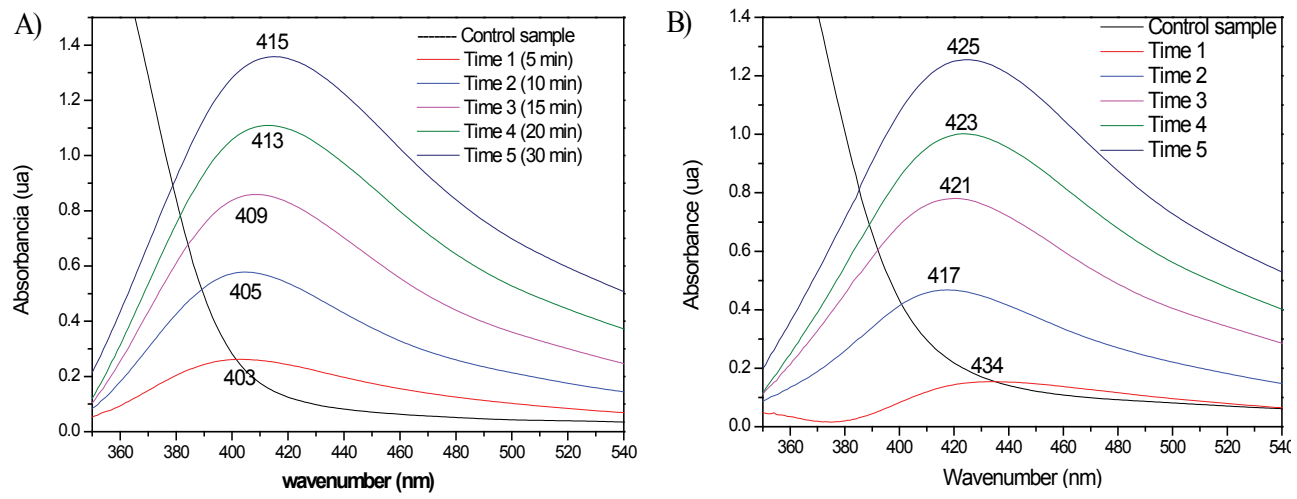

Figure 5: Surface plasmon spectra at different concentration metal ion concentration with 10 ml $AgNO_3$ 15 ppm A) At the time of synthesis, B) 4 months after synthesis has been made.

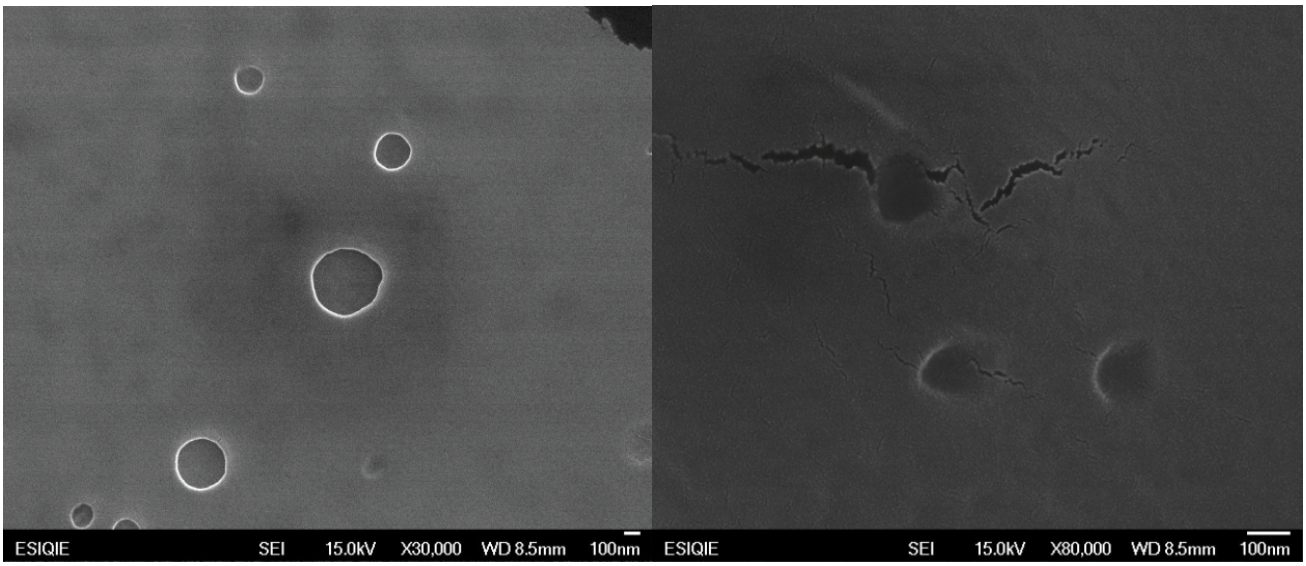

Figure 6: SEM micrograph obtained 40 days after synthesis.

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 $AgNO_3$ 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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