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Biosynthesis of Gold Nanoparticles Using *Loeselia Mexicana* Extract

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In recent years, the notorious importance of the study of nanomaterials has been appreciated. Nanotechnology is a relevant field that studies the synthesis, development and practical implementation of nanoparticles and nanomaterials, whose dimensions fall within the range of 1 to 100 nm. In this size range, the physical and biological properties change entirely concerning the features of the particles above this scale [1]. Among the wide variety of studies carried out in the area of synthesis, gold nanoparticles standout due to their catalytic properties and their ease of their obtainment by green methods [2]. Green synthesis employs antioxidant and surfactants biomolecules taken from the plant's extracts, which can be used for the nanoparticles synthesis, considering it as a novel and sustainable method. This method has been used mostly to synthesize gold and silver nanoparticles with suitable size and shape control [3].

In this work, *Loeselia Mexicana* (Lam.) Brandegee plant extract was used. Fresh *Loeselia Mexicana* leaves were separated from the stems to be dried, milled and washed with distilled water using magnetic stirring. The extraction of biomolecules was carried out by mixing the milled leaves with 100 ml of distilled water at 70°C for 10 minutes using magnetic stirring. The extract was filtered and cooled to room temperature. Gold nanoparticles synthesis was carried out by mixing the leaf extract with 2mM $HAuCl_4$ in a 1:1 volume ratio. A sample was left under sunlight for 20 minutes, and another one was heated in an oven at 40°C for 20 minutes. Synthesized samples showed a color change from pale yellow to violet, indicating that gold nanoparticles were synthesized. Nanoparticles growth and stabilization were monitored by UV-Vis spectroscopy (OceanOptics USB 4000). The XRD pattern was obtained (Bruker D8 Advance, DAVINCI Lynx eye) using CuKα radiation (λ = 1.5406 A°), angular range from 20° to 90° and 0.02° / second step. SEM images were obtained by backscattered electron technique (JEOL JSM-7600F).

Figure 1 shows the gold nanoparticles UV-Vis spectra, the peak is located between 500-600 nm in both samples, and it is characteristic of the gold nanoparticles [4]. It is noted that the specimen exposed to sunlight has a higher absorbance. However, the peak is broader, which indicates that a greater quantity of nanoparticles was obtained with a more extensive size distribution than the sample heated at 40°C. Thus, the results showed that *Loeselia Mexicana* (Lam.) Brandegee biomolecules can reduce the $HAuCl_4$ solution and stabilize the gold nanoparticles. Figure 2 corresponds to the XRD pattern, wherein the gold crystallographic phase formation can be seen. Figures 3a-b correspond to the sample heated at 40°C, therein an appreciable amount of spherical gold nanoparticles are observed between 50-60 nm accompanied by tetrahedral and icosahedral nanoparticles. Figures 3c-d corresponds to the sample under sunlight showing a reduced formation of nanoparticles around large particles greater than 300 nm. The sunlight presence induced an accelerated bioreduction provoking uncontrolled growth of the Au particles. Therefore, the sample heated at 40°C, show the best results. The heating control and temperature accuracy lead to a better size, morphology and size distribution control [5].

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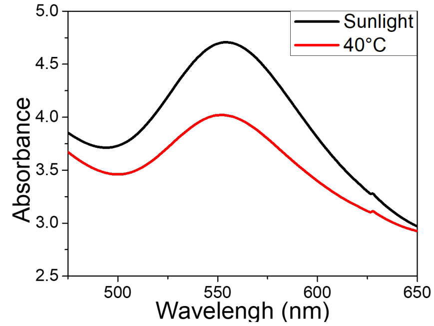

Figure 1. UV-Vis spectra of gold nanoparticles synthesized with *Loeselia Mexicana* extract under sunlight and heated at 40°C.

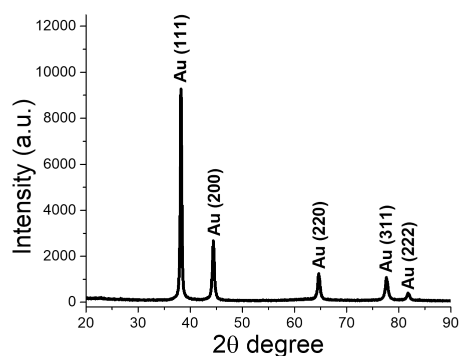

Figure 2. X-Ray diffractogram of gold nanoparticles synthesized with *Loeselia Mexicana* extract.

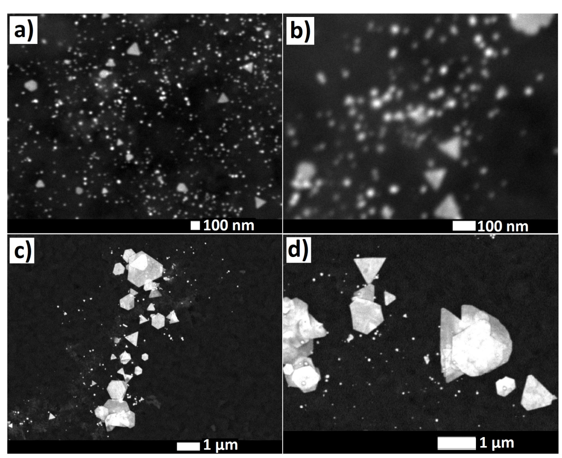

Figure 3. SEM images of gold nanoparticles synthesized with *Loeselia Mexicana* extract: (a-b) under sunlight, and (c-d) heated at 40°C.

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