

A Culinary Herb Extract to Synthesize Silver Nanoparticles

L.M. Carrillo-López^{1*}, H.A. Zavaleta-Mancera^{1*}, A.R. Vilchis-Néstor², R.M. Soto-Hernández¹, J. Arenas-Alatorre³, L. Trejo-Téllez¹, F. Gómez-Merino¹

¹Colegio de Postgraduados. Km. 36.5 Carr. México-Texcoco, 56230. Texcoco, Edo. Mex. México.

²Centro Conjunto de Investigación en Química Sustentable UAEM-UNAM. Km 14.5 Carr. Toluca-Atlaconulco, 50200 Estado de México, México.

³Universidad Nacional Autónoma de México. Instituto de Física, Circuito de la Investigación SN, Ciudad Universitaria, 04510. Ciudad de México, DF, México.

luismanuel@colpos.mx / arazavaleta@colpos.mx

The biosynthesis of nanoparticles with plant extracts or in whole plants is a promising technique which produces particles of attractive shapes, homogeneous in composition and sizes, in an organic and friendly environment. It has been reported the biosynthesis of Au nanoparticles by plants like alfalfa, *Aloe vera*, *Cinnamomum camphora*, neem, *Emblica officianalis*, lemongrass (*Cymbopogon flexuosus*) and tamarind (*Tamarindus indica*); however the potential of plants as biological material for the synthesis of nanoparticles has not been fully explored [1]. The aim of this research is to evaluate the potential of aqueous extracts of the Mexican culinary herb (*Chenopodium ambrosoides* L.) in the biosynthesis of Ag nanoparticles using AgNO₃ as precursor. For *in vitro* biosynthesis, the extracts were prepared according to Chandran [2]. Six volumes (0.1, 0.2, 0.5, 1, 2, 3 and 5 mL) of extract and two concentrations (10⁻² and 10⁻³ M) of AgNO₃ were tested. Formation of nanoparticles was monitored periodically by UV-Vis spectrophotometry (Perkin Elmer Lambda 40 spectrophotometer UV/VIS). The aqueous extracts developed a yellow color, associated with the formation of silver nanoparticles. The presence of nanoparticles was corroborated by the presence of the surface plasmon resonance (SPR) at 438 nm. Increases in quantity extract increases particle size, but the concentration of silver nitrate showed an inverse ratio. In most of our studied systems the shapes of the obtained particles were considered quasi-spherical. The intensity of the absorption at 438 nm in the UV-Vis spectra increases with time, reaching a stable value after 15 d of reaction (Figure 2). Increases in volume extracts promoted displacement of the maximum absorption band and the widening proportionally, specifically for particles above 10 nm diameter, leading to higher light dispersion [3]. Particle characterization, to examine the size and shape of the particles as well as the crystal structure, was performed using transmission electron microscopy (Jeol 2010 TEM) operating at 200 kV and selected area electron diffraction (SAED) at the Research Center of Sustainable Chemistry, UAEM-UNAM. Figure 3 shows a representative micrograph of the formed silver nanoparticles after 15 d of reaction, with 1 mL of extract. The particle size distribution indicated that average size was 14.9 ± 7.5 nm although the greater population was between 5-10 nm (Figure 4). The SAED pattern indicated that it was a polycrystalline sample (insert, Figure 3). The diffraction rings of inside out can be indexed with the planes (111), (200), (220), (311) and (420), respectively, which correspond to the structure face-centered cubic (fcc) of the silver (JCPDS 04 - 0784). The nanoparticles obtained with this system were stable for more than eight months at 20 °C.

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References

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Figure 1. Characteristic coloration of silver nanoparticles obtained with different volumes of extract of *C. ambrosioides* and 10^{-2} M AgNO_3 . From left to right: 0.1, 0.2, 0.5, 1, 2, 3 y 5 mL of extract.

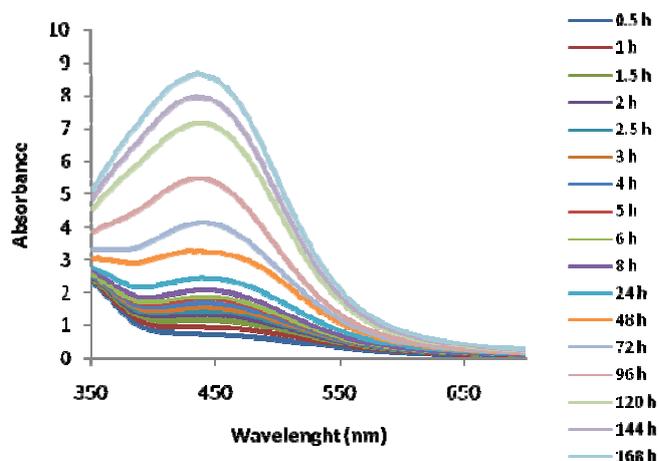


Figure 2. UV-Vis spectra of silver nanoparticles obtained with 5 mL of extract of *C. ambrosioides* and 10^{-2} M AgNO_3 at different times.

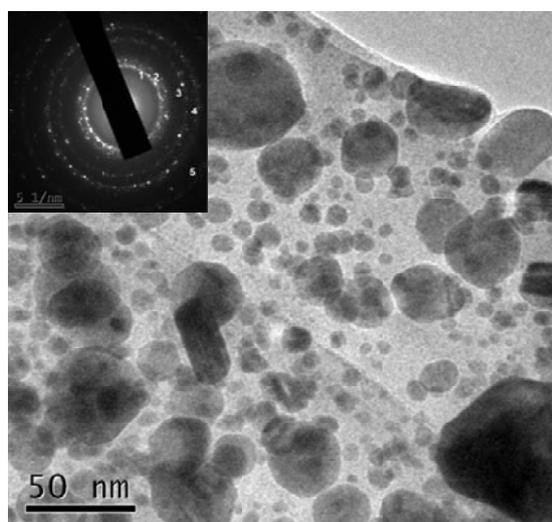


Figure 3. Representative TEM micrograph of silver nanoparticles synthesized from 1 mL of extract of *C. ambrosioides* and 10^{-2} M AgNO_3 . The insert corresponds to the electron diffraction pattern of a face-centered cubic (fcc) structure.

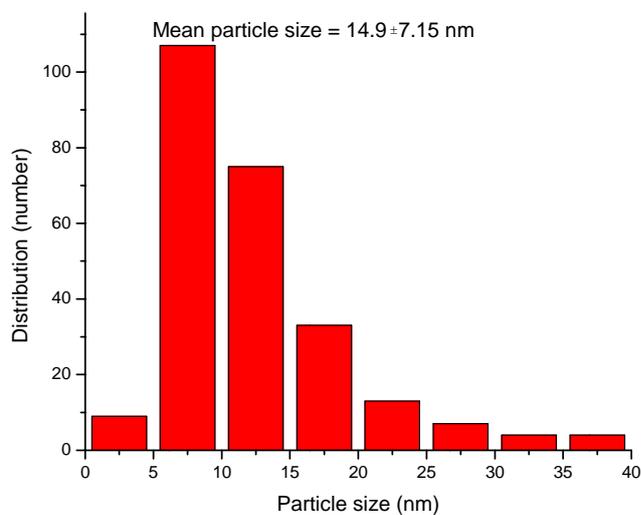


Figure 4. Dispersion of silver nanoparticles sizes synthesized from 5 mL of *C. ambrosioides* extract and 10^{-2} M AgNO_3 .