GOLD NANOPARTICLE FORMATION BY SEAWEED BIOMASS: INFLUENCE OF PH

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ABSTRACT

The unique properties of gold at the nanoscale are ensuring that gold is a candidate material for nanotechnology applications in the diverse areas of electronics, catalysis, colors and coatings and the biomedical sector. Specific examples of technologies considering or already using gold have been described, including: low resistance printable gold nanoparticulate inks for flexible electronics (1), gold nanowires for interconnections in future electronic devices (2), nanoparticulate gold colloid for rapid tests and biomedical assays (3), gold-silica nanoshells for targeted destruction of cancer cells (4), improved decorative coatings using thiol stabilised gold nanoparticles (5), thermosetting gold nanoparticle containing paints exhibiting novel aesthetic effects (6), nanoparticulate gold catalysts for pollution control and chemical synthesis (7), fuel cell electrocatalysts based on carbon supported nanoparticulate gold (7), etc.

All these applications demand nanoparticles with a well-defined size and shape. Biological methods using bacteria and fungi for the synthesis of metal and semiconductor nanoparticles represent a relatively unexplored and unexploited alternative, but have hitherto yielded little by way of size and shape control. Understanding biochemical processes that lead to the formation of nanoscale inorganic materials is therefore potentially appealing as environmentally friendly alternatives to chemical methods for nanoparticle synthesis.

In this study, we demonstrate the biological synthesis of gold nanoparticles by a single-step, room-temperature reduction of aqueous chloroaurate ions by brown seaweeds (*Fucus spiralis).*

The dry biomass (*Fucus spiralis*) was ground and sieved to 100 mesh in order to have particles of uniform size and more area exposed to the gold. The washed biomass was separated in several samples of 35 mg. Each sample was exposed to 70 ml of a 100 ppm Au (III) solution (prepared from potassium tetrachloroaurate salt). The pH values of the solutions containing the biomass were adjusted to 2, 4, 7 and 10, using different low concentrations of HCl and NaOH as needed. After the adjustment of the pH, the samples were run for 4 or 44 hours, and then analyzed using a high resolution JEOL JEM-3000 F Field Emission Electron Microscope.

The particles obtained by bioreduction of the chloroaurate with the algae show similar shapes and sizes to those obtained with other biomasses like alfalfa, oat or wheat (8). Thus, it can be inferred that the polysaccharides present in the cell walls play a more relevant part than the rest of the cell components. Although pigments (such as chlorophyll A and C or the diatoxanthine in brown algae) have a high reducing ability.

Figure 1 shows different colored solutions that were obtained for reducing times of 4 and 44 hours. For short times the color ranges between yellow, for pH 2 value, and purple, for pH 10 value. On increasing time all the solutions acquire a similar color. Color is related to the size of the gold nanoparticles.

Figures 2 and 3 show the images of the nanoparticles contained in the different solutions. All pH values show the presence of globular crystals that are between 5 and 40 nm. Nevertheless, along with globular shapes icosaedric, pyramidal, polygonal, laminar and rod-shaped particles were also found. Regarding the mechanism of crystal growth of the gold particles, 30-40 nm crystals were formed by the coagulation of smaller spherical nanoparticles.

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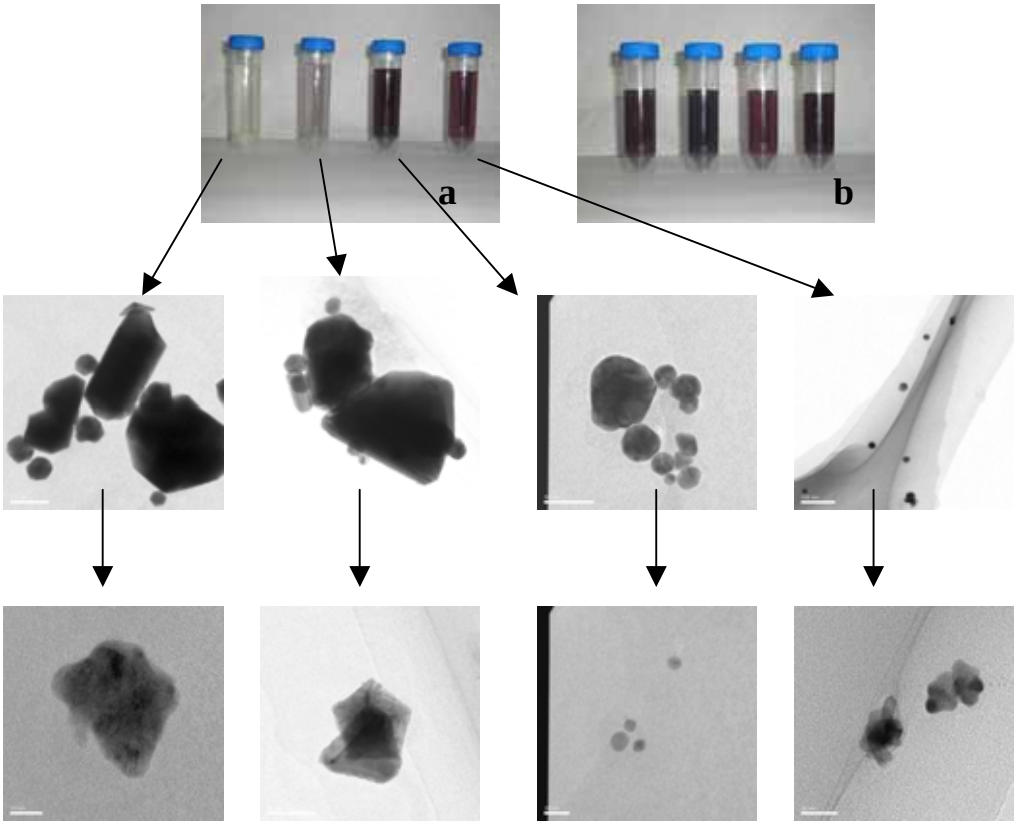

Figure 1. Gold solutions exposed to *Fucus spiralis* biomass: a) 4 hours, b) 44 hours. From left to right: solutions adjusted at pH values of 2, 4, 6 and 10.

Figure 2. Gold nanoparticles images obtained by reduction with *Fucus spiralis* at different pH.

Figure 3. Details of gold nanoparticles.