Preparation Eco-Friendly and Characteristic of Gold Nanoparticles by Orchid and Gum Arabic as a Reducing Agent

Dhelal A. Shabeeb, Abdulalah Th. Mohammed and Adawiya J. Haider

Abstract

Eco-friendly green synthesis is one of the favorable branches of nanoscience for usage in different biomedical fields this option due to nontoxic and very low cost of synthesis. we describe the preparation of gold nanoparticles using an orchid (polysaccharide) and gum arabic as reducing agent and use new method (inverse method) in preparation, a new easy and economical method has been developed by adding the gold ion (Au^{3+}) solution to the reducing agent solution with heating and stirring. Green synthesis of gold nano particle using various natural material reduces aqueous HAuCl_{4}.3H_{2}O to Au^{0}. Synthesized nano particle is confirmed by the change of color of chloroaauric acid which is yellow in color, and growth of nanoparticle was monitored by surface plasmon behavior using UV-Vis Spectroscopy. The prepared gold nanoparticles was characterized by a peak at 528 nm for both orchid and gum Arabic, zeta potential, AFM, and detect clearly TEM images and the size of the gold nanoparticles were 14-30 nm for orchid and 20-50 nm for gum Arabic in size. Morphology whereas TEM image shows different shapes like hexagonal, and spherical.

Key words: inverse method, gold nanoparticle, green synthesis, characterization, natural material
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The preparation by the green method or the environmental friendly is one of the branches in the field of nanotechnology and used in different fields of the biological medicine, because this method is non-toxic and environmentally friendly. In our research, we described the preparation of gold nanoparticles using natural materials, gum Arabic and honey as reducing agents.

Using the reverse method in the preparation, which is the opposite of the usual method, which makes it easier and more economical in controlling the interacting materials, where the gold trichloride solution is added to the reducing agent solution with continuous heating and agitation. In this method, we used materials to reduce the gold trichloride solution to the gold element, and the nanoparticles of gold were formed, which can be observed through the change in the yellow color of the gold solution and the growth of these nanoparticles in the solution, and the identification is done using the ultraviolet-visible spectrum, where the absorption peaks were clear in 825 nanometers for honey and gum Arabic, and 23-83 nanometers using gum Arabic, and different shapes for gold nanoparticles such as spherical and hexagonal.

Keywords: reverse method, gold nanoparticles, green preparation, analysis, natural materials
Introduction

Nano biotechnology is one the most common branches, which received the most attention from the researchers, due to its economic and eco-friendly process to preparation particles with a dimension smaller than 100 nm, [1]. Nanoparticles are prepared by different methods such as chemical, physical, mechanical and biological [2]. The gold nanoparticles is of special interest because of its application in catalysis, sensor, electronics, medicine, drug delivery, biomedical diagnostics, bio labeling, tissue/tumor imaging and photo thermal therapy [3,4]. Preparation eco-friendly of nanoparticles by natural materials is of great interest, the major goal of this study was the preparation of AuNPs by the aqueous. Orchid is herbaceous perennial plant which grows up to 60 cm its narrow leaves are often stained with colored black, leg flowers are purple color and has a couple of tubers exist beneath the surface of the ground color light brown and the inside creamy yellow. These tubers contain resins, gel, protein, starch, sucrose and minerals, orchid is utilized for variety of diseases including thread in children, skin diseases; a form of tuberculosis, besides it's big value in serving as a special diet [5]. Gum Arabic (GA) also known Gum Acacia is a natural gum harvested from the exterior of acacia trees in the form of dry, hard nodules about 10-50 mm in diameter, and ranging from almost colorless to brown. Gum Arabic has high water solubility It is a branched-chain, polysaccharide, either neutral or little acidic, found as a mixed calcium, magnesium and potassium salt of a polysaccharide acid. Gum acacia is utilized in pharmaceutical, cosmetic and food industries as an emulsifier and stabilizer, and in some countries in the traditional therapy of patients with chronic kidney disease, acacia is basically nontoxic when ingested [6].
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Figure 1: Form shows root of orchid. Figure 2: form of Gum Arabic

Figure 3: Structure of Gum Arabic
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Experimental

1- Prepare of gold nanoparticles by orchid plant as reducing agent

0.5g of orchid was dissolved in 250 ml distilled water, the solution was heated to a temperature between 60-70°C, to this solution 3.6 ml of 10 mM HAuCl₄·3H₂O (99% HIMEDIA) was quickly added with stirring orchid. After 1 hr the color of the solution was changed from pale yellow to deep red. This indicates the formation of GNP₅. Of the same method in prepared GNP₅ by using gum arabic.

Characterization of gold nanoparticles.

GNP₅ were characterized by UV-Vis spectroscopy (Shimadzu, Japan), Zeta potential analyzer (Brookhaven, USA), Atomic force microscope (AFM), (SPM AA 3000, USA), Transmission electron microscope (TEM), (Philips CM 100, Holland).

Results and discussion.

1- Visual and UV-Vis spectrum study.

The optical color variation from yellow to red after treatment of Au⁺³ with orchid and gum Arabic, the preparation of AuNPs by reduction of Au⁺³ to Au. This variation in solution color may be refer to the surface plasmon resonance (SPR), a particular phenomenon which appear due to the collective oscillations of electrons in the conduction band with that of electromagnetic radiation owing to which it gives absorption in the UV-Vis region [7]. The time-dependent appearance of two new absorption peaks at λ max=528 nm for both orchid and gum Arabic. The change in the position of these bands gives information about the particle size, morphology, and adsorbed kind on the surface [8, 9, 10, 11].
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Figure 4: UV-Vis absorption spectrum of GNPs using orchid as a reducing agent

Figure 5: UV-Vis absorption spectrum of GNPs using gum Arabic as a reducing agent
2- Zeta potential (ζ) study.
Zeta potential, the zeta potential is a key indicator of the stability of colloidal dispersions. The volume of the zeta potential indicates the degree of electrostatic repulsion between adjacent, similarly charged particles in a dispersion. For molecules and particles that are small enough, a high zeta potential will confer stability, the solution or dispersion will resist aggregation. When the potential is small, attractive forces may exceed this repulsion and the dispersion may break and flocculate, gold nanoparticle consider stable when their zeta potential are more positive than +30 mV or more negative than – 30 mV.[12] zeta potential for Au NPs utilized orchid reducing agent was -14mV was unstable for a long time while utilized gum Arabic as reducing agent was -23.18 mV was stable for long time keeping at room temperature.

3- AFM study
The atomic force microscope (AFM) is suitable for properties nanoparticles. It show the ability of 3D visualization and both qualitative and quantitative information on many physical properties including size, morphology, surface texture and roughness. Statistical information, including size, surface area, and volume distributions, can be specific as well. A wide range of particle sizes can be describe in the same scan, from 1 nanometer to 8 micrometers. As well as, the AFM utilized describe nanoparticles in double mediums including ambient air, controlled environments, and even liquid dispersions. [13] GNPS for orchid as reducing agent have a roughness surface and big particles diameter distribution, the range particle of GNPs was measured by AFM images was (68 nm) but GNPs for gum Arabic as reducing agent have a smooth surface and small particles diameter distribution. The range particle of GNPs was measured by AFM images was 53 nm figure 6, 7 shown that.
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Figure 6: AFM image of GNP (A) 2D, (B) 3D and (C) average particles diameter 68 nm for GNPs by using orchid as reducing agent
Figure 7: AFM image of GNP, (A) 2D, (B) 3D, (C) average particles diameter 53nm for GNP's by using gum Arabic as reducing agent.
4- TEM study

The morphology, size and crystallinity of the as-synthesized AuNPs were inspected by TEM measurement. Figures (8, 9) display TEM images of AuNPs prepared by orchid and gum Arabic respectively. This research indicates the formation of spherical and other shapes of particles in diameter in the range of 14-50 nm, this result that was constant with UV–Vis analysis. The hexagonal shape in gum Arabic (Figure 9), and spherical shape in orchid reducing agent (Figure 8).

Figure 8: TEM image of GNPS using orchid as reducing agent resulting particle size 14, 18 nm (low and high magnification).
Figure 9: TEM image of GNPS using gum Arabic as reducing agent resulting particle size between 20-50 nm
TEM is the one of the most popular characterization techniques for nanoparticles. [14] In this technique, a real image of nanoparticles is taken, different magnifications can be used to see a more detailed or general shape of nanoparticles. These images contain a lot of information regarding shape and size distribution, and even crystallographic structure and characteristics of nanoparticles [15]. TEM images information shows that structure and kind of reducing agent play an important role to reduce the HAuCl₄·3H₂O into gold nano composites of various morphology, this process supply highly stable. GNP, use gum Arabic as reducing agent the size of the nanoparticle 44 nm. Shape differently particles formats (clusters, spherical, branched chain) average size between (20 - 50) nm. Among the forms there was a hexagonal crystal. Using different reducing agents not only as a shape control but also as promoting formation of Au nano crystals for the synthesis and shape modulation of the highly pure Au nanostructure in high yield.

**Conclusion**

This paper describes the facile and rabid synthesis of gold nanoparticles by a novel biochemical route. The new method (reverse method) was used by adding the Au³⁺ solution to the reducing agent with heating and stirring. The advantages of the reverse method are Simple and easy method which can be done by undergraduate and graduate students. Control of the used amount of gold salt and the reducing agent and also an easy way to follow-up the gold nano-particles formation through the red color of solution In conclusion, we have inspected the use of orchid and gum Arabic as a reducing and stabilizing agent for the prepare of AuNPs in an water middle. The UV-Vis, Zeta potential, AFM and TEM results display that as prepared Au NPs are poly disperse nature, quasi-spherical and hexagonal form with an median size from 14 – 95 nm.

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