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

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

[*]Department of chemistry - College of science - University of Anbar - Iraq.
[**]Department of Nanotechnology and Advanced Materials Center University of Technology-Baghdad, Iraq.

Received 25 July 2016 ; Accepted 18 September 2016

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 $HAuCl_4.3H_2O$ to Au°. Synthesized nano particle is confirmed by the change of color of chloroauric acid which is yellow in color, and growth of nanoparicle 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 were14-30 nm for orchid and 20- 50nm 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

DIYALA JOURNAL FOR PURE SCIENCES

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

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

التحضير بالطريقة الخضراء والتشخيص لمواد الذهب النانوية باستعمال الصمغ العربي والسحلب كعوامل مختزلة

ظلال عبد الغفور شبيب* ، **عبد الاله ثابت محمد** * **و عدوية جمعة حيدر****

*قسم الكيمياء – كلية العلوم – جامعة الانبار – العراق

**مركز النانو تكنلوجي والمواد المتقدمة - الجامعة التكنلوجيا – بغداد

الخلاصة

التحضير بالطريقة الخضراء او ما يسمى الصديق للبيئة هو واحد من الفروع المفضلة في علم النانو والمستخدمة في مختلف مجالات الطب الحيوي سبب هذا الاختيار لعدم سمية هذه الطريقة وكلفتها الواطئة . في بحثنا تم وصف تحضير جسيمات الذهب النانوية باستخدام كل من المواد الطبيعية السحلب وهو مادة متعددة السكريات والصمغ العربي كعوامل مختزلة . باستخدام الطريقة العكسية في التحضير أي عكس الطريقة الشائعة في التحضير وذلك لكونه اسهل واقتصادي في التحكم بالمواد المتفاعلة حيث يضاف محلول الذهب الثلاثي الى محلول العامل المختزل مع التسخين والتحريك المستمر في هذه الطريقة تم استخدام مواد متنوعة لاختزال المحلول المائي لايون الذهب الثلاثي الى عنصر الذهب جسيمات الذهب النانوية يمكن ملاحظة تكونها من خلال تغير لون محلول الذهب الأصفر ونمو هذه الجسيمات في المحلول وتشخيصها يتم من خلال طيف الاشعة فوق البنفسجية –المرئية حيث كانت حزم الامتصاص واضحة في 528 نانومتر للنانو لكل من السحلب والصمغ العربي ، جهد زيتا ، مجهر القوة الذرية والمجهر الالكتروني الناقل الذي بينت صوره حجوم مختلفة في المدى 14-30 نانومتر باستخدام السحلب والمدى 20-50 نانومتر باستخدام الصمغ العربي وكذلك اشكال مختلفة للجسيمات الذهب النانوية مثل الكروي والشكل السداسي

كلمات المفتاحية : الطريقة المعكوسة ، جسيمات النانو ذهب ، التحضير الأخضر، التشخيص، المواد الطبيعية

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].

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

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

Figure 1: Form shows root of orchid.

Figure 2: form of Gum Arabic

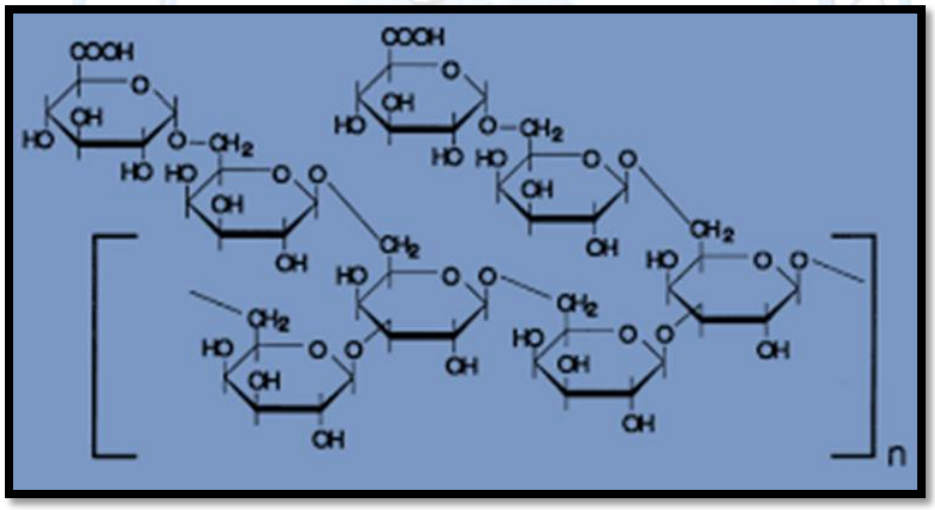

Figure 3: Structure of Gum Arabic

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^0 , to this solution 3.6 ml of 10 mM $HAuCl_4.3H_2O$(99% HIMEDIA) was quickly added with stirring orchid .After 1hr the color of the solution was changed from pale yellow to deep red. This indicates the formation of GNP_S. Of the same method in prepared GNP_S by using gum arabic

Characterization of gold nanoparticles.

GNP_S were characterized by UV-Vis spectroscopy (Shimadzu, Japan), Zeta potential analyzer (Brook haven, 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].

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

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

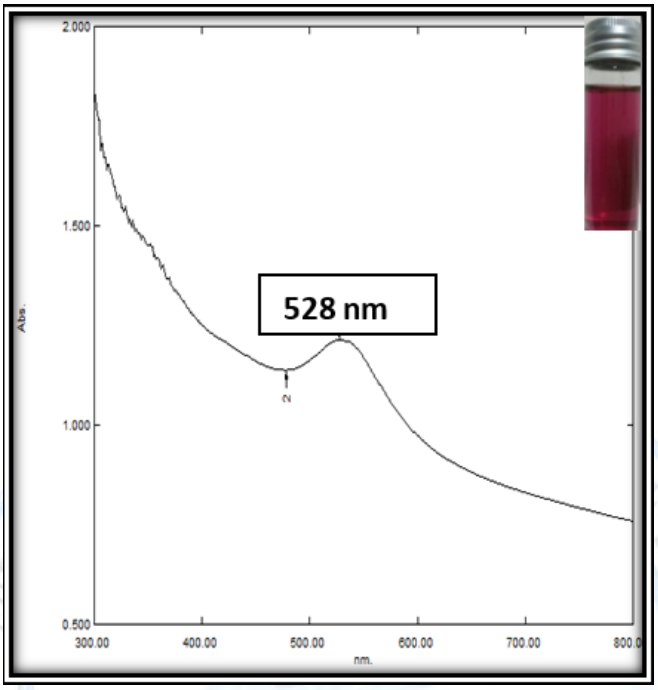

Figure 4: UV-Vis absorption spectrum GNPs using orchid as reducing agent

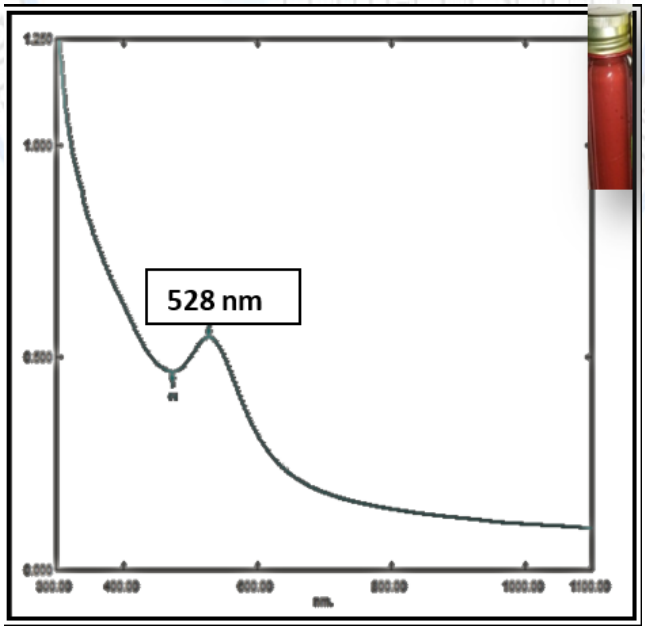

Figure 5: UV-Vis absorption spectrum of GNPs **of using gum Arabic as reducing agent**

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.

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

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

A B

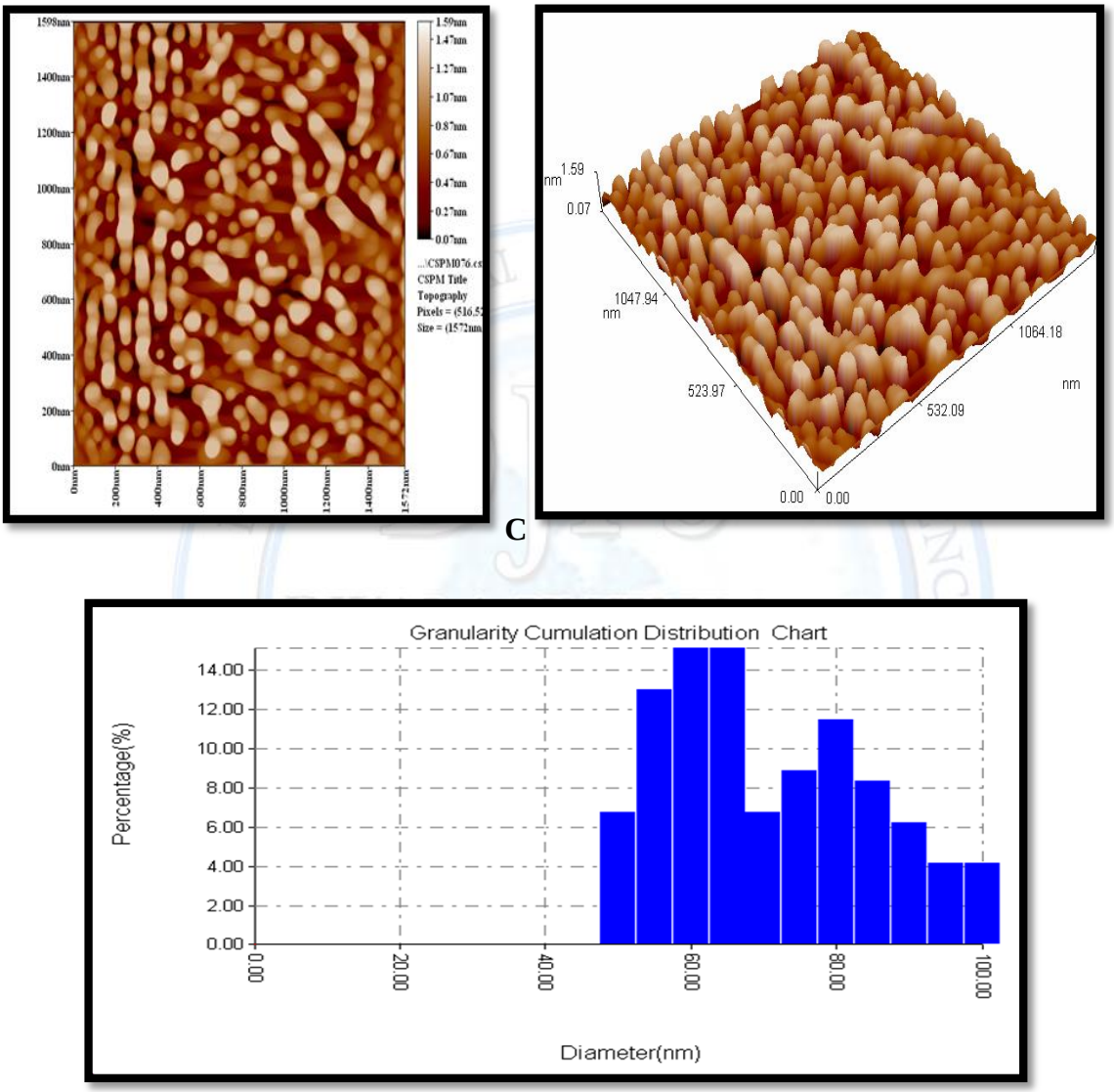

Figure 6: AFM image of GNP$_s$ (A) 2D, (B) 3D and (C) average particles diameter 68 nm for GNPs by using orchid as reducing agent

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

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

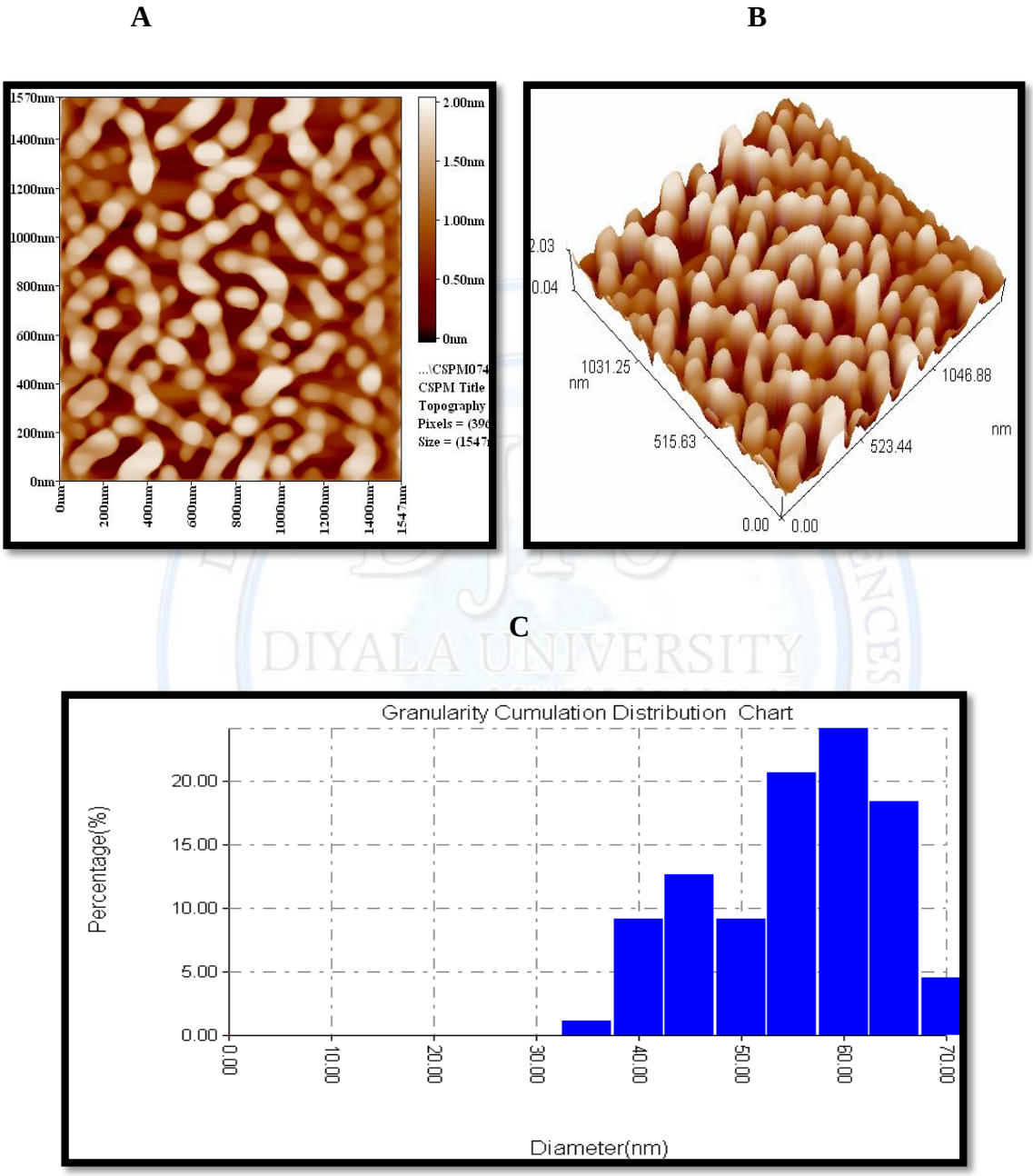

Figure 7: AFM image of GNP$_s$ (A) 2D, (B) 3D, (C) average particles diameter 53nm for GNPs by using gum Arabic as reducing agent

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).

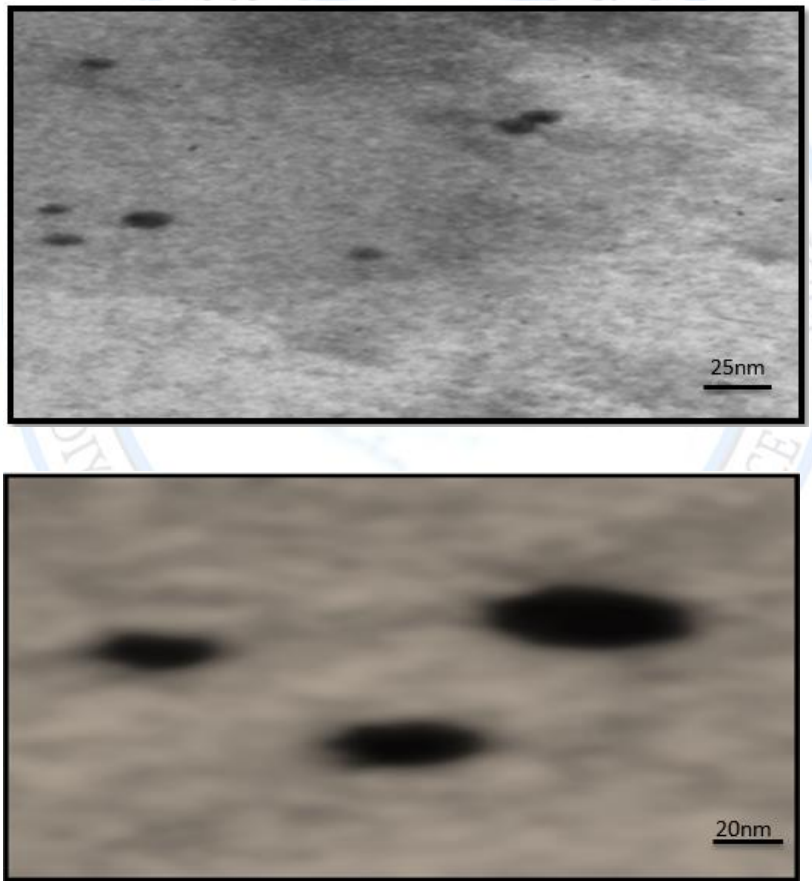

Figure 8: TEM image of GNPS using orchid as reducing agent resulting particle size 14, 18 nm (low and high magnification).

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

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

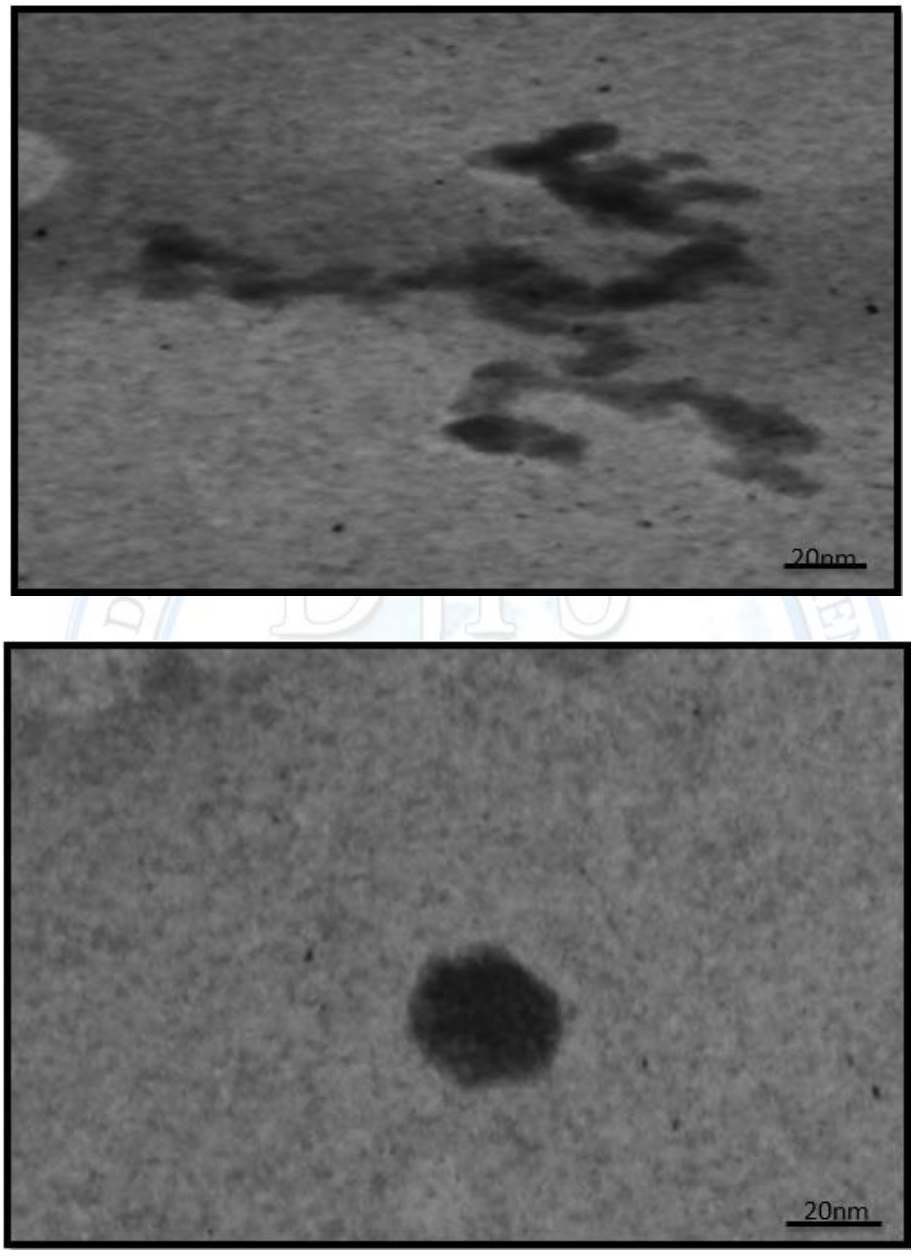

Figure 9: TEM image of GNPS using gum Arabic as reducing agent resulting particle size between 20- 50 nm

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 $HAuCl_4.3H_2O$ into gold nano composites of various morphology, this process supply highly stable. GNP_s 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 Au^{3+} 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.

Acknowledgment : The authors wish to thank Dr.**TahaShawi , engineer: Hemin R. Abdul rahman ,and Miss Muneera K. Ahmed** for performing the UV-Vis , AFM , TEM measurements

References

1. Ahmad A, Mukherjee P, Senapati S, Mandal D, Khan MI, et al . " *Extracellular biosynthesis of silver nanoparticles using the fungus Fusarium oxysporum "* . Colloids Surfaces, B: Bio interfaces. **(2003) 27: 313-318.**
2. Jain. PK, Huang. X, El-Sayed IH, El-Sayed. MA " Noble metals on the nanoscale: optical and photothermal properties and some applications in imaging, sensing, biology, and medicine ". Acc Chem Res . (2008) 41: 1578–1586.
3. Dykman. L, Khlebtsov. N " Gold nanoparticles in biomedical applications: recent advances and perspectives ". Chem Soc Rev . (2012) 41: 2256-2282.
4. Kumar. B, Smita. K, Seqqat. R, Benalcazar. K, Grijalva. M " In vitro evaluation of silver nanoparticles cytotoxicity on Hepatic cancer (Hep-G2) cell line and their antioxidant activity: Green approach for fabrication and application ". Journal of Photochemistry & Photobiology, B: Biology . (2016) 159: 8–13.
5. Jacquemyn. H, Brys. R, Honnay.O and Hutchings. M "Biological Flora of the British Isles: Orchismascula (L.) L." Journal of Ecology. (2009) 97(252): 360–377.
6. Azzaoui. K , Hammouti.B , Lamhamdi .A , Mejdoubi. E and Berrabah. M "The Gum Arabic in the southern region of Morocco" Mor. J. Chem. (2015) 3 (1): 99-107 .
7. Philip. D " Biosynthesis of Au, Ag and Au-Ag nanoparticles using edible mushroom extract". Spectro chim Acta A Mol BiomolSpectrosc . (2009) 73: 374-381.
8. Sinha. T, Ahmaruzzaman. M "Indigenous north eastern India fern mediated fabrication of spherical silver and anisotropic gold nano structured materials and their efficacy for the abatement of perilous organic compounds from waste water-A green approach". RSC Adv6: (2016) 21076-21089.
9. Shankar. SS, Rai. A, Ahmad. A, Sastry. M "Controlling the Optical Properties of Lemongrass Extract Synthesized Gold Nanotriangles and Potential Application in Infrared-Absorbing Optical Coatings". Chem Mater . (2005) 17: 566-572.

10. Nilsson, L. A "Anthecology of Orchismascula (Orchidaceae)".Nordic Journal of Botany. (1983) 3: 157-179.

11. Eqbal. D. auqan andAminah Abdullah "Utilization of gum Arabic for industries and human health" American Journal of Applied Sciences . (2013) 10 (10): 1270-1279 .

12. Raj . V , Sreenivasan. K "Selective detection and estimation of C-reactive protein in serum using surface – functionalized gold nano – particles"Analytic Chemica Acta. (2010) 662 . 186-192.

13. Vasenka. J , Manne. S , Giberson . R , Marsh . T and Henderson. E "Colloidal Gold Particles as an Incompressible AFM ImagingStandard for Assessing the Compressibility of Biomolecules," Biophysical Journal . (1993) 65. 992-997.

14. Wang. Z , Mohamed. M , Link. S , El-Sayed . M "Crystallographic facets and shapes of gold nanorods of different aspect ratios"Surface Science. (1999) 440(1): 809- 814

15. Chandran. SP, Chaudhary. M, Pasricha. R, Ahmad. A, Sastry. M "Synthesis of gold nanotriangles and silver nanoparticles using Aloe vera plant extract." Bio technolProg . (2006) 22: 577-583.