

Synthesis and characterization of gold nanoparticles using fruit extract of *Crescentia cujete L*

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Abstract:

Nanoparticles play important role in biotechnology such as food and drug industries. Gold nanoparticles (Au-NPS) have been widely used in any drug therapies like drug delivery system for cancer, tumor, and diabetes treatment. Recently, Au-NPS have been developed to increase drug selectivity between tumor and normal cells. In the present studies, we use the fresh fruit extract (FFE) of *Crescentia cujete L* mediated blue green alga for the synthesis of Au-NPS. The characterization of Au-NPS was carried out by using UV-Vis spectroscopy, Fourier transform infrared spectroscopy (FTIR), and Transmission Electron microscopy (TEM). UV-VIS spectrometry indicated formation of nanoparticles which produces an intense absorbance peak at 531 nm. FTIR reveals the functional group involved in reduction and stabilization of Au-NPS. TEM have shown the morphology of Au-NPS with mean size 10,11 nm.

Keywords: *Crescentia cujete*; gold nanoparticles; green alga

Introduction

Nanotechnology, a combination of principles involving biology, physical and chemical. Nanoparticles have a special place in nanotechnology due to which they have been widely used in daily lives like detecting environmental toxic metals, diagnostic imaging, biosensing, cancer therapeutics and targeted drug delivery.

Generally the synthesis of Au-NPs has been carried out using microwave irradiation, electrochemical, thermal decomposition and chemical reduction. Rohiman et al. (2014) used sodium citrate as a reducing agent which may hamper the surface modifications and functionalization of agents for particular applications, require high energy, usage of toxic chemicals and leaves hazardous by-products. Inayah et al. (2014) used mangosteen extract act as bioreductor and Polyvinyl alcohol (PVA) as stabilizer to control the growth of Au-NPS. PVA is synthetic polymer can be potentially harmful and Non-biodegradable materials. Blue green alga *Spirulina platensis* also has been used in synthesis of AuNPs with smaller size (average 5 nm) and uniform shape (Suganya et al. 2015). AuNPs can be used as nanocarrier in the treatment of brain tumor which have ability to deliver the drug at targeted site (Tripathi et al. 2015).

Plant based synthesis is more advantages due to their its therapeutic potency as bactericidal, fungicidal, nematocidal, mosquitocidal and anticancer agent (Noruzi, 2015). Seetharaman et al. (2017) have studied the fabrication of gold nanoparticles using an aqueous leaf extract of *Crescentia cujete* and the potency of its fruit was ignored. Berenuk (*Crescentia cujete L.*) fruit is widely used by the community in East Java as traditional medicine and have many active compound like saponins, flavonoids, cardenolides, tannins, and phenols (Hasanah et al. 2018; Ginting et al. 2018; Musa et al. 2019). In the present study, we have studied the synthesis of AuNPs using FFE

from *Crescentia cujete* and blue green alga to degrade the toxic chemicals may be produced during reduction process.

Materials and Methods

Material and instrumentation

The research specimen is fruits of *Crescentia cujete* Linn were collected from cilegon, Banten, Indonesia in June 2019. The chemicals used in this research were $\text{HAuCl}_4 \cdot 3\text{H}_2\text{O}$ (99.9%, Sigma Aldrich) and blue green alga extract. Instrument used spectrometer UV-Vis, FTIR, and TEM.

Extraction and synthesis

Dried green algae of *S. platensis* (1 g) powder was added to 10 mL of aquadest and the mixture was centrifuged at 5000 rpm for 10 min (Suganya et al. 2014). The supernatant was used for synthesis of AuNPs. The fruits of *Crescentia cujete* Linn. were squeezed directly to get fresh fruit sample. Then the sample was filtered through What Mann Filter and the filtered extract was used for synthesis of AuNPs. The experimental synthesis method consisted in mixing 50 ml of $\text{HAuCl}_4 \cdot 3\text{H}_2\text{O}$ (99.9%, Sigma Aldrich) 5×10^{-4} M with 2 mL blue green alga extract and 2 mL fruit extract of *Crescentia cujete* L.

Characterization of AuNPs

The synthesized AuNPs were initially confirmed by UV-Vis spectroscopy at the wavelength of 200–650 nm. FTIR analysis was carried out to identify the reduced bio-compound present in AuNPs. TEM samples of the gold nanoparticles synthesized using fruit and algae extract were prepared by placing drops of the product solution onto carbon-coated copper grids. TEM instrument operated at an accelerating voltage of 200 kV (Seetharaman et al. 2017).

Results

The successful synthesis of gold nanoparticles can be proven using UV-VIS, FTIR, and TEM. Fig 1-2 shows UV-Vis absorbance of HAuCl_4 before and after reaction with fruit extract. The presence of tannin as bioreductor compounds was confirmed by FTIR analysis (Fig 3-4). Fig 5 shows the size and morphology of AuNPs.

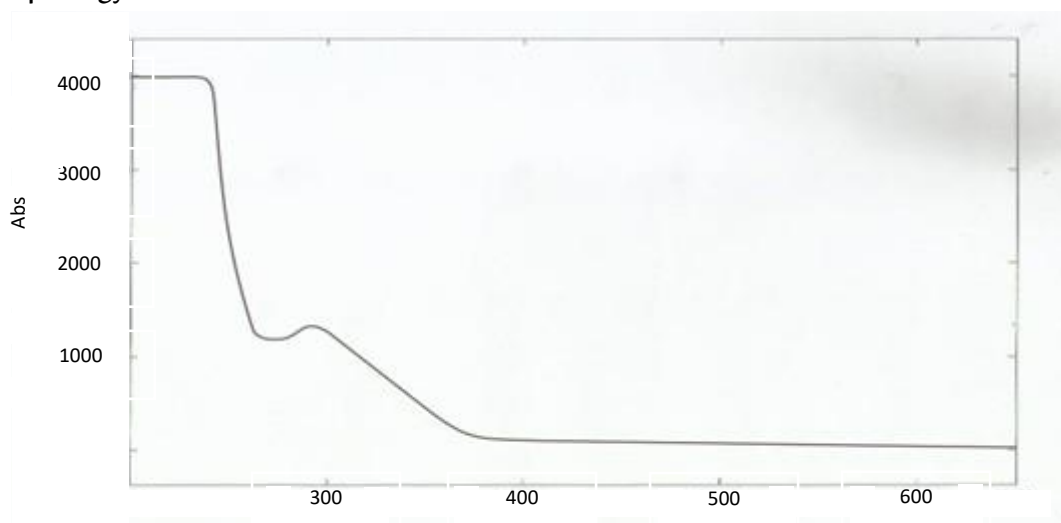


Fig 1. UV-Vis spectra of standard solution of HAuCl_4

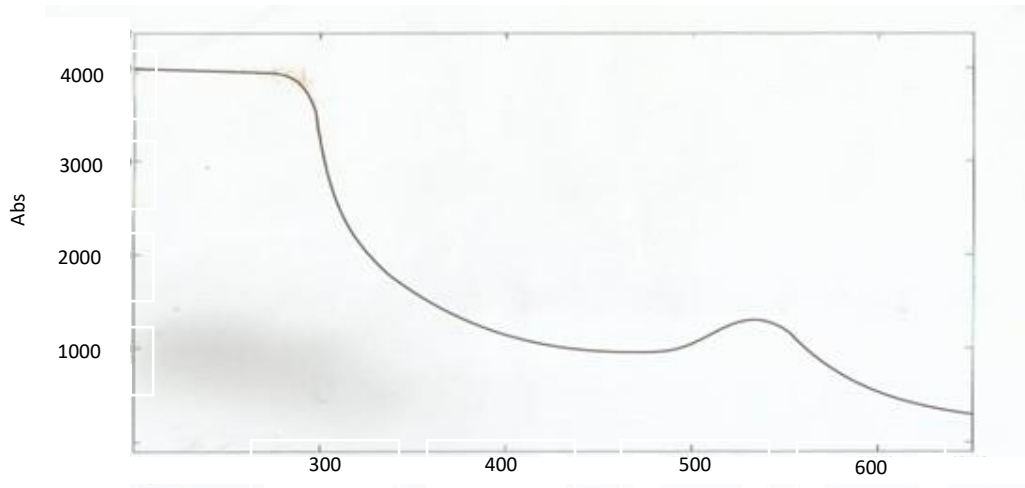


Fig 2. UV-Vis spectra of AuNPS using fruit and algae extract

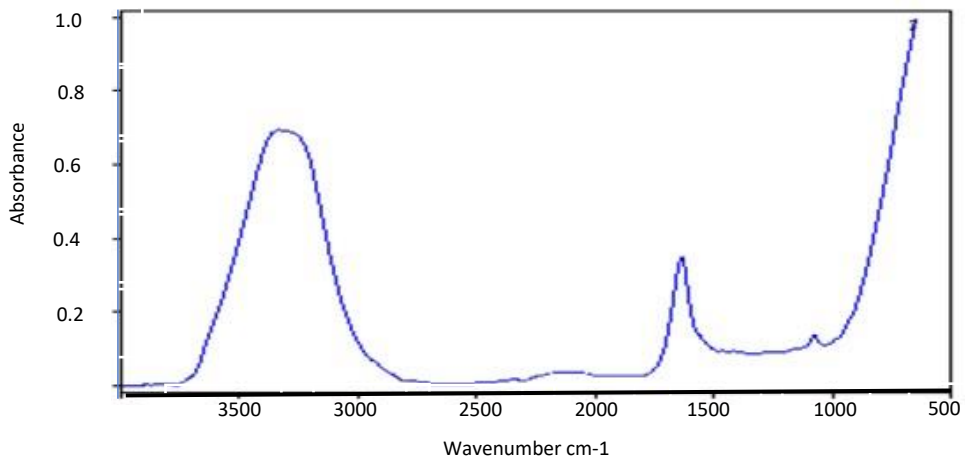


Fig 3. FTIR Absorbance of aqueous fruit extract

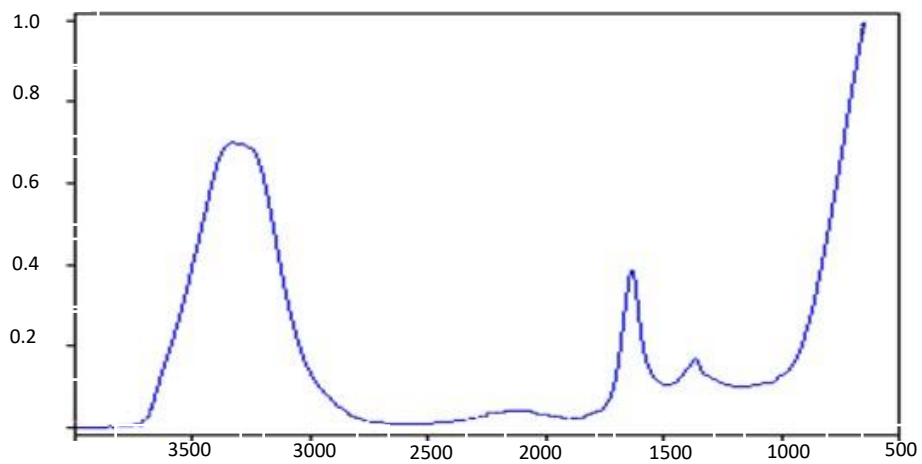


Fig 4. FTIR Absorbance of AuNPs

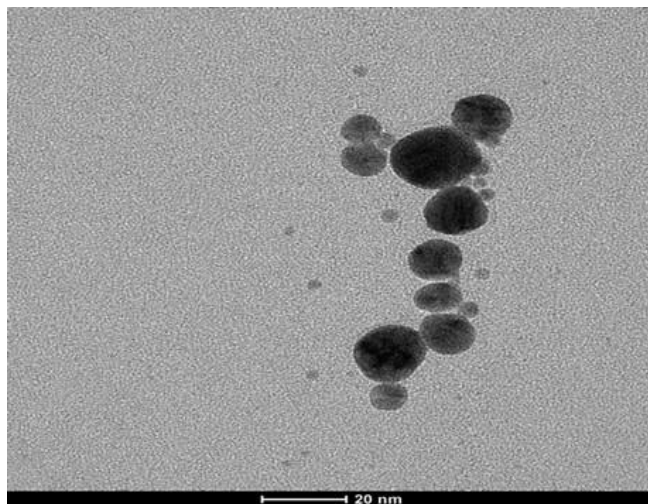


Fig 5. TEM images of AuNPs

Discussion

Figure 1 shows the absorbance spectrum in the visible region for standard solution of H₂AuCl₄. Maximum absorption for this solution occurs at wavelength of approximately 300 nm which is the characteristic of H₂AuCl₄ before reaction with the fruit and algae extract (Setiawan et al. 2014).

The synthesized AuNPs were initially confirmed by visual colour change from yellow to pale to ruby red due to excitation of Surface Plasmonic Vibrations. The formation of AuNPs was also measured using UV-Visible spectroscopy and usually ranges from 500–550 nm related to size, shape, dielectric constant, and collective oscillation of conduction electrons excited by the electromagnetic field of light (Rohiman et al. 2014). In our study, UV-Vis spectroscopic analysis of synthesized CCAuNPs produces an intensely bathochromic shift from 300 nm (Fig 1) to 531 nm (Fig 2). Fruit extract plays a role as reductor and stabilizer of AuNPs because of its ability to reduce Au³⁺ ions of chloroauric acid to Au⁰ in which is stabilized by other chemical compounds. Stability of AuNPs is important for application in pharmacological and biomedical studies. However, fruit extract contains secondary metabolites that are distasteful or toxic to consumers and can be easily degraded by algae extract (Menon et al. 2017).

Many bioactive compounds such as alkaloids, flavonoids, tannins, and saponins were present in the fruit extract of *Crescentia cujete* L (Billacura & Laciapag, 2017). Tannins or phenolic compounds are effective reducing agents to form a high concentration of AuNPs by reduction of Au³⁺. The FTIR analysis revealed the presence of tannins in the fruit extract (Fig 3). In the Fig. 3, two major vibrational stretches were observed at 1600–1750 cm⁻¹ corresponding to carbonyl (C=O) and 3300–3500 cm⁻¹ O-H stretch or H-bonded of alcohols and phenol groups. FTIR spectra also recorded for AuNPs which produce a stronger peak for 1600–1750 cm⁻¹ due to phenolic oxidation (Fig 4). Unassigned peaks like 1300 cm⁻¹ may be attributed to the formation of new bonds between metallic nanoparticles AuNPs and the functional group present in the aqueous fruit extract. The presence of tannin was observed also using Ferric Chloride Test which forms a brown color to show a positive result.

TEM results gave a clear indication on size and shape of AuNPs. Particle size is related to the surface area with smaller sizes having shown higher activity. Fig 5 depicts the uniformity of the spherically shaped nanoparticles with an average size of 10.11 nm. Our research is in accordance with AuNPs using a bioreductor extract of ketapang leaf with microwave irradiation (Rahmah, 2019).

Conclusion

In this research, fruit extract of *Crescentia cujete* L and algae are used for biosynthesis of gold nanoparticles an inexpensive, nature- friendly and simple process. The formation of AuNPS was proven by ultraviolet-visible spectroscopy, FTIR, and TEM which implies that AuNPS are in nano size and highly stable.

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