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# Characteristics Of Silver Nanoparticles Produced By Green Synthesis Method Using Citrus Sinensis Peels Extract

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***Abstract:***
*Silver nanoparticles have been fabricated by a variety of techniques. The green synthesis process presents several benefits, such as cost-effectiveness and simplicity in production, as well as the potential to eliminate chemical waste. Microwave assistance has the potential to speed up the green synthesis process. The present study successfully conducted a green synthesis of silver nanoparticles utilizing Citrus sinensis peel extract with the help of microwaves at a power of 300W for 5 minutes. Silver nanoparticle colloids were prepared using varying precursor concentrations, specifically 1 mM and 50 mM. The UV-Vis analysis results indicate that the peak wavelength of silver nanoparticles is 404 nm at a concentration of 1 mM, and 416 nm at a concentration of 50 mM. The TEM analysis results indicate that both samples have an average diameter of 10.6 and 11.8 nm, respectively.*

***Keywords****: Silver nanoparticles, citrus sinensis, green synthesis, microwave-assisted irradiation.*

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## I. Introduction

Nowadays, nanotechnology is being developed for use in a wide range of industries, including textiles, medical care, agriculture, and technology. Nanotechnology employs materials with dimensions ranging from 1 to 100 nm. Nanoparticles can be produced in one of two ways: top-down or bottom-up. The top-down approach involves the disintegration of the macroscopic molecule into its constituent atoms [1]. This is achieved using many methodologies, such as thermal breakdown, ball milling [2]-[3], and laser ablation [4]-[6]. On the other hand, bottom-up synthesis begins with atoms, molecules, or clusters that are arranged in a way that results in nanoparticles of the required size. This procedure may be accomplished using many methods, such as the sol-gel technique, pyrolysis, chemical reduction [7]-[10], and others. Green synthesis, which utilises chemical compounds found in plants [11]-[12], is one of the most popular chemical reduction techniques due to its affordability [13], less toxicity [14], and ease of implementation [15].

Plant chemicals like phenols, flavonoids, tannins, and alkaloids can help turn silver ions into nanoparticles [16]-[17]. By transferring hydroxyl groups (OH-), this compound reduces the silver ion Ag+ to Ag0 [18]. Plant chemicals like phenols, flavonoids, tannins, and alkaloids can help turn silver ions into nanoparticles [16–17]. By transferring hydroxyl groups (OH-), this compound reduces the silver ion $Ag^+$ to $Ag^0$ [18]. Previous studies research [16]-[17] show that Citrus Sinensis peel extract has phenols, flavonoids, saponins, and alkaloids in water extracts. These parts have hydroxyl (–OH) and carboxyl (–COOH) groups, which are crucial to the reduction process [19].

The process of synthesising silver nanoparticles using Citrus sinensis peel extract has been conducted by the heating method [20]-[22] which typically requires 1-4 hours using conventional heating and 15-30 minutes when utilising sunlight [23]. Meanwhile, Nmeneka et al. [15] effectively synthesised silver nanoparticles using microwave irradiation for 5 minutes. Due to the direct interaction between molecular dipoles and electromagnetic waves [24], microwaves can speed up the reduction process and make the heat more even. In this study, we aimed to synthesise silver nanoparticles with Citrus sinensis peel extract through microwaves at a power of 300 W within 5 minutes. The precursor concentration was varied to determine its effect on the size of the nanoparticles. To ensure the success of this method, the results of UV-Vis and TEM tests are reported.

## II. Material and Methods

**Materials and Instrument:** Silver nitrate powder (Merck, 99.8%), Citrus sinensis peel, aquadest, sodium hydroxide (NaOH), Whatman filter paper no. 42, hotplate, Samsung ME731K (2.45 GHz) microwave, sonicator, UV-Vis, and TEM.

**Preparation of Citrus sinensis peel extract**: Citrus sinensis peel extract undergoes a process of washing and subsequent drying. According to the procedures provided by Genevieve et al. [25], the Citrus sinensis peel extract is subsequently diced and subjected to boiling in distilled water. Then, the solution underwent filtration with Whatman filter paper, and the resulting extract was then kept at a temperature of 4º C.
**Preparation of silver nitrate solution:** To make a solution with 1 millimolar (mM) of AgNO3, 135 millilitres (mL) of purified water and 0.023 g of silver nitrate powder are mixed. Meanwhile, 135 ml of purified water is mixed with 0.45 grammes of silver nitrate powder to make a solution with a concentration of 50 mM AgNO3. The solution was then stirred for 10 minutes to ensure the uniformity of the sample.
**Synthesis of silver nanoparticles:** 5 ml of peel extracts are combined with 25 ml of silver nitrate (AgNO3) solution that has been diluted in filtered water and adjusted to pH 10. The mixture is then heated in a microwave (Samsung, 2.45 GHz) at 300 W for 5 minutes. After the reaction, the mixture changed from clear yellow [26] to reddish brown, suggesting the creation of silver nanoparticles [27]. The solutions were collected for further characterization.

## III. Result and Discussion

Silver nanoparticles were synthesised using a heating power of 300 W for 5 minutes. The transition from a clear yellow to a reddish brown colour indicates success [28]. Figure 1 shows that when the concentration of silver nanoparticle colloids increases, the intensity of the brownish hue increases. Therefore, an increase in the concentration of colloidal silver nanoparticles will result in a deeper brown tone.

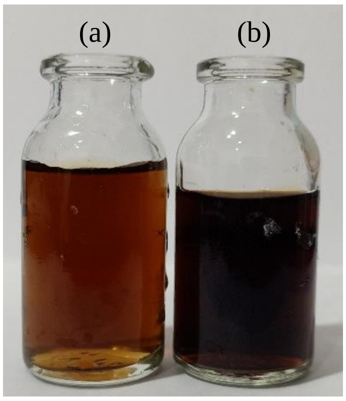


**Figure 1.** Silver nanoparticles synthesized at a precursor concentration of (a) 1 mM and (b) 50 Mm

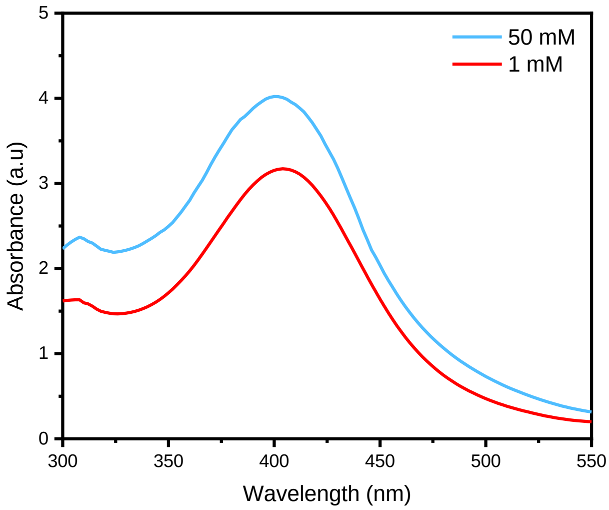


**Figure 2.** UV-Vis spectra of synthesised silver nanoparticles synthesised with Citrus sinensis peel extract assisted by microwave at a precursor concentration of 1 mM and 50 mM

A quantitative examination of the colloidal synthesis of silver nanoparticles was conducted using UV-Vis. Figure 2 depicts a comparison of colloidal silver nanoparticles at concentrations of 1 mM and 50 mM. At a concentration of 1 mM, the colloidal silver nanoparticles displayed a distinctive absorption peak at 404 nm with an absorbance of 3.226. Similarly, at a concentration of 50 mM, the nanoparticles exhibited an absorption peak at

416 nm with an absorbance of 4.251. Consistent with earlier studies by Porrawatkul [29], this study shows that when absorbance rises, so does the concentration of silver nanoparticles. Consistent with earlier studies by Porrawatkul [29], this study shows that when absorbance rises, so does the concentration of silver nanoparticles. Meanwhile, a shift in the peak wavelength to the right indicates an increase in the size of the nanoparticles [30][31]. Therefore, the findings of the UV-Vis analysis suggest that the colloidal silver nanoparticles produced at a 50 mM concentration have a larger size than those produced at a 1 mM concentration.

Transmission electron microscopy (TEM) is another tool that is used to study the colloidal silver nanoparticles. Figure 3 displays the TEM test results. The observations depicted in Figures 3(a) and (b) show that the nanoparticles have a spherical shape. For a concentration difference of approximately 50 times, the size distribution of the two colloids, as shown in Figures 3(c) and (d), shows very little variation. The average diameters of the colloids of silver nanoparticles produced at concentrations of 1 mM and 50 mM are 10.6 nm and 11.8 nm, respectively. According to this study, the diameter of the nanoparticles grows as the concentration of the precursor—silver nitrate powder—increases. This result supports earlier research by Omran et al. [31] and Simatupang et al. [23], which indicates that precursor concentration and nanoparticle size are positively correlated.

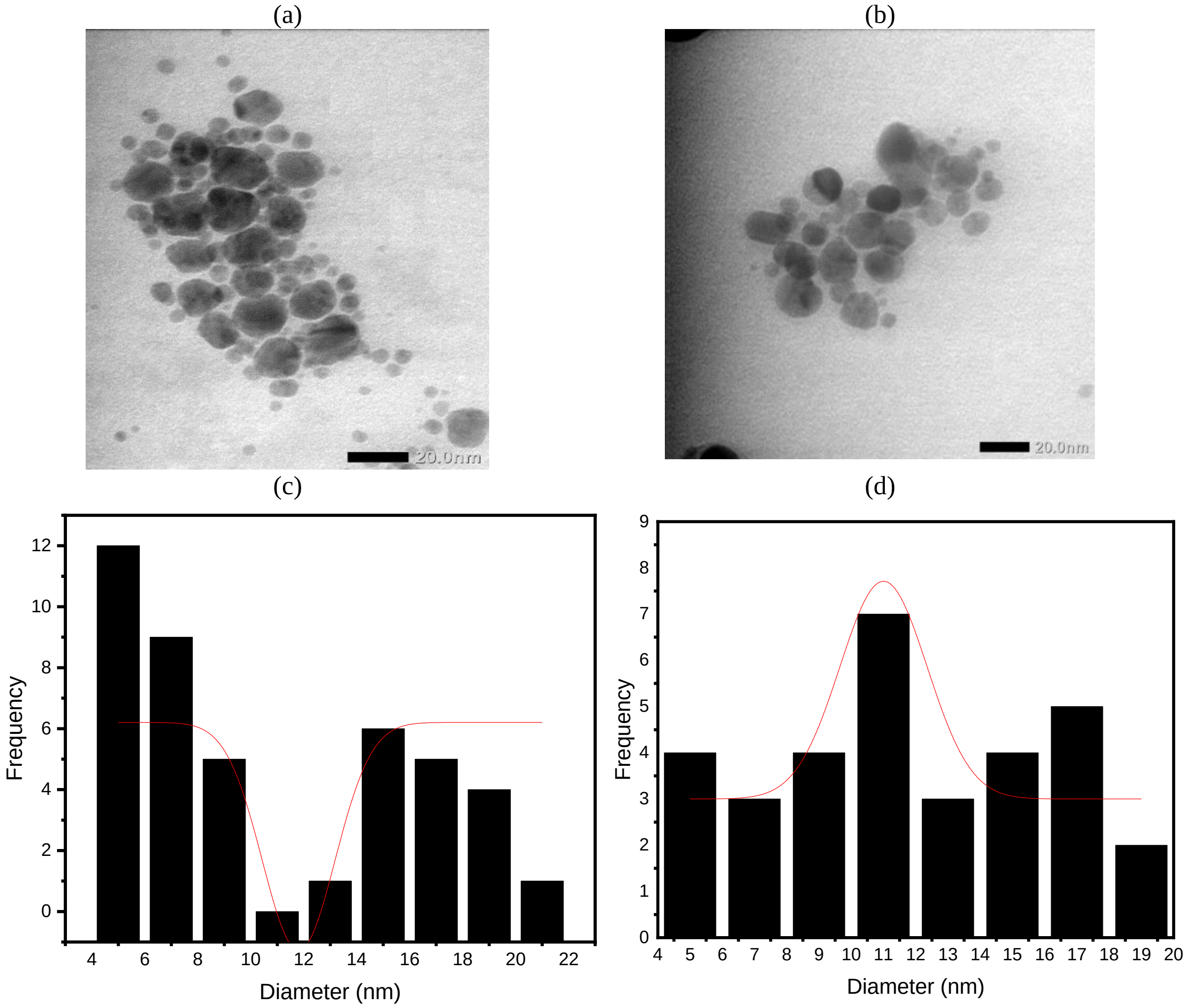


**Figure 3.** Morphology of colloidal silver nanoparticles synthesised with Citrus sinensis peel extract assisted by microwave with a power of 300W for 5 minutes at a precursor concentration of (a) 1 mM; (b) 50 mM
and size distribution at a precursor concentration of (c) 1 mM; (d) 50 mM

## IV. Conclusion

Colloidal silver nanoparticles were successfully created using a power of 300W for a 5 minute exposure time with precursor concentrations of 1 mM and 50 mM. The UV-Vis spectroscopy data shows that the wavelength of colloidal silver nanoparticles at a concentration of 1 mM is 404 nm. Meanwhile, at a concentration of 50 mM, the wavelength is measured to be 416 nm. Based on the results of transmission electron microscopy

(TEM), they both exhibit a spherical morphology, with average diameters of 10.6 nm and 11.8 nm, respectively. Hence, it can be inferred that there is a positive correlation between the concentration of the precursor and the average diameter of the resulting silver nanoparticles.

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