

CONFERENCE PROCEEDING

Green Synthesis of Silver and Gold Nanoparticles from Local Sabah Tea Extract (*Camellia Sinensis*)

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Abstract

Metal nanoparticles such as silver and gold with a particle size between 1 to 100 nm can exhibit size-related properties that make it suitable in various applications such as sensors, catalysis, medical and others. For synthesis of metal nanoparticles, common techniques such as photo-catalytic reduction, solvothermal methods and reduction using chemicals not only found to be costly but also consume a significant usage of toxic and hazardous chemicals. Therefore, the need for a 'greener' approach that utilize eco-friendly materials (organisms like plants) and processes must be implemented in order to solve this issue. In this study, we aim to use a plant extract from local Sabah tea (*Camellia Sinensis*) as a reducing agent for synthesis of silver and gold nanoparticles. For the preparation of tea extract (*Camellia Sinensis*), water will be used as the solvent where the tea will be simply immersed and boiled in the water for 20 minutes. For synthesis of silver nanoparticles, the resulting tea extract will be directly added to silver nitrate and gold(III) chloride solution to allow the reduction of Ag(I) to Ag(0) and Au(III) to Au(0) to take place respectively. The successful synthesis of silver and gold nanoparticles will be observed based primarily on any physical colour changes. Future studies will involve the potential application of the synthesized metal nanoparticles in catalytic applications such as degradation of 4-nitrophenol commonly found in industrial wastewater.

Keywords: Tea extract, *Camellia Sinensis*, Silver nanoparticles, Gold nanoparticles

INTRODUCTION

Metal nanoparticles (NPs) can exhibit significantly different properties from their bulk counterparts and they have been found to hold potential and promise for use in biomedical, biosensor, pharmaceutical, catalytic, drug delivery and many more (Ishak *et al.*, 2019). As for synthesising metal nanoparticles, chemical synthesis is commonly used nowadays. This method used hazardous substances and costly. Therefore, it is best to replace with green synthesis which is safer. In this study, local Sabah tea (*Camellia Sinensis*) will be used as a reducing agent for synthesis of silver and gold nanoparticles. The phytochemicals, polyphenols and flavonoids present in tea show role as reducing agents (Alegria *et al.*, 2018).

The use of plant extract in green synthesis has stimulated various investigations and studied till now. It was demonstrated that the formation of metal NPs using plant extract could be finished in the metal salt solution within short duration at room temperature depending upon the nature of plant extract. After the selection of the plant extract, the main affecting parameters are the concentration of the extract, temperature, metal salt, pH, and contact time (Mittal *et al.* 2013). The benefits of using plants for

the formation of NPs are that plants are easily accessible and safe to handle and have a large range of active agents that can advance the reduction of Ag ion. Mainly the plant parts like roots, latex, stem, seeds, and leaves are being used for NPs synthesis (Kharissova *et al.*, 2013). The interesting point is the active agent presents in these parts, which makes the stabilization and reduction possible and plant extracts incorporate biomolecules which act both as reducing and stabilizing agent that produce stable and shape-controlled NPs. Main compounds which influence the reduction and capping of the NPs are biomolecules, i.e., terpenoids, polysaccharides, phenolics, alkaloids, flavones, amino acids, alcoholic compounds enzymes, and proteins.

Nanoparticles can also have a variety of size and shape based on the preparation's method. Likewise, gold nanoparticles (AuNPs) have been studied in many research fields too due to their simplicity, fast and reliable properties. Apart from only being the subjects of study in laboratory, AuNPs have been developed until to the point of practical use like as a catalyst, in clinical applications or even as biosensors (Eguílaz *et al.*, 2011). Moreover, the optical properties of AuNPs were heavily depended based on their shape, size, type of functional groups attached to it and degree of aggregation. Nowadays, chemists can easily control and modify the environment during synthesis of AuNPs, thus extending the possibility for scientific study on resulting optical properties of AuNPs to be applied in other research areas. In addition, AuNPs with various forms and shapes possessed unique optical and electronic properties compared its bulk state. It is also worth mentioned that by changing the synthesis temperature, concentration of chemical used, type of surfactant and pH, the resulting size and shape of the AuNPs can be preferably varied and controlled. AuNPs also can have different colors resulted from surface plasmon resonance (SPR) phenomenon of their quantum-size effects. To improve the biocompatibility of AuNPs it is preferable to use non-toxic reagents. All AuNPs-preparation methods are based on the reduction of gold ions, mostly as solutions of HAuCl_4 while for synthesis of silver nanoparticle (AgNPs), silver nitrate solution was used as the metal source.

AuNPs have been widely applied in catalysis reactions since the outstanding works with the high catalytic activity of AuNPs even in low temperature compared to its bulk materials done by Haruta and his co-workers (1987). One of the major chemical reactions that utilized AuNPs as the catalysts includes the reduction of nitroaromatic compounds (Bhosale *et al.*, 2017). 4-nitrophenol (4-NP) is an example of nitroaromatic compounds that is harmful to human beings due to their anthropogenic and highly toxic nature to the environments. Nevertheless, in the presence of reducing agents such as sodium borohydride (NaBH_4) and metal catalysts, 4-NP reduction to 4-aminophenol (4-AP) was carried out comprehensively. 4-AP was also an essential precursor for synthesis of corrosion inhibitor, antipyretic drugs and analgesic as well as drying agents. Meanwhile, for application as biosensors, AuNPs were commonly selected due to their capability to form a stable immobilization during the testing so that they can maintain their bioactivities (Eguílaz *et al.*, 2011). Likewise, the recent research results also have shown that the silver nanoparticles (AgNPs), due to their special characteristics, have immense potential for applications as anti-microbial, anti-parasitic and anti-fouling agents as agents for site-specific medication, water purification systems, etc.

As stated in Surah Al-Zalzalah verse 7-8;

فَمَنْ يَعْمَلْ مِثْقَالَ ذَرَّةٍ خَيْرًا يَرَهُ،
وَمَنْ يَعْمَلْ مِثْقَالَ ذَرَّةٍ شَرًّا يَرَهُ،
“So whoever does an atom’s weight of good will see it.” (7)
“And whoever does an atom’s weight of evil will see it.” (8)

Based on Surah Al-Zalzalah verse 7-8, particles in terms of chemistry refers that molecule, atom, or ion are too small and cannot be seen with naked eye. These verses briefly relate to us about no matter how small your deeds either a good or a bad one, even by the size of an atom size will be seen by Allah SWT. Nowadays, scientists can already explain how exactly the size and the shape of any particle even if it exists in nanosize by using modern and complex scientific instruments.

METHODOLOGY

Stage 1: Preparation of tea extract (*Camellia Sinensis*)

The commercially bought Sabah tea will be grounded with a mortar and a pestle. Fourier-transform infrared (FTIR) analysis was conducted on the tea powder to study the functional groups present in the tea. For preparation of tea extract, 8 g the finely grinded tea paste will be transferred into a 250 mL conical flask. 70 mL of deionized water was added into the conical flask and the water was heated until boiled. Later, the mixture was stirred for 10 minutes before being allowed to cool down until room temperature. The mixture was filtered, where the tea extract was collected as the filtrate as shown in Figure 1.

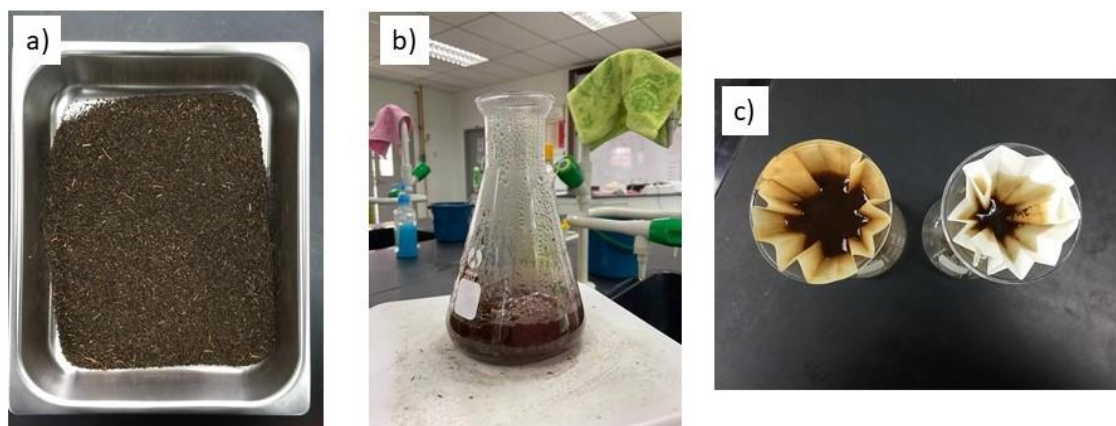


Figure 1: a) The tea powder after being finely grinded, b) Boiling process of tea for 10 minutes and c) The filtration process of reaction mixture to obtain tea extract as the filtrate

Stage 2: Synthesis of Silver and Gold Nanoparticles

For the synthesis of gold nanoparticles, 100 ml of 1mM HAuCl₄ was prepared and poured into a 250 ml conical flask. Next, 15 ml of tea extract was added into the conical flask, stirred at room temperature, and left for 4 hours. For the synthesis of silver nanoparticles, the same procedures were repeated in dark condition using 100 ml of 1 mM AgNO₃ solution. Any physical colour changes were recorded to indicate the successful synthesis of AuNPs and AgNPs after the reduction of Ag(I) to Ag(0) and

Au(III) to Au(0) have taken place.

RESULTS AND DISCUSSION

FTIR spectroscopy was done on the tea powder and its result was shown in Figure 2. Based on the FTIR spectrum, these were bands at: 3268 cm^{-1} (OH groups), $2849\text{-}2914\text{ cm}^{-1}$ (aliphatic νCH_2), 1600 cm^{-1} (mainly due to C=C and C=O vibrations), and in the range of $1321\text{ to }1004\text{ cm}^{-1}$ (C-O- vibrations) that were observed. The FTIR result suggested the presence of polyphenolic compounds as described in previous work (Boruah *et al.*, 2012).

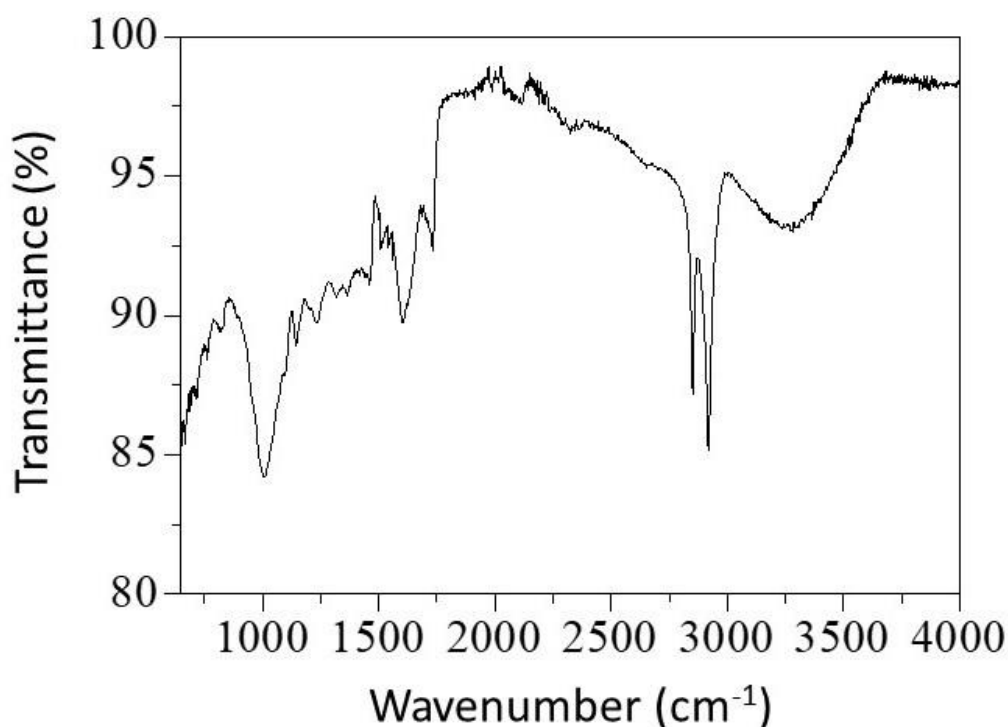


Figure 2: FTIR spectrum of local Sabah tea extract (*Camellia Sinensis*)

The colour change was noted by visual observation in the conical flask which contains HAuCl_4 and AgNO_3 solution with tea extract. The color of the HAuCl_4 change from colourless to claret colour (Figure 3), while the AgNO_3 solution changed from colorless to light brown (Figure 4) after at least 4 hours. This color change indicates the formation of AuNPs and AgNPs in the solution. Tea extract without HAuCl_4 or AgNO_3 did not show any color changes. Based on previous study, the presence of polyphenolic compounds in tea extract is the acting reducing agent which is responsible for reduction of both Au(III) to Au(0) and Ag(I) to Ag(0) thus producing the metal nanoparticles.

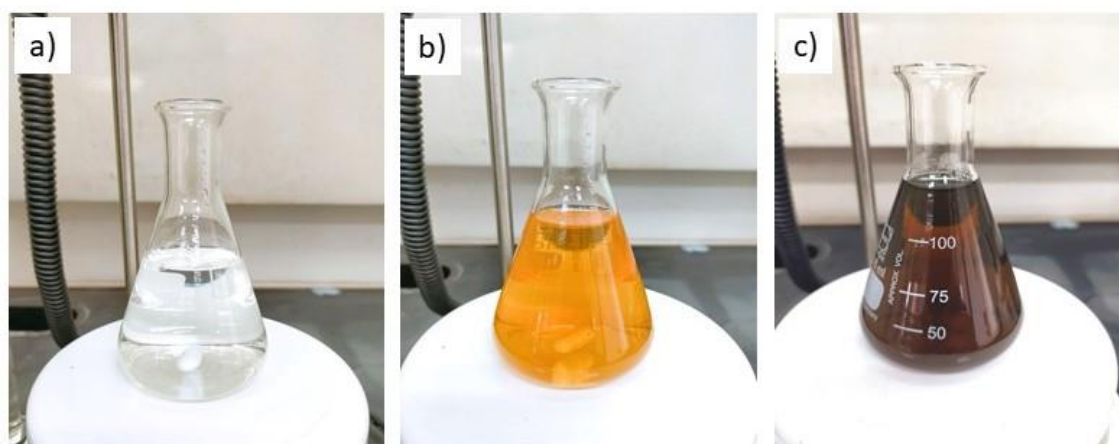


Figure 3: a) Colourless solution of HAuCl_4 , b) HAuCl_4 solution after addition of tea extract and c) AuNPs solution with claret colour

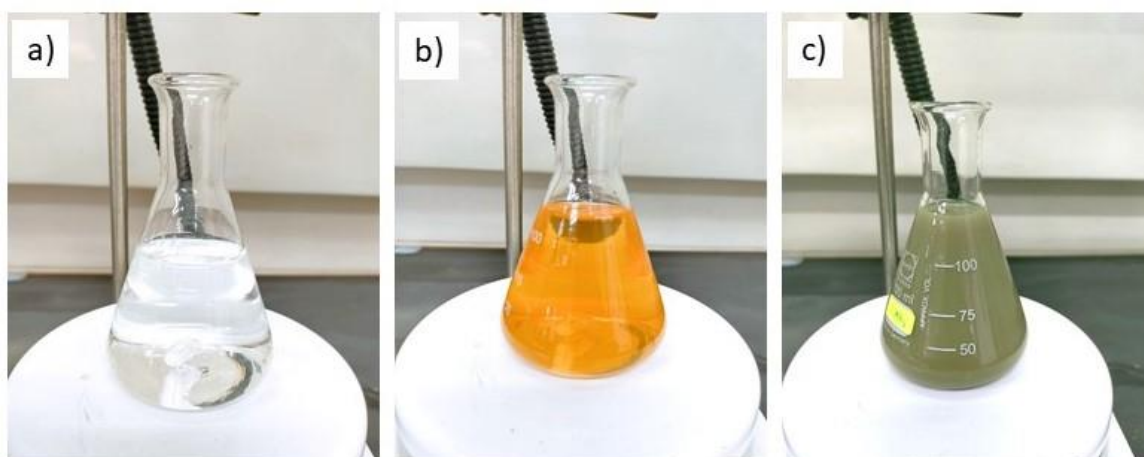


Figure 4: a) Colourless solution of AgNO_3 , b) AgNO_3 solution after addition of tea extract and c) AgNPs solution with brownish colour

CONCLUSION

Herein we report a green approach for the synthesis of gold and silver nanoparticles using local Sabah tea extract. This approach proved to be a simple, green, and efficient method to synthesize the metal nanoparticles at room temperature without using any harmful chemicals as the reducing agents such as sodium borohydrite. Future works include the analysis of synthesized gold and silver nanoparticles with UV-Vis spectroscopy to further support the results and application of the metal nanoparticles in catalysis reactions.

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