



Water Extracts of *Sapindus rarak* as Medium/Reduction System for Silver Nanoparticles Formation

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Silver ion was transformed into silver metallic form easily at room temperature using *Sapindus rarak* water extract. It takes a few minutes to form silver nanoparticles even at room temperature. The formation of silver nanoparticles was explained in terms of the strength of interaction of the silver ions with the compounds available in the extract such as saponins, phenol and flavonoid derivatives. The UV-VIS spectrophotometry analysis shows a broad band near 400 nm as specific surface plasmon resonance of the silver nanoparticles. The TEM analysis revealed the average size of the nanoparticles under current conditions was about 50 nm.

Key Words: Silver nanoparticles, Reduction, *Sapindus rarak*.

INTRODUCTION

The use of organisms as raw materials for foods, drugs, precursors, medicine, polymers and biomaterials is widely known¹. Increasingly, the awareness towards green chemistry and other biological processes has led to the development of eco-friendly approaches. One of them is the utility of natural products for advanced materials synthesis by either intracellular or extracellular systems, e.g. synthesis of metal nanoparticles^{1,2}. Based on the reason that the hazardous effects of organic solvents, reducing agents and toxic reagents applied for the synthesis of nanoparticles on the environment, encouraged researchers to develop convenient methods for the preparation of metal nanoparticles³⁻⁵. It is already known that plant extracts could be used as a medium for the synthesis of several metal nanoparticles. One of the most important metal nanoparticles is silver nanoparticles since they possess excellent biocompatibility and low toxicity. Furthermore, they have important applications such as antibacterial agents, DNA sequencing and several photonic applications⁶⁻⁸.

The development of silver nanoparticles synthesis using surfactants was reported. For instance, synthesis of silver nanoparticles by sophorolipids⁹ and stabilized by Gemini surfactant¹⁰ are already known. Since common synthetic surfactants can have negative effects such as skin

irritation, therefore, the trend towards natural and vegetable-derived surfactants is becoming a great interest¹¹. Although there is one report on the use of soapnut for silver nanoparticles formation, no specific species was reported and the current reaction conditions are different with the reported one¹². In this report, we would like to explain the utility of the *Sapindus rarak* water extracts as a medium as well as a reducing agent of the silver ions to form silver nanoparticles. The *Sapindus rarak* or well known as soapnuts contain saponins, which are a natural surfactant¹³. The plant extracts have been used for washing clothes by Asia native peoples. On the other hand, the soapnuts were also used in folk remedies as a contraceptive, excessive salivation, epilepsy and to treat chlorosis and migraines and even for to improve animal production¹⁴. The presence of essential compounds in the water extract could be used as a reducing or capping agent in the silver nanoparticles synthesis.

EXPERIMENTAL

All analytical reagents and media components were purchased from Sigma-Aldrich and Merck. Deionized-double distilled water was used. The *Sapindus rarak* samples were collected in Talo, Province of Bengkulu, Sumatera island, Indonesia. The samples were washed with deionized water and the rind was separated for the next procedures.

Sapindus rarak rinds extract was prepared by boiling of 50 g of fresh *Sapindus rarak* for 10 min, after which filtered to get the clean rinds extract. 0.01 M aqueous AgNO_3 solution was added to 2 mL of rinds extracts. The reduction of silver ions was monitored by taking photograph of the solution every 5 min and measuring the absorbance of the reaction mixture in a range of wavelength from 200 to 750 nm using UV-VIS spectrophotometer to find characteristic of silver nanoparticles band. TEM measurements were performed on a JEOL JEM 1400 instrument operated at an accelerating voltage of 120 kV. Samples for TEM studies were prepared by placing drops of the silver nanoparticle solutions in samples 1-4 on carbon-coated TEM grids.

RESULTS AND DISCUSSION

The soapnut rind was separated from the seed as shown in Fig. 1b. The rinds were introduced to water and boiled for 10 min. The extract was cooled to room temperature and subsequently kept at 4 °C.



Fig. 1 *Sapindus rarak*

The extract was used as a medium and reductor for the formation of silver nanoparticles. When the AgNO_3 solution was subjected to *Sapindus rarak* water extract, the biosynthesis reaction started within few minutes and the colour reaction was observed in which clear AgNO_3 solution changed into yellow colour and finally to brown colour which indicates that formation of corresponding silver nanoparticles. Briefly, Fig. 2 shows the colour change (for 5-25 min) after addition of AgNO_3 0,01 to the *Sapindus rarak* water extract.

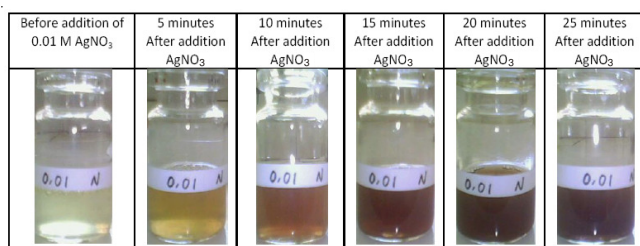


Fig. 2. Colour change due to the formation of silver nanoparticles

Spectrophotometric analysis of the *Sapindus rarak* water extract shows that no peaks at 390-430 nm (Fig. 3). The colour changes showed an evidence that the reaction of the compounds in the solution with silver ions to form silver nanoparticles. To get more evidences, the solution of the extracts after addition of the 0.01 M AgNO_3 , small aliquot of solution is used for the UV-VIS spectroscopy and the analysis shows a broad band at 390 to 410 nm (Fig. 4). The distinct peak shows a surface

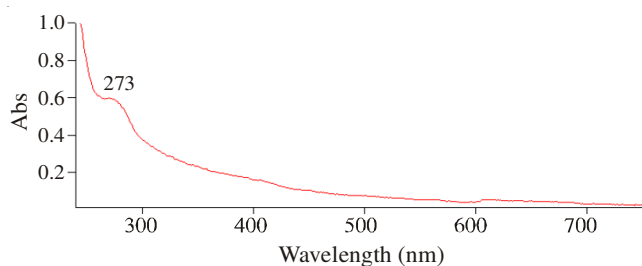


Fig. 3. UV-VIS pattern of the *Sapindus rarak* soapnuts water extracts before addition of AgNO_3 solution

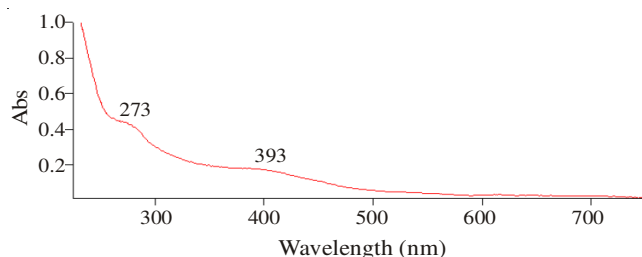


Fig. 4. UV-VIS pattern of the *Sapindus rarak* soapnuts water extracts after addition of AgNO_3 solution

plasmon resonance of the silver nanoparticles and the band related to the formation of the silver nanoparticles in the solution.

According to the transmission electron micrograph, the morphology of the silver nanoparticles was observed and approximately spherical, in which the partially nanoparticles is in aggregated form (Fig. 5).

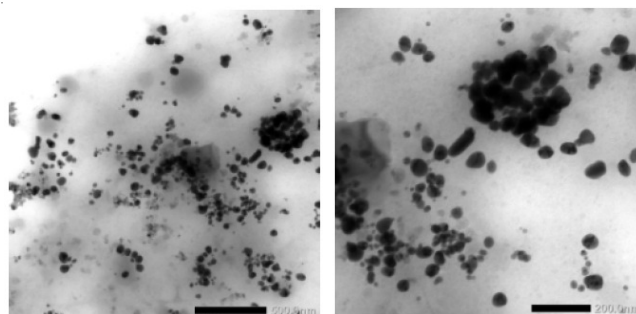


Fig. 5. TEM Pattern of the silver nanoparticles

These results suggested that the silver nanoparticles are synthesized due to the action of plant extract, *Sapindus rarak*, which act as good bioreductor for biosynthesis of the silver nanoparticles. This result is especially remarkable taking into account that saponins are glycosides of hydrophobic alcohols that provide surface activity and form soap-like, foaming solutions in water. The presence of saponin is might responsible for the reduction of silver ions. On the other hand, the presence of flavonoid and phenol derivatives compounds in the extracts could also considered as active compounds as reductor of silver ions¹⁵.

According to the TEM micrograph and based on the calculation as shown in the histogram (Fig. 6), the nanoparticles sizes in range of 20-83 nm and particles distribution were 50.7 ± 14.53 nm.

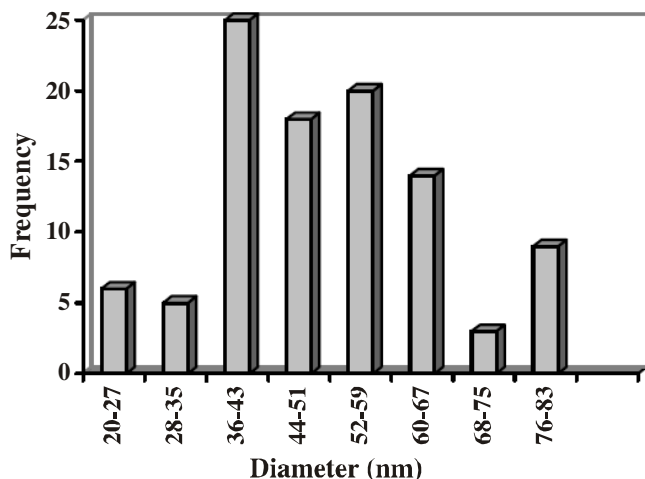


Fig. 6. Histogram of the silver nanoparticles

Conclusion

In summary, the *Sapindus rarak* water extracts was applied for synthesis of silver nanoparticles at room temperature and the produced nanostructures was characterized. The use of the current plant extract gives a new entry the utility of the bioresources as supporting agent for preparation of the advanced material.

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