GREEN SYNTHESIS AND CHARACTERIZATION OF SILVER NANOPARTICLES USING NOTHOPANAX SCHUTELLARIUM LEAF EXTRACT

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Abstract - Silver nanoparticles have been synthesized using the green synthesis method in which Nothopanax schutellarium leaf extract is used for reducing silver ions from silver nitrate. These silver nanoparticles then were characterized using SEM-EDS, XRD and UV-vis. The results of SEM and XRD show the particle size of about 68 nm. Based on the XRD results, peaks appear at 2 theta of 37.909^o, 64.302^o, and 77.239^o with the hkl planes are (111), (220) and (311) respectively. Furthermore the UV-vis result shows the maximum wavelength absorbed at 436 nm.

Keywords - Silver Nanoparticles, Green Synthesis, Nothopanax Schutellarium, SEM, XRD, UV-vis

I. INTRODUCTION

Nowadays many studies on silver nanoparticles get a lot of attention. At the nanoscale, silver particles have unique physical and chemical properties, and also antibacterial activity [1]. The benefits and applications of silver nanoparticles are currently being used in various fields such as environment [2], health [3], beauty products [4], agriculture [5], textiles [6-8], electronics [9] and sensors [10-11].

Besides the research on the uses and applications of silver nanoparticles, many studies on how to synthesize this material also still are being developed. The process of synthesizing silver nanoparticles uses a variety of methods. Physical synthesis methods such as laser ablation [12] and microwave assisted [13] have been widely used as well as chemical methods such as sol-gel [14-15] and electrochemical [16]. Unfortunately, these physical and chemical synthesis methods use hazardous chemicals to humans and the environment and also require expensive costs. Based on this, the researchers have successfully created an eco- friendly, simple and inexpensive method for synthesizing nanoparticles. This novel method, also called the green synthesis method, uses extracts of plant leaves, fruits and bio-organisms to reduce particle size [17].

The use of plant extracts to synthesize silver nanoparticles has been extensively explored by many researchers. Extracts from several plants that have been used such as Allium cepa and Musa acuminata[1], Mangifera indica [17], Musa balbisiana, Azadirachta indica and Ocimum tenuiflorum [18], Cycas circinalis, Ficus amplissima, Commelina benghalensis and Lippia nodiflora [19], Tectona grandis Linn. [20], Syngonium podophyllum [21], Cycas [22], Hydnocarpus pentandra [23] and Allium sativum, Zingiber officinale and Capsicum frutescens [24]. In the present work, we have utilized Nothopanax schutellarium leaf extract and silver nitrate as a green synthesis technique to obtain silver nanoparticles. This material was then investigated using SEM-EDS, XRD and UV-vis.

II. MATERIALS AND METHOS

A. Materials

Nothopanax schutellarium leaves that will be extracted are found in many home yards in Indonesia. This plant is an ornamental plant and some people in Indonesia eat the leaves of this plant as a vegetable (see at Fig.1). Next silver nitrate ($AgNO_3$) was purchased from Merck..

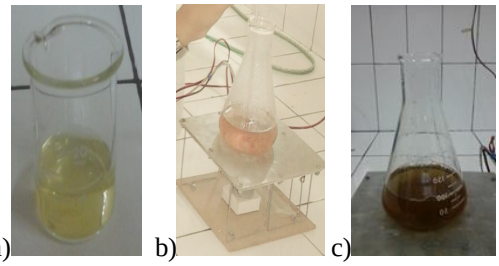


Fig.1. Nothopanax schutellarium plant

B. Silver nanoparticle synthesis

In this study, synthesis of silver nanoparticles was carried out by mixing 0.3 grams of $AgNO_3$, 90 ml of DI-water and 10 ml of Nothopanax schutellarium aqueous extract then were heated to a temperature of 65 ^{o}C for 15 minutes. During the heating process, the solution was stirred using a magnetic stirrer and the color of the solution changed from pale yellow to light

brown and finally the color became dark brown (see at Fig.2). The color change of the solution indicates the formation of silver nanoparticles. Furthermore, the solution containing silver nanoparticles was centrifuged for one hour with a rotational speed of 6000 rpm. The precipitate formed due to centrifuging was separated from the extract solution in which the solution must be discarded. Then the precipitate was refilled with DI-water to be centrifuged again with the same time and rpm speed as the first. The purified precipitate was then dried for 60 minutes at temperature of 40 ^{o}C and the black powder formed was taken which is used for further characterization.



a) b) c)

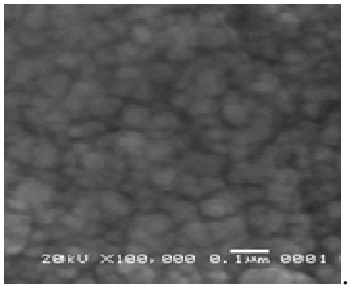
Fig.2. Discoloration of the silver nitrate mixture and Nothopanax schutehllarium leaf extract solution from (a)pale yellow to (b) light brown and (c) finally dark brown.

C. Characterization of silver nanoparticles

Characterization of silver nanoparticles was carried out to determine the properties and structure of the material formed. To determine the X-ray diffraction pattern, the sample powder was recorded using X-ray diffractometer (Bruker D8) with Cu Kα radiation (λ = 1.54 A^{o}). The UV-Vis spectrum of this material was measured using a UV-Vis spectrometer (Nano Calc-2000) at the wavelength range of 240 nm to 860 nm. The powder was then characterized using SEM (JEOL JSM-6510 LA) to observe the morphology and size of these nanoparticles and also energy dispersive x-ray (EDX) to measure the atomic composition of silver nanoparticles.

III. RESULTS AND DISCUSSION

The characterization result using SEM to determine the morphology of the material is shown in the figure below.



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Fig.3. SEM image of synthesized silver nanoparticles

In Figure 3, the size of silver nanoparticles with an average grain size is 60-90 nm in spherical shape. The SEM result is in accordance with the XRD result, which is calculated based on the Scherrer's equation with a particle size of 68.49 nm.

The EDX result shown in Figure 4 and the elemental composition in silver nanoparticles material are shown in table.1.

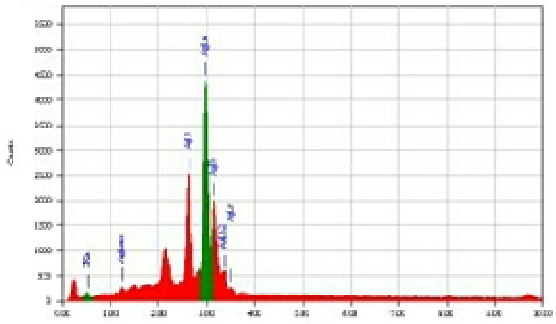


Fig.4. EDX result of synthesized silver nanoparticles

Table.1. The composition of the elements contained in the sample of synthesized silver nanoparticles

Element	(Kev)	Massa %	Erorr %	At %
O K	0.525	0.56	2.83	3.68
Ag L	2,833	99,44	1,71	96,32
Total		100,00		100,00

Based on the result of EDX, the Ag element has a mass presentation of 99.44% and an atomic presentation of 96.32% while the O element has a mass presentation of 0.56% and an atomic presentation of 3.68%. It can be seen that the presentation of mass and atomic Ag is much greater than O which indicates that this sample is dominated by Ag.

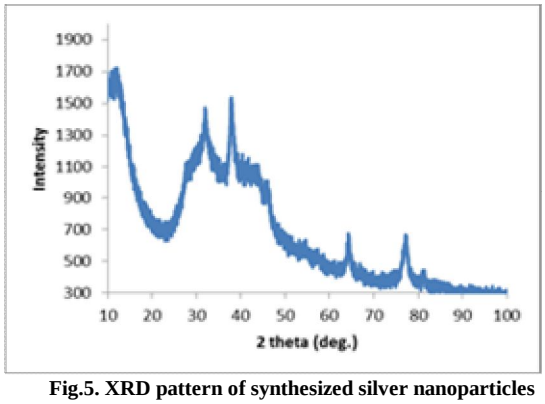


Fig.5. XRD pattern of synthesized silver nanoparticles

From the XRD result, information on scattering angle and distance between planes as well as the calculation of orientation of the hkl planes obtained, proving that silver nanoparticles which were successfully synthesized had a FCC crystal structure that is obtained by corresponding hkl values for the type of

the crystal structure. Once matched with the data in the Powder Diffraction Data from the JCPDS (Joint Committee Powder on Diffraction Standard) table turns out that the closest or corresponding data is 2θ = 37.909°, 64.302°, 77,239° with hkl plane (111), (220) and (311), respectively, where these planes are pure Ag. However, at an angle of 2θ = 31.972°, it is assumed that at the peak it is not pure Ag. At this angle indicates the presence of silver oxide (Ag_2O), which has a hkl (110) plane with cubic crystal structure. The formation of this compound is due to lack of contact time so that the synthesized silver is not reduced.

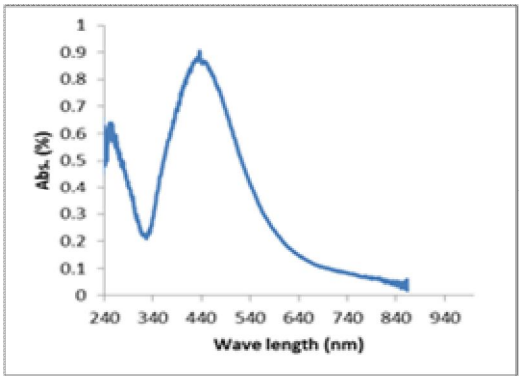


Fig.6. UV-Vis absorption spectrum of synthesized Ag nanoparticles

The UV-vis result is shown in Figure 6 which shows the maximum wavelength absorption at 436 nm. This result is almost consistent with some of the results of previous researchers [23] and [25]. By using the Einstein's photon energy equation, the conduction band energy of the silver nanoparticles can be calculated directly by substituting the maximum wavelength value of the UV-Vis absorption spectrum. The value of the conduction band energy is 2.84 ev which is almost the same as the value researched by Gharibshahi, et al at a calcination temperature of 600 °C. [25].

CONCLUSION

Based on the above explanations it can be concluded that the use of Nothopanax schutellarium leaf extract is capable of producing silver nanoparticles by reducing silver ions. Discoloration of the silver nitrate mixture and Nothopanax schutellarium leaf extract solution from pale yellow to light brown and finally dark brown indicate the formation of silver nanoparticle material.

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