THE EFFECT OF ARABIC GUM AS STABILIZER ON PHYSICAL STABILITY OF SILVER NANOPARTICLES (AgNP)

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ABSTRACT

The silver nanoparticle is one of the metal nanoparticles that have pontentially as antibacterial, but its physically unstable. The instability of silver nanoparticles can affect the effectiveness of the silver nanoparticles, so it is necessary to add a stabilizer agent to the silver nanoparticles that can increase its physical stability. The aim of this research was to know the effect of Arabic gum as stabilizer to physical stability of silver nanoparticles, with variation of 1%, 2%, 3% and 4% Arabic gum concentration. Tests performed in the form of organoleptic test, which showed the four formulas to produce a clear yellow colloid until brownish yellow. The results of particle size distribution analysis of 1% had addition of particle size of 41 nm followed by 2% formula of 28 nm, 3% by 11 nm and 4% by 20.5%. The UV-Vis spectrum analyzes showed the four formulas during the 8 weeks of wavelength not shifting past 450 nm. Based on the results of the study of the used Arabic gum as a stabilizer of silver nanoparticles with a concentration variation 1% -4% did not produce stable silver nanoparticles (AgNP).

Keywords: *stability, silver nanoparticles, Arabic gum, variations of stabilizers.*

INTRODUCTION

In recent years nanotechnology has attracted attention, both from various quarters because it is believed nanotechnology has a huge prospect in the social and economic field. With nanotechnology, nano-sized materials can be made or often called nanoparticles that have sizes ranging from 1-100 nm (Sharma, et al. 2009). Research in the field of nano has produced products with better performance compared with those who do not use nanotechnology. One of the materials that can be made into nanoparticles is silver.

The synthesis of silver nanoparticles is one of the applications of nanotechnology to produce nano-sized silver material, which has a number of chemical and physical properties that are superior to large materials (Abdullah & Khairurijal 2010). The methods that can be used are electrochemical methods, ultrasonic irradiation, photochemistry, poly-ol and chemical reduction of silver ions with or without stabilizers. The method of synthesis of the commonly used silver nanoparticles is the chemical reduction method. As did Abdalrahim (2014) using dextrose as a reductor and PVP (polyvinylpyrrolidone) as a stabilizer and Zielinska (2009) using hydrazine hydrate as a reductant and PVA (polyvinylalcohol) as a stabilizer.

Until now the manufacture of silver nanoparticles (Ag) is still a constraint, namely silver nanoparticles are unstable and easy to happen agglomeration of silver nanoparticles. The effect of this agglomeration is the loss of antibacterial properties of the silver nanoparticles. Therefore, to prevent the occurrence of agglomeration needs to be added stabilizer. In a previous study conducted by Dong et al (2014) has made copper nanoparticles. In this study used Arabic gum as a stabilizer that gets the best concentration at 2%. At the use of concentrations above 2% yields unstable copper nanoparticles with continued significant size and concentration usage below 2% of copper nanoparticles agglomerated.

In this study used Arabic gum as a stabilizer. The use of Arab gum as stabilizer has its own advantage because Arabic gum is not toxic, biodegradable and water soluble, Arabic gum is a perfect emulsion and active on the surface so it is very good when used on metal nanoparticles. With complex polysaccharide and protein structures in Arabic gum, it is hoped to be effectively irreversibly bound with nanoparticles in the protein matrix to produce stable nanoparticle construction.

METHODOLOGY

Preparation of standard silver nitrate solution

Weigh carefully AgNO3 (silver nitrate) as much as 0.085 gram, then put into Beaker glass 500mL and dissolve AgNO3 with aquades as much as 500mL, insert into suitable container and tightly sealed.

Making standard solution of Sodium Citrate

Weigh carefully Sodium citrate as much as 1.4705 grams, then put in a Beaker glass 500 mL and dissolve the sodium citrate with aquades as much as 500 mL, and insert into a suitable container and tightly sealed.

Preparation of Arabic Gum raw solution

Weigh Arabic gum as much as 2 gram, 4 gram, 6 gram, 8 gram. Enter each Arabic gum into different Beaker glass, then dissolve each of the Arabian gums with aquades as much as 200 mL. put it into a suitable container and tightly closed.

Preparation of Silver Nanoparticles (Anung, 2014)

Add 30 mL of Arabic gum solution into Beaker glass, then heat it at 85^oC while stirring with magnetic stirrer, set speed at 600rpm. In the hot Arabic gum solution, add 50 mL of $AgNO_3$ standard solution and stir for 1 minute. Add standard solution of sodium citrate as much as 5 mL, then stir at 600 rpm until color change, if there has been change of color stop heating but keep doing stirring until the solution temperature decrease reach temperature 25^oC.

Characterization of Silver Nanoparticles

The synthesized silver nanoparticles were then characterized to determine the characteristics of the silver nanoparticles. Analysis performed for characterization is using UV-Vis spectrophotometer, PSA and SEM.

1) Analysis of UV-Vis Spectrum Nanoparticles of Arab Silver-Gum

From each formula was then examined using a UV-Vis Spectrophotometer. Perform the UV-Vis absorption spectrum analysis. The examination is carried out at a wavelength of 390-600 nm on the first day to week 8.

2) Particle Size Distribution Analysis, Poly-dispersed Index and Determination of Zeta Potential Value of Silver Nanoparticles

Particle size analysis of silver Nanoparticles using the Dynamic Light Scaterring (DLS) method contained in PSA. Dispersion 1 mL of silver nanoparticles solution in 10 mL aquadest, then input into Flow Cell.

3) Analysis of Silver Nanoparticle Form

Analysis of Silver Nanoparticle form using SEM (Scanning Electrone Microscope). Sample in freeze dried first then sample is mounted into specimen chamber. After that the sample is analyzed.

RESULTS AND DISCUSSION

1. Physical Appearance of Silver Nanoparticles

The physical appearance of the resulting silver nanoparticles shows a clear, yellow to brownish yellow and odorless yellow as seen in figure 1.

Figure 1. Results of silver nanoparticles synthesis

The clear liquid shown by the four formulas indicates that there has been a process of reduction of Ag^+ ions to Ag^0. Reduction reaction can be seen in reaction 1.

$4Ag^+ + C_6H_5O_7Na_3 + 2H_2O \text{---->} 4Ag^0 + C_6H_5O_7H_3 + 3Na+ + H+ + O_2$ ……………………………………………………….…………………………..(1)

The color change that occurs is an indication of the formation of silver nanoparticles. The color formed is the influence of the Surface Plasmon Resonance (SPR) is the phenomenon of light absorption by the particles and is a characteristic possessed by metal nanoparticles (Anung, 2014). The formation of reinforced silver nanoparticles with the resulting wavelength is in the range 410 nm - 450 nm indicating that silver nanoparticles have been formed (Handaya et al. 2010).

In figure 1. the color difference of each colloidal nanoparticle produced, at 4% concentration has a more turbid color. This is because, in the formula 4% of Arab gum concentration is used high, thus increasing its viscosity. The higher the viscosity causes the distance of the particles to each other to be close so that the particles cannot move freely causing the force between the particles to be strong, so that the particles combine to form a larger size that causes the formula 4% more colorful. This is in line with Pony's (2014) statement that the clearer a solution of nanoparticles the smaller the particle size therein, and the more cloudy the nanoparticle solution the larger the particle size therein.

2. Stability Analysis of Silver Nanoparticles Through Upper Absorption and UV-Vis Spectrum.

The stability of the silver nanoparticles was observed through changes in the absorbance peak and the fourth wavelength of the formula each week for 8 weeks. The change in the absorption peak can be seen in Fig. 3 as well as the wavelength in Fig. 4 and appendix 2.

From the data obtained can be observed in the formula 1 and 2 experienced began to increase the highest absorbance of each at the third and fourth week and in the next week decreased the absorbance of this is because began to occur agglomeration process in colloids during the week.

This is due to the long-time effect of storage and the low concentration of Arabic gum used so as to make the steric hindrance made by Arabic gum also low cause the particles to be more easily enlarged and more easily subjected to agglomeration characterized by decreasing absorption and shifting wavelengths in a larger direction and as seen in the absorbance value data decreases each week. As stated by Sulistiyawati et al (2015) that the agglomeration process is characterized by decreasing the absorption intensity (absorbance) and shifting wavelengths in a larger direction.

While the formula 3 and 4 in the second week increased absorbance and decreased wavelength. This is due to the effect of the length of storage time and the inhibition of the growth process that is the stage of formation of silver nanoparticles that have not been perfect and still continue during storage due to high steric barriers from Arabic gum. If seen in the data, the absorbance of each week has increased which is an indicator of more and more nanoparticles formed so that tend to increase the peak absorption and shift wavelength in the shorter direction. As stated by Qadriah (2015) that the incomplete growth phase causes an increase in absorption peak (absorbance) and wavelength shifts in the shorter direction.

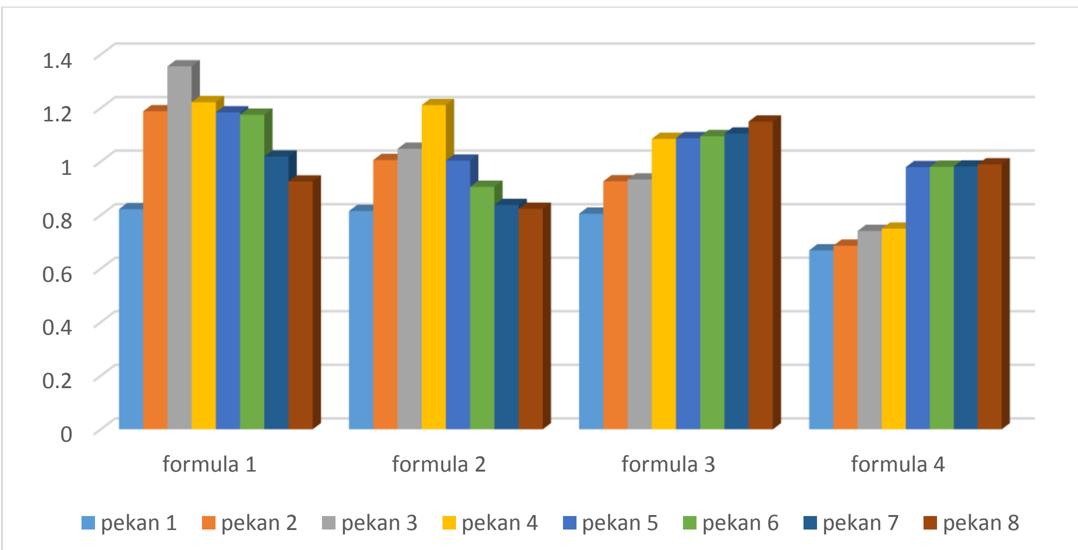

Figure 2. Absorption peak of silver nanoparticles for 8 weeks

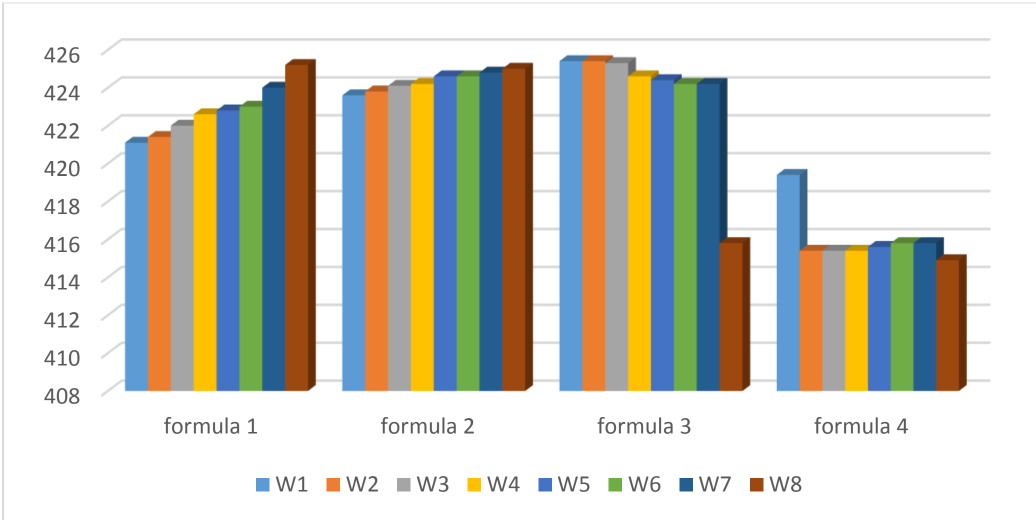

Figure 3. λ maximal of silver nanoparticles for 8 weeks

3. Stability Analysis of Silver Nanoparticles Through Particle Size Distribution

The stability of silver nanoparticles is also analyzed by particle size distribution, which can be determined by Particle Size Analyzer. The data obtained can be seen in figure 5 and appendix 2. Based on the data of silver nanoparticle size distribution value, in the first week of formula 1 and 2 yielding particles below 100 nm while in formulas 3 and 4 produce particles above 100 nm. This is due to the use of different aromatic gums whose concentration may affect the viscosity of the colloids, if the low viscosity of the particles in the colloids can move freely there is no accumulation of particles and produce a small particle size and when the high viscosity of the particles cannot move freely and there can be accumulation of particles so that the particles generated great.

It can be seen from the data that the formula using 3% Arabic gum concentration shows the smallest size up to 8th week compared to 3 other formulas that is 11 nm. In the formula 1% and 2% the size of the particles produced until the 8th week experienced a large increase of 41 nm and 28 nm respectively, this was due to the effect of the Arabic gum concentration used and the length of storage time. If in a low concentration, the Arabic gum bind to the particles are also small so that they cannot effectively decrease the force between particles, over time can cause the joining of particles to form larger particles and may occur agglomeration (Dong and Hao, 2014). In the formula 4% the size of the particles up to 8 weeks increased considerably by 20.5 nm. This corresponds to the viscosity of the solution, since the 4% formula uses the highest Arabic gum concentrations, in accordance with Stephen's (1995) assertion that the higher the Arabic gum concentration the higher the viscosity so that with its high viscosity it can stop Brownian motion from silver nanoparticle particles, making the distance between the particles close together and the particles unable to move freely, causing the accumulation of particles to form larger particles.

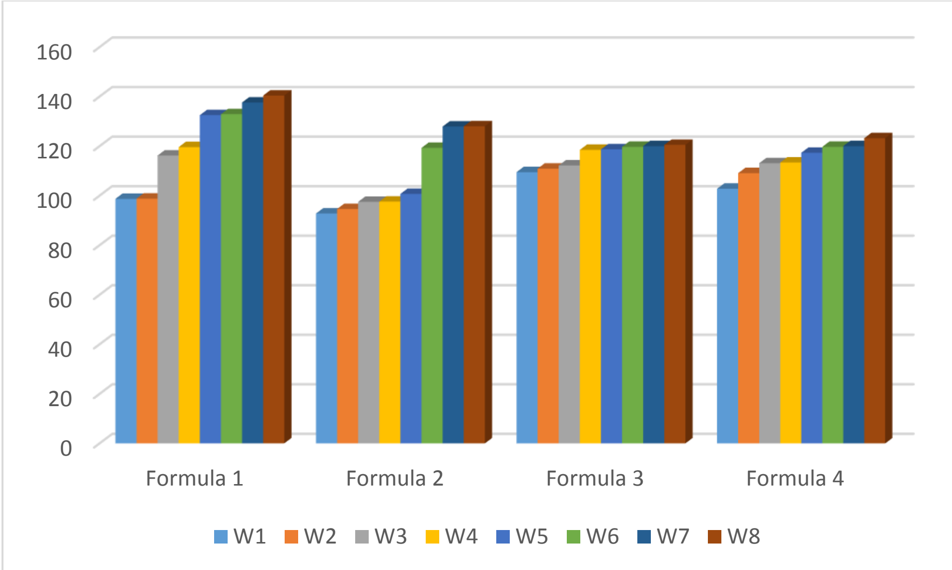

Figure 4. Particle size distribution diagram

4. Determination of Value of Poly-dispersed Index

The poly-dispersed index is a parameter showing the uniformity of particles in a sample using a Particle Size Analyzer (PSA). Data from the result of determining the Value of Poly-dispersed Index can be seen in appendix 2. From the data obtained shows that the increase of Arabic gum concentration and the length of storage time is followed by the declining of index value of poly-dispersed in the last week.

The higher concentration of Arabic gum used the lower the poly-dispersed index value, as in the 3% and 4% formulas which have PdI value in the last week respectively 0.236 ± 0.003 and 0.238 ± 0.001 indicating the particles in colloid have high uniformity of size, whereas in the formula 1% and 2% had PdI value in the last week respectively 0,571 ± 0,000 and 0,302 ± 0,004 indicating uniformity of particle size in colloid is quite uniform because its value is still below 0.7. It is based on, the closer the value of PdI, the higher the uniformity (Agus et al., 2012). In this study the silver nanoparticles produced were mono-dispersed nanoparticle systems, it proved that the four samples had a poly-dispersed index below 0.7, as stated by Anung (2104) that nanoparticles having a poly-dispersed index between 0.01-0.7 were mono-dispersed nanoparticles.

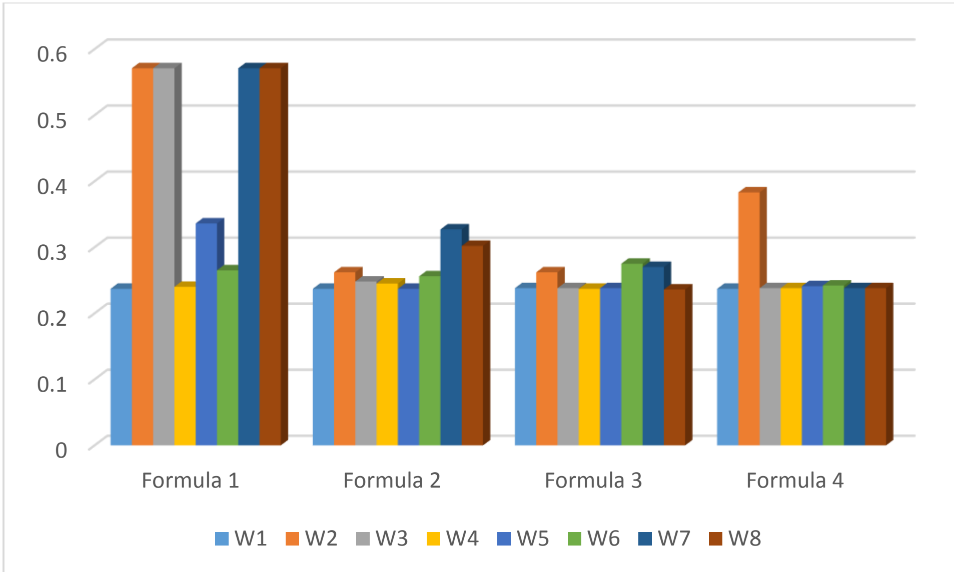

Figure 5. Diagram of Silver Panel Value of Silver Nanoparticle Index

5. Determination of Zeta Potential Value of Silver Nanoparticles

Zeta potential was determined based on electrophoresis movement that relative motion of particles caused by electric charge using PSA (Particle Size Analyzer). The zeta potential has a practical application in the stability of the system containing the dispersed particles because it is this potential that governs the degree of rejection between equally charged and closely spaced dispersed particles (Martin et al., 2008). Data of potential zeta value determination can be seen in appendix table 5.

From the results obtained, the resulting potential zeta value is negatively indicating the charge of the silver nanoparticles (AgNP) is negatively charged. This is due to get the charge of particles in the colloids having the ability to adsorb particles in the dispersing medium so that the resulting charge depends on the charge of the adsorption of the particulate if the adsorbs are negatively charged then the particle will be negatively charged and if the particulate particles in the adsorbs are positively charged the particle will positively charge (Lyklema, 1991). With the zeta value generated in this study indicating that all formulas have a good degree of stability, in accordance with Anung's (2014) statement that the zeta potential value of a nanoparticle greater than + 30 mV or smaller than -30 mV indicates a degree of stability good.

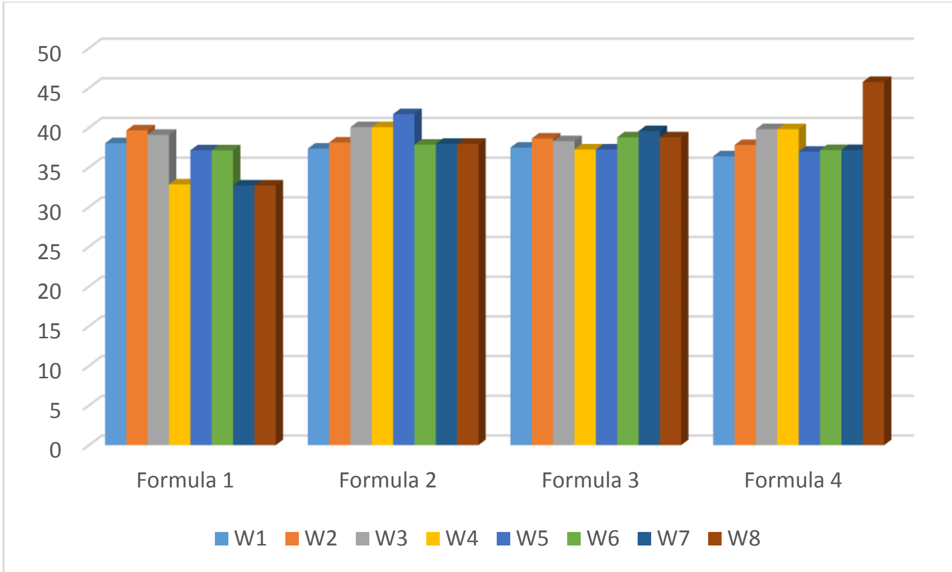

Figure 6. Diagram of Zeta Potential Value of Silver Nanoparticles

6. Morphological Analysis of Silver Nanoparticles

Synthesis of silver nanoparticles has many methods that can be done, the stabilizers and reducers are used too diverse, so it can affect the silver nanoparticles produced both particle size and particle shape. To know the morphology of silver nanoparticles was analyzed using SEM (Scanning Electrone Microscope). The formula analyzed was formula 3 because of this formula which has the smallest size increase. From the SEM analysis shown in FIGS. 7, the silver nanoparticles formed are not uniform. This is due to the manufacture of silver nanoparticles using the Bottom Up method, as stated by Anung (2014) that making nanoparticles using the Bottom Up method is very difficult to produce nanoparticles with a uniform shape.

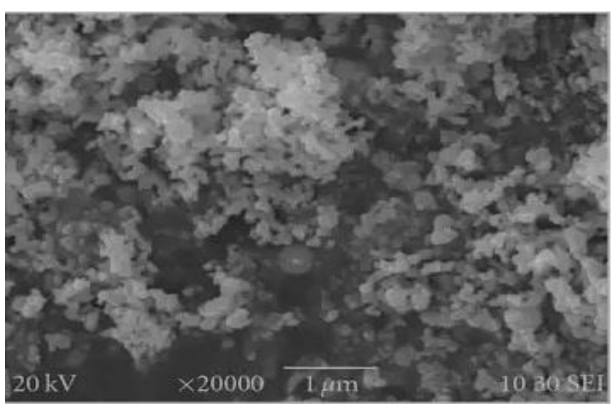

Figure 7. The Results of Morphological Analysis Using SEM 250x Magnification

CONCLUSION

Based on the results of the study, it can be concluded that the use of Arabic gum as a stabilizer in the synthesis of silver nanoparticles produces silver nanoparticles that have wavelength and absorbance are not stable. The use of a 1% to 4% aromatic gum concentration did not produce a stable silver nanoparticle (AgNP)

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