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Production Of Hand Sanitizer Using Aloe Vera And Silver Nanoparticles As An Active Agent

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Abstract – The synthesis of colloidal silver nanoparticles was performed using a pulsed laser ablation technique. Laser ablation, unlike chemical techniques, can produce high-purity silver nanoparticles without any chemical deformation making them suitable for use as a hand sanitizer. In an experiment, a high-purity silver metal was immersed in a polyvinylpyrrolidone (PVP) liquid. The silver plate in the liquid was then bombarded using a 1064 nm Nd: YAG laser. Silver nanoparticles were successfully produced in PVP solution with a color change from transparent to yellow or brownish yellow. Silver nanoparticles have a spherical shape with a nanoparticle size of around 13 nm. Silver nanoparticles have an LSPR resonance peak at 402 nm, which is a great potential as hand sanitizers because of the size of the article on the nanoscale, so they can easily kill annoying microbes. The hand sanitizer product using the active ingredient aloe vera and silver nanoparticles has been tested on Escherichia coli bacteria for 60 seconds, resulting in the percentage of simplo bacteria killing of 98.091% and Duplo of 98.778%.

Keywords – hand sanitizer; silver nanoparticles; aloe vera; antibacterial

I. INTRODUCTION

The increase in the number of COVID-19 sufferers of the new Omicron variant is due to the ease with which this virus spreads [1]. In general, there are two processes of transmission of the COVID-19 virus, namely via close physical contact and droplets from the respiratory tract [2]. In addition, this virus is also known to spread through airborne transmission and eventually attaches to all surfaces of matter [3]. Because the process of spreading is very easy either through physical contact or airborne, protective measures against COVID-19 are very much needed.

The use of hand sanitizers as a preventive measure against COVID-19 is very important [4]. The use of hand sanitizers is mandatory to maintain cleanliness and the possibility of transmitting the virus [5]. The results showed that the COVID-19 virus remained viable for up to 1 day on cloth and wood, on glass for up to 2 days, up to 4 days on stainless steel and plastic, and up to 7 days on the outer layer of medical masks [6]. Other studies have also found that the COVID-19 virus persists for 4 hours on copper, 24 hours on cardboard, and up to 72 hours on plastic and stainless steel [7]. The COVID-19 virus also survives at various pH levels and ambient temperatures but is susceptible to heat and standard disinfection methods [8]. With the use of this hand sanitizer, it is hoped that it will break the chain of further transmission.

There are several hand sanitizer products currently available in the market. Generally, the manufacture of these products refers to the guidelines for making hand sanitizers using the active ingredient alcohol [9]. As explained in the manufacturing guidelines according to WHO standards, the active ingredient of hand sanitizer is alcohol with a minimum concentration of 70% [10]. However, from the results of the study, the use of alcohol with high concentrations will easily irritate the skin and has a fairly short life as an active ingredient [11]. In addition, the use of hand sanitizers with high concentrations of alcohol is also rarely used in some places of worship because of doubts about their halalness.

As an alternative to hand sanitizer products, we have conducted research on the manufacture of pure silver (nanosilver)

nanoparticles in colloidal form as an active ingredient in hand sanitizer products [13-15]. Nanosilver is an active substance that can be used as an antimicrobial agent including fungi and bacteria [16]. Despite containing very low concentrations (parts per million or 1/1,000,000 scale), nanosilver is very effective as an antimicrobial [17]. Although it contains a very low concentration of nanosilver, this product is very effective as a hand sanitizer and is an alternative as a way to prevent exposure to COVID-19 [18]. In addition, this product is also safe for humans and environmentally friendly because it contains nanosilver with a very low concentration of ppm level.

In this study, our team of researchers has made a more effective hand sanitizer formula using natural ingredients such as aloe vera and active agent silver nanoparticles.

II. Experimental procedure

2.1. Synthesis of colloidal silver nanoparticles

The radiation source used was Nd: YAG laser (New Wave Research, Polaris II, 20 Hz) with a wavelength of 1064 nm and pulse width of 7 ns. Laser Exec II software was used to set the laser parameters (energy, repetition rate). The laser energy was set to 30 mJ and the repetition rate was 10 Hz. Experimentally, a pulse laser beam was directed using a silver mirror and focused using a quartz lens with a focal length of 30 mm on a silver metal plate placed in a petri dish containing liquid mediums for 11 hours. As the number of laser bombardments increases the color of the liquid medium changes from clear to light yellow and finally to brownish yellow. The experimental setup used for this work is shown in Figure 1.

2.2. Antibacterial testing

Antibacterial testing with AOAC 960.09 (the year 2013) with a minor modification [19]. The bacteria used were Escherichia coli (ATCC 8739) and Staphylococcus aureus (ATCC 6538). The culture temperature is 35°C and the test temperature is 24°C. Samples of 10 ppm AgNPs were inoculated with test microorganisms including E. coli and S. aureus at concentrations of 13 × 106 CFU/mL and 11 × 106 CFU/mL respectively at a contact time of 10 min. Add 1 ml of AgNPs with 1 ml of the test suspension. This mixture is then placed in a solid medium TSA plate in four squares with 4 stripes on the inclined surface. Each quadrant was incubated for 48 h at 35oC. After incubation, the growth of the inoculated organism was counted in each quadrant.

2.3. Production of hand sanitizer

The steps for making a hand sanitizer in one liter are as follows: 1. Dissolve 200 ml of aloe vera. 2. Adding 600 ml of 10 ppm colloidal silver nanoparticles. 3. Add 200 ml of 70% alcohol. 4. Blend all ingredients until homogeneous. 5. Adding essential oil as much as 1-2 bottles of 10 ml. Aloe vera is used in a gel, so it needs to be melted. The 10 ppm colloidal silver nanoparticles used are the result of synthesis using pulse laser ablation so that the purity of the nanoparticles is high. The addition of 70% alcohol here functions when hand sanitizer is used, it will bring a little coldness to the hands, thus adding freshness. These ingredients such as aloe vera, nanosilver, and alcohol are mixed using a mixer. After everything is mixed, then add the essential oil, and mix again using a mixer. The essential oil here is used to give the hand sanitizer a fragrant aroma.

III. Result and Discussion

As an alternative to hand sanitizer products, research has been carried out on the manufacture of pure silver nanoparticles (nanosilver) in colloidal form as an active ingredient in hand sanitizer products [13-15]. Nanosilver is an active substance that can be used as an antimicrobial agent including fungi and bacteria [16]. Despite containing very low concentrations (parts per million or 1/1,000,000 scale), nanosilver is very effective as an antimicrobial [17]. Silver nanoparticles used contain a concentration of 10 ppm. Although it contains nanosilver in low concentrations, this product is very effective as a hand sanitizer and an alternative as a way to prevent exposure to COVID-19 [18].

Silver nanoparticles were characterized using Scanning Electron Microscope (SEM) and Ultraviolet-Visible Spectroscopy (UV Vis). Then a hand sanitizer made from silver nanoparticles that have been mixed with aloe vera and other ingredients was tested on E. coli bacteria to see the percentage of bacteria killed.

3.1. Analysis of Morphology and Size of Silver Nanoparticles

SEM test was used to see the morphology of silver nanoparticles. Figure 2 shows the morphology of the spherical nanoparticles. The size distribution of the nanoparticles can be seen in Figure 3. The size of the silver nanoparticles in the PVP

solution is around 13 nm. At the nanoscale, it becomes an antimicrobial active ingredient.

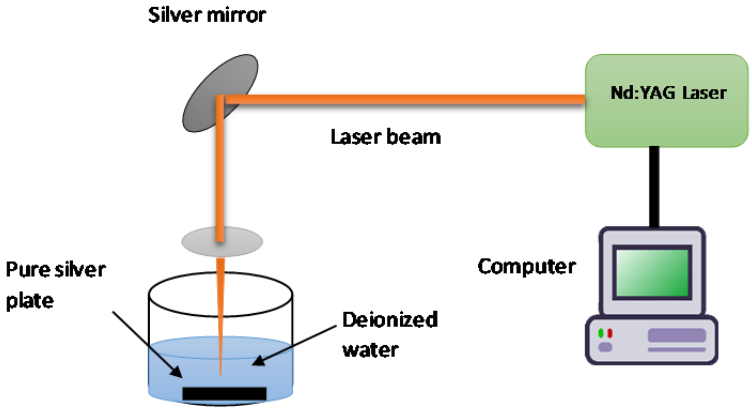

Fig. 1. Experimental setup used in this work

3.2. Optical Properties of AgNPs Using UV-Vis Spectrometer

Silver nanoparticles are produced as an active ingredient in hand sanitizers. Silver nanoparticles have been successfully produced using the pulsed laser ablation (PLA) method to produce a brownish-yellow color. UV-Vis analysis was carried out to determine the intensity of the colloidal silver nanoparticles produced. Figure 4 shows the absorption spectrum of silver nanoparticles in a PVP solution. Localized Surface Plasmon Resonance (LSPR) peaks were obtained at a wavelength of 402 nm. The presence of this LSPR indicates silver nanoparticles have been formed.

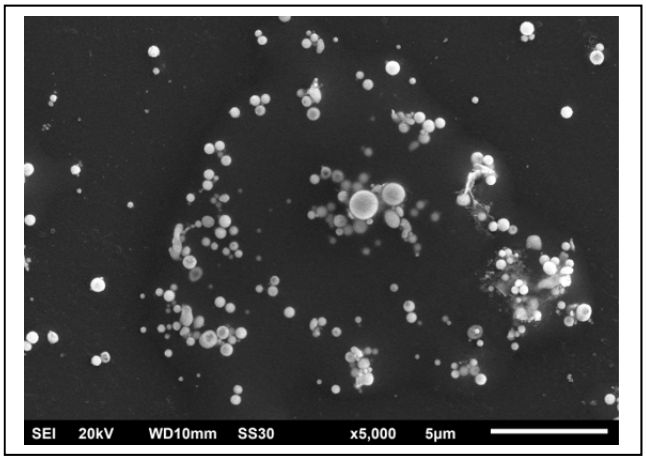

Fig. 2. Image of silver nanoparticles obtained by using SEM

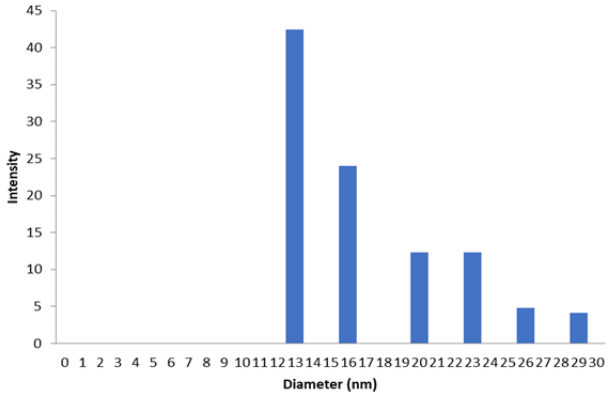

Fig. 3. Size distribution of silver nanoparticles calculated by using imageJ

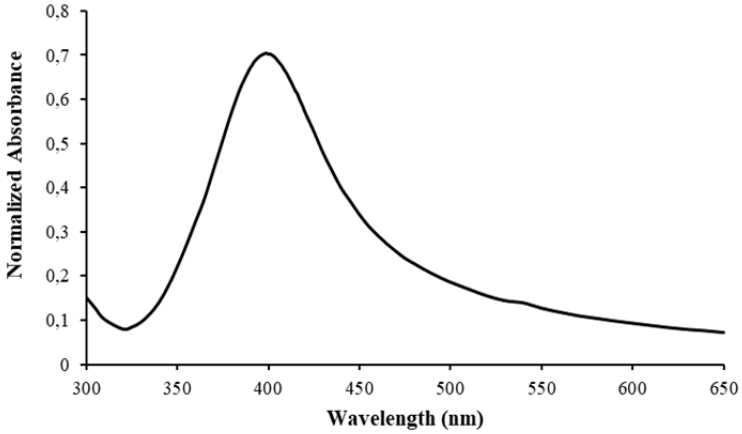

Fig. 4.UV-Vis spectrum of the silver nanoparticles

3.3. Antibacterial activity of E. coli in hand sanitizer

Silver Aloe vera and silver nanoparticles as active agents in the manufacture of hand sanitizers. The hand sanitizer made with the previously mentioned formula was then tested on Escherichia coli bacteria. The test results can be seen in Table 1.

TABLE I. ANTIBACTERIAL TEST OF THE HAND SANITIZER PRODUCT USING ALOE VERA AND SILVER NANOPARTICLES AS AN ACTIVE AGENT

Contamination time (s)	Number of initial bacteria (CFU/mL)	Number of remaining bacteria (CFU/mL)	Number of dead bacteria (%)
60 (Simplo)	2.2×10^7	3.0×10^5	98.091
60 (Duplo)	1.8×10^7	1.8×10^5	98.778

It can be seen in the table that hand sanitizers made from aloe vera and active agents of silver nanoparticles can degrade E. coli bacteria within 60 seconds resulting in the percentage of killing simple bacteria at 98.091% and Duplo at 98.778%. Silver nanoparticles can kill bacteria because silver nanoparticles can accumulate in the holes formed in the cell wall after adhering to the cell surface, and this can cause the denaturation of cell membranes in microbes. Silver nanoparticles also can penetrate bacterial cell walls and subsequently change the structure of cell membranes, due to their nanoscale size [20]. Denaturation of cytoplasmic membranes can damage organelles, and even result in cell lysis. In addition, silver nanoparticles can be involved in

bacterial signal transduction affected by protein substrate phosphorylation, and nanoparticles can dephosphorylate tyrosine residues on peptide substrates [21].

It was stated in Avicenna's research that silver nanoparticles with a concentration of 20 ppm succeeded in killing 100% of E. coli bacteria [14]. In this hand sanitizer made with the addition of 10 ppm silver nanoparticles, it can kill 98% of bacteria, almost close to 100%. This can also apply to viruses, by using silver nanoparticles in hand sanitizers, will prevent the virus from entering the body through the hands. This is evidenced in Merkl's research, which states that nanosilver shows potential as an antiviral [22]. Thus, hand sanitizers with active silver nanoparticles can minimize the incidence of transmission and spread of the Covid-19 virus.

IV. CONCLUSIONS

Production of hand sanitizer using aloe vera and silver nanoparticles has been successfully carried out. Hand sanitizer with the addition of silver nanoparticles can kill 98% of E. coli bacteria in 60 seconds. At the nanoscale, silver can penetrate bacterial cell walls well and can be a more effective hand sanitizer because the size of silver nanoparticles is around 13 nm.

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