FORMULATION OF LIQUID HAND SOAP MADE FROM NEEM SEED OIL AND LEMONGRASS ESSENTIAL OIL

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Abstract: The COVID-19 outbreak has overly emphasized the importance of handwashing with soap to reduce the spread of the virus. This study was conducted to formulate a liquid hand soap with neem oil and lemongrass essential oil as a natural antibacterial component. Three different concentrations of neem oil 5%; 10% and 15% and three different concentration of lemongrass essential oil (0.2%; 0.4%;0.6%) were formulated as liquid soap using coconut oil, castor oil and neem oil as its soap bases. The natural liquid soap was made by saponification reaction between oils and potassium hydroxide. The soap was evaluated for its pH value, density, foam stability, insoluble in alcohol content, free fatty acid and antibacterial activity. The results showed that the colour of the liquid soap was transparent with yellowish colored and had distinctive smell of neem oil. The pH values of the different formulated liquid hand soaps are within the accepted pH range of 4 - 10. The specific gravity was 1,083 – 1,088 g/ml. The foam stability range was 25.35% - 78.38%, respectively. The insoluble in alcohol content range were 0.14 – 0.4. The free caustic alkali range was 0.12 – 0.47. The liquid hand soap can inhibit the growth of *Staphylococcus aureus*. The inhibition zone diameter of liquid hand soap was 1.98- 2.61 cm. It was therefore proven that neem oil and lemongrass essential oil is effective as an antibacterial component in the formulation of liquid hand soap.

Keyword : neem, lemongrass, soap

I. INTRODUCTION

An acute respiratory disease pandemic, caused by a newly discover novel coronavirus (SARS-CoV-2), the coronavirus disease 2019 (COVID-19) has spread throughout China and affects nearly all countries in the world. On 11 March 2020, World Health Organization (WHO) officially declared the COVID-19 pandemic as a public health emergency of international concern. COVID-19 has spread around the world with virtually no region left untouched. The speed of the spread and the alarming death rates have seen many countries and jurisdictions introduce measures to prevent the spread of COVID-19, and hand hygiene is considered as one of fundamental preventive against disease. Handwashing with soap is an easy and affordable solution that everyone should be able to do. It not only protects us from contracting diseases, but also avoids transmission to others, breaking the chain of infection. Handwashing, together with other preventive measures, with soap and clean water for at least 20 s or the use of alcohol-based hand

rub when soap and water are not available is the number one defense in stopping the spread of infection (CDC 2020).

There are a variety of liquid hand soap products available. The term soap is associate to any cleaning agent (Draelos, 2018). Soaps are made of sodium or potassium hydroxide and natural fats. Soap is created when a fat interacts with an alkali, resulting in a fatty acid salt with cleansing properties. Soap removes dirt, stain, grease, inactivates viruses and microbes by disrupting the lipid membrane and intracellular lipids. Several studies indicate that soap as a more effective method of hand hygiene than hand rub. Hand washing with soap has the added benefit of physically washing away debris and pathogens with running water (Levin and Miller, 2011).

There are 2 classification of soap, depend on a kind of alkali use, which are soap bar or sodium soap and liquid soap or called potassium soap. Many advantages of liquid soap, such as easy to use, lower contamination, and several of formulation, all these reasons lead liquid soap products to commonly use in every day. Liquid soap is now commonly accepted because of its practical use and better appearance (Anggraini et al., 2012).

Natural liquid hand soap with neem oil and lemongrass oil is an alternative cleanser to replace synthetic chemicals used in the soap. Neem seed oil, extracted from the seed of neem plant (*Azadirachta indica*) is reported as an important source of natural antimicrobial compound, have been used for centuries in the Indian sub-continent in ayurvedic medicine. Upadhyay et al. (2010) studied that neem oil to be highly bactericidal. Neem oil has been used in the treatment of inflammation, pain and swelling that occur inarthritis (Subapriya et al., 2005). In Indonesia,neem trees could be found in central Java, East Java, Bali and West Nusa Tenggara (Indiati, 2008). The major lipid in neem oil was triglycerides. Neem oil is rich in essential fatty acids, triglycerides, vitamin E and calcium. Because of its essential fatty acids and vitamin E, Neem oil penetrates deep within the skin to heal the minute cracksbrought on by severe dryness. Fatty acids present in the neem kernel oil are oleic acid (52.8%) as the main component, linoleic acid (2.1%), palmitic acid (12.6%) and stearic acid (21.4%) and other lower fatty acids (2.3%) (Sadekar, 1998).

Neem oil has been used to produce of natural and organic cosmetics, medicinal cosmetics, personal care products, toothpaste, hair and skin care products, emulsions, liquors and ointments (Chatterjee,1994). However neem oil can be extracted mechanically (hot or cold expression) or chemically (solvent extraction) from dried neem seeds. The best quality neem oil with a majority of phytoconstituents intact is obtained through cold press. In cold press the oil is lighter in colour and has a milder odour (Ramakrishna, et al, 1993).

Lemon grass *(Cymbopogon citratus)*, is a member of poaceae family. Lemongrass is a tropical perennial plant which yields aromatic oil. The name lemongrass is derived from the typical lemon-like odour of the essential oil present in the shoot. The herb originated in Asia and Australia (Joy, 2006). It is a medicinal plant with compounds capable of controlling pathogens and increasing herbal resistance to pathogenic diseases. This aromatic plant is used in perfume production and is grown to produce essential oils for business purposes. Due to its good aroma, it is used for preparation of the colognes, deodorants and soaps in different pharmaceutical industry. Its major components are citral monoterpenes (an isomeric mixture of the geranial and neral) and myrcene both of which have anti-bacterial and medicinal importance. The citral mono terpenes show anti-fungal and anti-microbial action (Car, 2011). Many studies have confirmed that lemongrass oil has potent antifungal and antimicrobial activities (Shah,2011; Chalchat, 1997; Onawunmi,2000) However, it does present a high risk of skin irritancy and sensitizing activity on the skin.

The purpose of this study is to formulate natural liquid hand soap with neem oil and lemongrass essential oil at various concentration. The physico-chemical properties and antibacterial activity was evaluated to determine the quality of the liquid hand soap.

2. METHODS

2.1 Soap Preparation

Experiments of liquid hand soap producing have been conducted in the laboratory of Chemical Science, Djuanda University. For the formulation of liquid hand soap, hot process method was used in the study. Coconut oil, castor oil and neem oil were heated in a beaker at 100°C. Three different concentrations of neem oil 5; 10 and 15% were used.The temperature was checked using a thermometer. Sodium lactate and sucrose were mixed with oils. KOH and glycerin was weighed and water was prepared. The KOH was mixed with distilled water and glycerin. Stirred using a stirring rod to dissolve the KOH. The mixture served as the lye-water solution. Once the lye-water was completely mixed until it became clear, the lye-water solution was then slowly added to the heated oils. The lye-water solution were poured into the heated oils in a beaker. The solution was heated at a maintained temperature of 100°C for 30 - 40 minutes. After which, the solution was continuously stirred using a stick blender. This served as the soap paste. The soap paste was then mixed to distilled water and citric acid. Lemongrass essential oil was added to the liquid soap with three different concentration (0.2;0,4 and 0,6%). Liquid hand soap poured into containers and closed tightly.

2.2 Soap characteristics

Characterization of soap includes parameters: pH, density, foam stability, free fatty acids, insoluble in alcohol and antibacterial activity. The liquid hand soap characteristics were assessed according to the SNI 2588 : 2017 standard guidelines.

2.2.1. *pH*

A volume of 1 ml on each of the natural liquid hand soap was dissolved in a 100 ml distilled water. The pH of the soap solution was verified using a calibrated pH-meter.

2.2.2. *Density test*

Density is a physical property. It represents the mass per unit volume of matter using pycnometer. Empty piknometer was weighed. Measure the weight of the pycnometer filled fully with aquadest at the temperature was lowered to 25 °C, if volume decreased, aquadestis added through the capillary. The natural liquid hand soap is drawn into a pycnometer of known weight. The weight of the natural liquid hand soap is then measured when it reaches a reference temperature of 25°C.

2.2.3. *Foam stability test*

Foam stability test done by taking one mL liquid hand soap and inserting it into test tube which had been given scale, and then 5 mL of distilled water was added. The reaction tube was shaken strongly to form a foam and then the height of the foam formed was measured. The height of the formed foam was measured at 10 minutes.

2.2.4. *Insoluble in alcohol*

Soap sample were dissolved in 50 ml hot ethanol and quantitatively transferred in a pre weighed filter paper. The residue was dried in the oven at 105˚C for 30 minutes, cooled and weighed again then reading taken.

2.2.5. *Free Caustic Alkaline*

The FCA value refers to the amount of alkaline-free properties in the soap which can cause skin itch when present in excess value. The free caustic alkali is the amount of alkali free to counter and avert the soap from becoming oily

2.2.6. *Antibacterial activity*

Antibacterial Activity Test is conducted using the Disk Diffusion Method. *Staphylococcus aureus* is used as the bacteria, while Dettol Soap and Sterilized Aquades as positive and negative control. The bacteria, should be cultured in Nutrient Broth (NB) medium and incubated for 18 to 24 hours in 36 ^{o}C Temperature. Then the bacterial solution disperse into Nutrient Agar (NA) using sterilized swap. A sterilized swab was dipped into the inoculum tube and was streak over the surface of the nutrient agar in a backand-forth motion and by moving across and down the plates. The disk paper soaked with 1 mL Soap Sample were place into the NA and incubated for 24 hours at 36 ^{o}C Temperature. Each of disk paper that soaked with Dettol Soap and Sterilized Aquades as positive and negative control also placed into the NA and incubated with the same period of time and temperature as the soap sample. Inhibitory diameter measurement conducted after ± 24 incubation time (Rosalina et al, 2018).

2.2.7. *Data analysis*

Data analysis used was factorial completely randomized design. Factors tested were the concentration of neem oil and lavender essential oil. The data obtained were analyzed using Statistical Product Services Solution (SPSS) for windows. The results that showed a real difference will be analized by DMRT test (Duncan's Multiple Range Test) with 95% confidence level (α = 0,05)

3. RESULT ANF DISCUSSION

The process to make natural liquid hand soap is done using hot process method. Saponification is the name of the chemical reaction that produces soap. Then the soap was diluted and added with lemongrass essential oil. Saponification is an exothermic chemical reaction that

occurs when fats or oils (fatty acids) come into contact with alkali, a base. In this reaction, the triglyceride units of fats react with potassium hydroxide and are converted to soap and glycerol. There are many variables that will impact saponification and different soap ingredients have very distinct characteristics. The natural liquid hand soap in this research using coconut oil, castor oil and neem oil as its soap base. When soap is only made with one oil it may not be the most balanced soap. By adding coconut oil and castor oil to the formulation, Each oil contributes something different to create a more balanced soap. Coconut oil is one of the most popular oils to produce soap. It offers a unique combination of cleansing, firming and skin-loving properties. Castor oil added to a liquid hand soap results in a stable lather that is low, dense, creamy and add moisturizing qualities.

The purpose of addition of neem seed oil and lemongrass essential oil are to give antibacterial and aromatic effects to the soap. Among all the parts of neem tree, the seeds are listed as one of the most important source of medicaments in antibacterial activity as the oil contains extensive spectrum against antibacterial infections.

The previous study showed that the blending ratio of neem seed oil to eucalyptus oil of 20:80 was found to be the best blending ratio for the antiseptic soap (Bello,2019), the antibacterial properties of the neem and shea butter oil blends compared favorably well to a commercial antiseptic soap containing triclorocarbanilide (Ameh, 2013) and neem seed oil could be used as a substitute for palm oil in producing cosmetic toilet soaps with favourable medicinal properties (Mensah,2011)

The soap in this research gives a transparent yellowish colour with smells like earthy, slightly nutty and kind of fresh citrusy scent from lemongrass essential oil. The colour deepens as the concentration of neem oil increases probably due to some sort of reactions between the neem oil and the soap paste. The liquid soap samples remain stable and did not separate.

The characteristic of the soap were divided into several criteria, namely pH, density, foam stability, insoluble in alcohol content, free fatty acid, and antibacterial activity. The physico-chemical properties of soap actually determine its quality. Then the result were compared with SNI 2588: 2017.

3.1 pH

The pH value of the liquid hand soap has fulfilled the requirements according to SNI (2588 : 2017), in the range of 4-10. All the formulated liquid hand soaps fall within the accepted limit pH range. Statistical analysis shows that there is no significant difference ($p = 0.05$) in the pH value of the liquid soap . A neutral pH is 7, and anything higher than that is more on the alkaline side, while anything with a lower number falls more on the acidic side. Liquid hand soap in this research tend to fall in the pH range of 8 – 9. Liquid hand soap with saponification reaction is naturally alkaline due to the presence of potassium hydroxide components as the base material. (Irmayanti, et al, 2014). Citric acid was used in this research to adjust the pH of soap.

The human skin has an acidic pH of 5.4 to 5.9, which is an important factor in the protection against microorganism where in alkaline substances such as soaps neutralize the body's protective mantle that acts as barrier against bacteria (Onyango *et al.,* 2014). Furthermore, highly alkaline pH could damage the acid mantle and as well as the disruption of the lipid lamellae of the epidermis, that could possibly result to skin dryness due to higher trans-epidermal water loss allowing the access of potential irritants and allergens (Mendes *et al.,* 2015). pH value of liquid hand soap is safe for the skin.

3.2 Density

Density is the ratio of liquid hand soap mass to the water mass at the same volume and temperature. The density of the prepared natural liquid hand soap were determined simply by using a pycnometer. The aim of density test is to determine the weight ratio of liquid hand soap and the effect of components use in liquid soap formulations. The density of liquid soap is influenced by the concentration and type of raw components that was added.

The higher the value of molecular weight of the raw components added, the higher the density. Density of liquid soap formulation is 1,083 – 1,088 g/ml. Statistical analysis shows that there is no significant difference ($p = 0.05$) in the density of the liquid soap. The value of density is influenced by its constituent material and its physical characteristics. The density may increase by the addition of materials such as sugar, sodium lactate and glycerin used in the formulation of liquid hand soap. Analyze the density of liquid hand soap is important because it can determine whether a solid can be dissolve or not with other substances so that it will be easier in the formulation of soap.

3.2. Foam Stability

The liquid hand soap results show the value of foam stability with a range of 25.35% - 78.38%. One factor that affecting foam stability is the fatty acid component in soap formulations. The stability of foam obtained increases with increasing neem oil and lemongrass oil concentration. Coconut oil composed of saturated fatty acid (lauric acid, miristic acid) is known of its high cleansing properties with bubbly, foamy and unstable lather. The neem seed oil contains oleic acid which can produce a stable with a long lasting and soft foam, palmitic acid and stearic acid which has the stabilizing properties of the foam. In general, good and stable foam is one of the important attributes for effective cleansing action by soaps.

3.4 **Insoluble in alcohol**

The insoluble in alcohol content range were 0.14 – 0.4. Statistical analysis shows that there is no significant difference ($p = 0.05$) in the insoluble in alcohol content value of the liquid soap. The result of the insoluble in alcohol content liquid hand soap is in accordance with SNI. Insoluble in alcohol is a parameter that is used to determine the purity of soap. It is the measure of non-soap ingredients known as builders or fillers such as sodium silicate, sodium phosphate, sodium carbonate and minor constituents such as bleachers, whitening agents and fluorescing agents in the finished product. The soap with high insoluble in alcohol values suggests that it contained high level of impurities which may be attributed to the level of impurities of alkali used for producing the soap.

3.3. Free Caustic Alkaline

The free caustic alkaline analysis aims to determine the amount of free alkaline present in the liquid hand soap products. Formulated soaps have a range of free caustic alkaline 0.12 – 0.47. The analysis results show that the free caustic alkaline amount in antibacterial liquid soap is not in accordance with SNI. The high amount of free caustic alkaline in liquid hand soap formulation is caused by the content of excess alkali components in the soap. The excess alkali in liquid hand soap should not exceed 0.05 % because alkali is hard and can cause irritation to the skin

3.5 Antibacterial activity

The antibacterial activity test on the liquid hand soap was done on gram-positive bacteria i.e *S. aureus* bacteria. Among many types of bacteria identified, *Staphylococcus aureus* had been listed as one of the most common bacteria that contribute towards pneumonia and skin diseases. *Staphylococcus aureus* is a normal flora bacteria of the skin, but if it exists in large quantities it can cause skin disease (Brooks, et al., 2012). It triggers the need for additional protection to the skin, one is to use antibacterial liquid hand soap preparations.

The test sample was divided into liquid hand soap (A), commercial Dettol (B) brand soap as a positive control, and aquadest (C) as negative controls. The ability to inhibit *S. aureus* bacteria shows antibacteraial activity of liquid hand soap when it is used. The inhibition zone diameter of liquid hand soap is 1.98- 2.61 cm. The antibacterial properties of liquid hand soap compared favorably well to a commercial antiseptic soap (Dettol). The inhibition zone diameter of commercial antibacterial hand soap is 1.48- 1.8 cm. The natural liquid hand soap of this study had demonstrated the greatest antibacterial activity against *S. aureus* compared to similar commercial liquid soap that use syntetic agent as an antibacterial..

4. CONCLUSION

This study shows that the combination of neem seed oil and lemongrass essential oil could be used as natural ingredient producing antibacterial liquid hand soaps. The liquid hand soap from the was found to have antibacterial activity against gram positive bacteria *Staphylococcus aureur*. It is a product innovation of a natural soap produced from neem oil and lemongrass essential oil that is free from chemicals, such as sodium sulfate (SLS), artificial colourant, and artificial fragrance. However, further research should be improve the quality of the soap.

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