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SYNTHESIS OF ANTIOXIDANT LIQUID SOAP FROM PANDAN LEAF EXTRACT (*Pandanus amaryllifolius Roxb.*) AND COCAMIDE-DEA

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ABSTRACT

Exposure to UV rays can form free radicals, which will cause progressive damage to the skin's cellular structure, resulting in accelerated aging. The antioxidants contained in pandan leaves can capture free radicals and reduce their adverse effects. This study aims to determine the correct formula for antioxidant liquid soap by adding pandan leaf extract. The antioxidant liquid soap formula was made using four variations of cocamide-DEA concentrations, namely 2%, 4%, 6%, and 8%, and three concentrations of pandan leaf extract (Pandanus amaryllifolius Roxb.), namely 20%, 30%, and 40%. The extract was made using the maceration method with 96% ethanol solvent. Soap formulations are tested using free alkali, fatty acid, and water content tests. The results of observations of the antioxidant liquid soap formula with pandan leaf extract and the addition of cocamide-DEA have good physical quality and stability and meet standards.

Keywords: pandan leaves, antioxidants, cocamide-DEA, free alkali, free fatty acids, water content.

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INTRODUCTION

As the body's outermost organ, the skin is exposed to oxidizing environments such as ultraviolet light, drugs, air pollution, and cigarette smoke. Exposure to this environment causes the formation of free radicals, which are also called Reactive Oxygen Species (ROS). Apart from being caused by external factors, free radicals are also formed naturally through the physiological metabolism of cells. Free radicals are formed when an oxygen molecule has one or more unpaired electrons. The mechanism of damage by free radicals is quite complex, through chain reactions to oxidative stress, which can cause cell damage. This knowledge about free radicals brings us to the role of free radicals in skin disorders. The body has antioxidants, the defense mechanism to neutralize formed free radicals. Antioxidants are substances that inhibit oxidation, even at relatively low concentrations. These antioxidants can be depleted quickly, disrupting the balance of the antioxidant system and intact cell antioxidants. Factors that reduce antioxidant production are bacteria, viruses, chronic inflammation, and aging [1-3].

Antioxidants are needed to prevent free radicals. Antioxidants can protect cells from damage caused by unstable molecules known as free radicals. Examples of antioxidants include β-carotene, lycopene, vitamin C, vitamin E, and flavonoid compounds [4]. Flavonoid compounds are secondary metabolite compounds from the polyphenol group that can act as antioxidants by preventing free radical compounds. Many studies show the ability of flavonoids to scavenge free radicals [5]. Many plants are effective as antioxidants, namely plants that contain carotenoids and polyphenols, especially flavonoids, formulated as natural antioxidants that can be produced in dosage form, consumed orally as vitamins, and topically as skin care products. Plant extracts with antioxidant properties arouse great interest in phytocosmetics because they contain molecules capable of inactivating ROS, restoring skin homeostasis, thereby preventing erythema and premature skin aging [6-8].

One of the plants that contains flavonoid compounds is pandan leaves (*Pandanus amaryllifolius Roxb.*) Pandan leaf extract has antioxidant activity and is hypoglycemic. Pandan leaves contain polyphenols, tannins, alkaloids, saponins, and flavonoids. Pandan leaf flavonoids can be polar compounds extracted using the maceration method with ethanol solvent [9, 10].

One pharmaceutical preparation that can prevent or maintain the health of the body's skin from free radicals is soap, which contains flavonoid compounds that act as antioxidants. Soap is a preparation produced from the reaction of fatty acids with a strong base, which functions to wash and clean fat (dirt). Most consumers are currently more interested in liquid soap than solid soap because liquid soap has a liquid form that allows liquid soap to react on the skin's surface more quickly than solid soap. Liquid soap is a liquid preparation intended for cleaning the skin which is made from soap base ingredients, which are added with surfactants, preservatives, foam stabilizers, fragrances, and dyes which are permitted and can be used for bathing without irritating the skin [4, 11, 12].

Diethanolamine (DEA) is widely used to synthesize critical heterocyclic compounds such as morphine, piperazine, oxazolidine, dioxazine, crown ether, and ionic liquids. Diethanolamine and its derivatives have wide applications in the pharmaceutical, surfactant, polisher, and cosmetic industries. DEA is used as an intermediate in the rubber chemical industry and as an emulsifier and dispersing agent in various agricultural products. DEA is also used in adhesives, cement, coatings, electroplating, printing inks, lubricants, paints, paper, petroleum, coal, polymer production, and textile finishing [13-15]. DEA derivatives exhibit a broad spectrum of biological activities, including antibacterial, antifungal, antituberculosis, anticancer, local anesthetic, antiplatelet aggregation, and antioxidant [16, 17]. Based on the description above, it is necessary to know whether pandan leaf extract can be used as an antioxidant to ward off free radicals and to observe the effect of variations in cocamide-DEA concentration on the characteristics of the liquid soap produced.

MATERIALS AND METHODS

Materials

The ingredients used in this research were pandan leaves (*Pandanus amaryllifolius Roxb.*), Cocamide-DEA fragrance, distilled water, and coconut oil from Barco. Ethanol, KOH, Na-CMC, Glycerin, and stearic acid were obtained from E Merck.

Preparation of Pandan Leaf Extract

Fresh pandan leaves are cleaned using running water to remove adhering dirt, cut into small pieces, and dried in the sun. The dried sample is then blended, and after blending, the powder is sieved using a sieve to get a finer powder. The fine powder is then soaked using 96% ethanol with a ratio of 1:10; the powder is soaked for three days in a dark place. After that, the marinade is filtered using filter paper. The filtrate obtained is then evaporated using a microwave to obtain a thick pandan leaf extract.

Making Antioxidant Liquid Soap

All ingredients to be used are weighed first according to the recommended measurements. First, develop CMC in hot distilled water. Put 30 mL of coconut oil into the Beaker glass, then add 16 ml of 40% potassium hydroxide (KOH) little by little while heating at 50ºC until you get a soap paste. Add ± 15mL of distilled water to the paste soap, then, carboxyl methyl cellulose (CMC) developed in hot distilled water, and stir until homogeneous. Then add stearic acid and stir until homogeneous. Add 13 mL glycerin and stir until homogeneous. After the stirring process, the temperature is lowered to 40°C. Cocamide-DEA is added to the soap paste and stirred until the mixture becomes homogeneous. Add 1 mL of aroma. Add pandan leaf extract according to the formula and stir until homogeneous. The soap paste is added with distilled water to a volume of 100 mL to form liquid soap, then put into a clean container that has been prepared.

Water Content Analysis

Determination of water content is carried out using the gravimetric method. 1 gram of sample was weighed in a petri dish of known weight and heated in a drying cabinet at 105^{o}C for 2 hours until the weight remained constant [18].

Analysis of Free Alkali and Free Fatty Acid Levels

Determination of free alkali and free fatty acid levels can be used to determine the quality of oil or fat. The liquid soap sample was weighed as much as 5 G and then put into a 250 mL beaker. Next, add 100 mL of 96% alcohol, then boil and add a few drops of phenolphthalein indicator solution. It was then heated in a bath for 30 minutes until boiling. If the purple solution is titrated with a 0.1 N HCl solution in alcohol until the purple color disappears, then the free alkali content is calculated using the following formula [19].

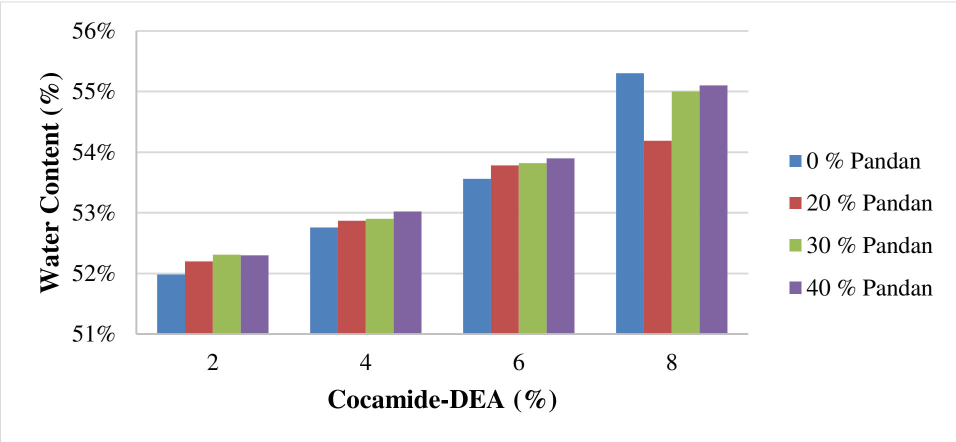

Figure-1. Results of water content analysis in liquid soap.

RESULTS AND DISCUSSIONS

Water Content Analysis

The water content test is carried out to determine the percentage of water content contained in each preparation. The water content standard set by the Indonesian National Standard (SNI) is a maximum of 60% [20]. To test water content, the petri dish is weighed; the sample is weighed as much as 1 g, and then placed in an oven at 105°C for 2 hours. After 2 hours, the sample and the heated petri dish were weighed and then calculated using the water content formula to obtain results ranging from 51.98% to 55.10%. The results of the water content analysis in liquid soap can be seen in Figure 1. Based on Figure-1, the experimental results of water content in antioxidant liquid soap with pandan leaf extract are still

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within the specified SNI. Water content can affect the level of hardness of the soap produced. The higher the water content in the soap preparation, the softer the hardness of the soap, and vice versa; the lower the water content in the soap, the more complex the soap will be [21, 22].

Water content can be influenced by several ingredients such as cocamide-DEA, distilled water, CMC, and glycerin. Based on the results, the highest water content was in formulas 4 and 8, adding 8 mL of cocamide-DEA. At the same time, adding pandan leaf extract did not significantly affect the water content. This shows that cocamide-DEA affects the water content of liquid soap preparations.

The addition of cocamide-DEA increases the water content produced. This is because cocamide-DEA is hygroscopic and tends to absorb water [23]. High water content can also be influenced by other hygroscopic materials, namely SLS, CMC, and glycerin, and can also be influenced by the addition of distilled water [16, 20].

Analysis of Free Alkali Content

Free alkali is the alkali in soap that is not bound as a compound. The excess free alkali in soap should be 0.1% for soap using NaOH and 0.14% for soap using KOH. Excess-free alkali in soap can be caused by a concentrated or excessive alkali concentration in the saponification process [24]. The free alkali test measures the alkali in soap, which does not react with fatty acids. A high percentage of free alkali value indicates that the soap can irritate [25]. The free alkali test is carried out to determine whether there is free alkali in liquid soap. According to SNI, free alkali in a liquid soap preparation is a maximum of 0.14%. The free alkali test results can be seen in Figure 2. Based on Figure-2, the free alkali content obtained from each liquid soap formula is 0.097%-0.111%. Based on SNI, the standard for free alkali in liquid soap is a maximum of 0.14%.

The results in Figure-2 show that adding cocamide-DEA affected the free alkali content, although the difference was insignificant. This is because cocamide-DEA is basic [26]. The free alkali content is influenced by the KOH concentration; however, in the preparation of antioxidant liquid soap with pandan leaf extract and the addition of cocamide-DEA, the same KOH concentration is used for each formula so that the free alkali content obtained does not significantly influence the free alkali content. Meanwhile, the addition of pandan leaf extract affects free alkali levels, although not significantly, because pandan leaf extract contains alkaloid compounds.

Alkaloids are basic or alkaline organic compounds [27]. Apart from that, the alkali content is also influenced by the length of stirring and heating when making liquid soap base so that the soap becomes a dry paste, which causes potassium hydroxide, which is one of the forms of soap base, to react with fat or oil [28]. The addition of distilled water also affects the reduction of free alkali levels because distilled water can reduce the concentration of free alkali in soap [29].

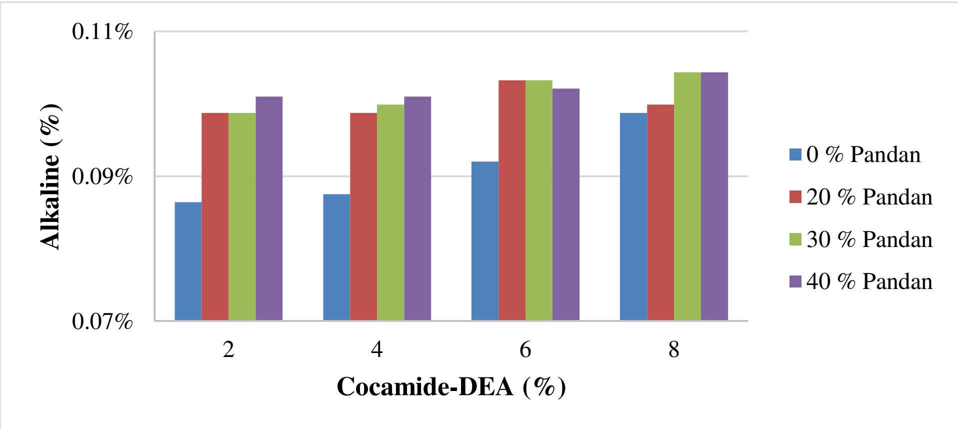

Figure-2. Results of analysis of free alkali content in liquid soap.

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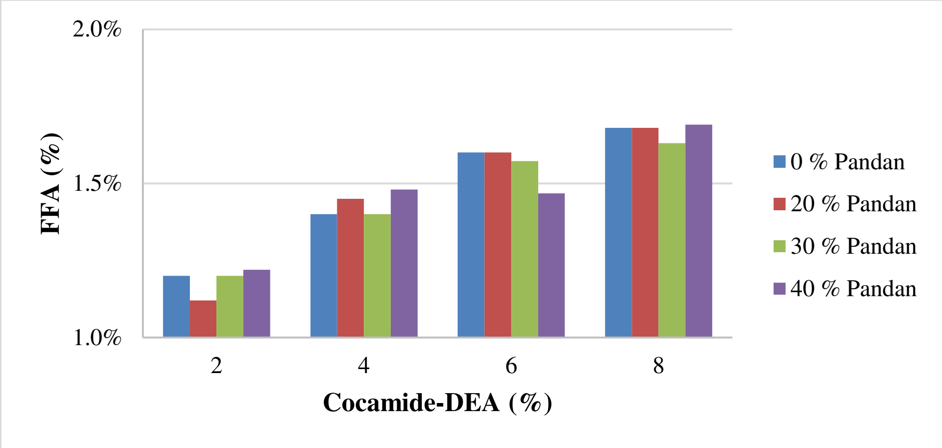

Figure-3. Results of analysis of free fatty acid levels in liquid soap.

Analysis of Free Fatty Acid

Soap is made through saponification, which is a reaction between fatty acids and alkali. High-quality soap is produced through an optimal saponification process, so there is no residue after the reaction. Free fatty acids are not bound as compounds with sodium or triglycerides (neutral fat). Large amounts of fatty acids can affect soap's ability to bind dirt, oil, grease, and sweat. Unlike fatty oils, free fatty acids cannot retain dirt because they have polarity. Likewise, impurities cannot bind with free fatty acids [27].

Fatty acid levels should not be high because this will trigger rancidity, thereby reducing the shelf life of the soap [30]. The results of the free fatty acid analysis can be seen in Figure-3, where it was found that the free fatty acid content obtained from each liquid soap formula was 1.20% -1.90%. Based on SNI, the standard for free fatty acids in liquid soap is < 2.5%.

Based on the results obtained, the high level of free fatty acids was due to adding 8 mL of cocamide-DEA in the liquid soap formulation, and the low level of fatty acids was due to adding 2 mL of cocamide-DEA. The high levels of free fatty acids are caused by fatty acids derived from stearic, palmitic, and lauric acids found in palm and coconut oils, essential ingredients for making DEA surfactants and components for making soap itself [31]. The free fatty acids found in soap are because they do not undergo a saponification reaction. The free fatty acids in soap can reduce the soap's absorption capacity for dirt in oil, fat, or sweat [30].

The free fatty acids can also influence the levels of free fatty acids in soap in the oil used in making liquid soap [27]. In this study, coconut oil was used as a raw material for making soap, where coconut oil's free fatty acid content was 0.25% [32]. The decrease in fatty acids is thought to be due to the presence of active compounds, namely alkaloids, in pandan leaf extract. The active group of alkaloids can break the double bonds of oil. Breaking double bonds into single bonds causes the oil to become saturated, so the amount of fatty acids in the soap becomes low [27]. Based on experiments, it was found that the formulation of antioxidant liquid soap, with pandan leaf extract and the addition of cocamide-DEA, met the SNI requirements for free fatty acids.

Boxplot Analysis

The sample distribution can be presented graphically in boxplot form. Boxplot analysis helps summarize information about the distribution of observational data. Figure-4 is a box plot of the effect of the amount of pandan leaf extract on the water content of the soap produced.

The median water content value for the three variations of sage leaf extract used is less symmetrical, with the median value for the 20% extract being 53,325; if the extract is 30%, the median is 53,360, and the median for the 40% extract was 53,460. The entire observation data in Figure-4 does not have outliers and extreme values but does have whiskers. Whiskers that are not symmetrical are found, whereas, in 20% pandan leaf extract, lower whiskers will be found, indicating a water content value that is lower than the data set within the IQR. Skewness in this condition is negative -0.28.

Positive skewness was found when using 30% and 40% pandan leaf extract, 0.58 and 0.48, respectively. So, in these two conditions, you will find top whiskers, which indicate a water content value higher than the data set within the IQR.

The most extended interquartile range (IQR) was found with 40% extract (2,320), and the shortest IQR was found with 20% extract (1,720). So, the best data distribution was found when using 40% extract. The low quartile Q1, for the three variations of pandan leaf extract, has almost the same water content values, 52,368, 52,458, and 52,480, respectively. The maximum water content is 55.1, and the best water content, namely the minimum, is 54,190.

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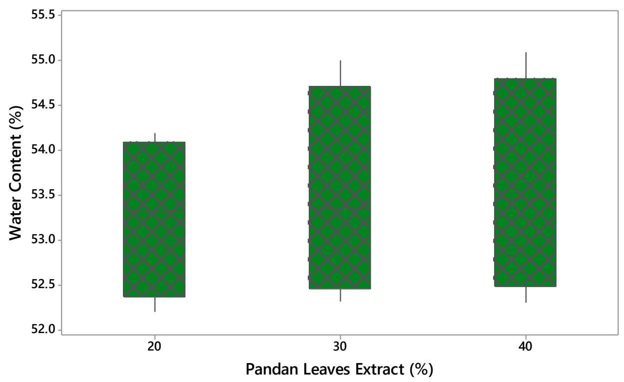

Figure-4. Boxplot analysis for the effect of the amount of pandan leaf extract on the water content of soap.

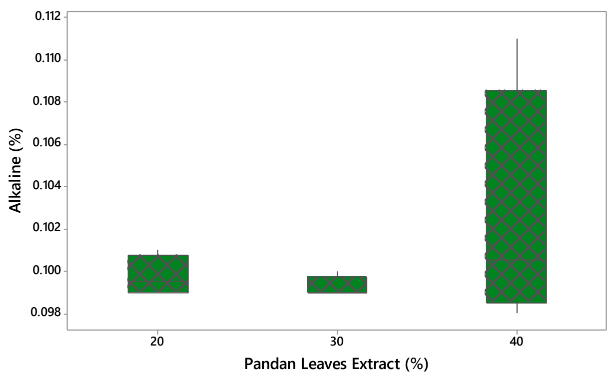

Figure-5. Boxplot analysis for the effect of pandan leaf extract on soap-free alkali content.

Boxplot analysis for alkaline content on changes in the amount of pandan leaf extract is given in Figure-5. The longest IQR was found when 40% extract was used (0.0100), and the smallest IQR was for 30% (0.00075). The box length depicted in Figure-5 corresponds to the difference between the highest quartile (Q3) and the lowest quartile (Q1), which means that the 40% extract has the best data distribution. The overall variation has an upper whisker even though it is not symmetrical, which shows higher alkaline content values in the data set within the IQR. The minimum and best alkaline level is also found if 40% extract is used, namely 0.09800.

Figure-6 shows a box plot analysis of the effect of the amount of cocamide-DEA on the water content of the soap obtained. It can be seen that the longest IQR is when cocamide-DEA 8% is used. The IQR value in this condition is 0.910, while the IQR for the other three boxes is almost the same, ranging from 0.110-0.150. So, referring to Figure 6, if cocamide-DEA of 2-6% is used, it will have the same distribution of water content data.

Figure-7 shows the results of boxplot observations of the amount of cocamide-DEA produced on the alkaline content of the soap. The most extended box size is at 2% cocamide-DEA content, which means the data distribution for alkaline levels at 2% cocamide-DEA is the largest.

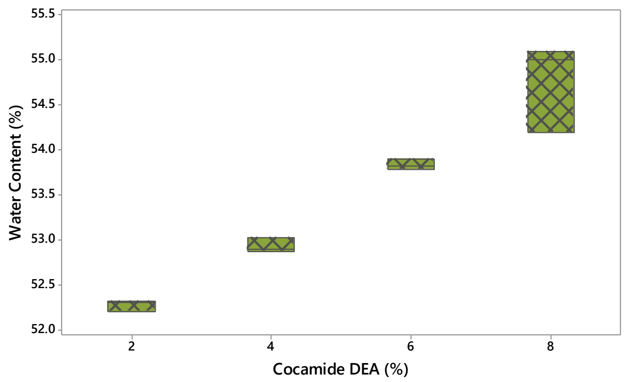

Figure-6. Box plot analysis of the effect of the amount of cocamide-DEA on soap water content.

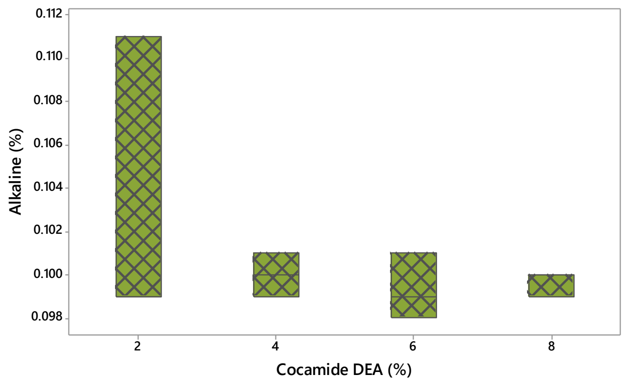

Figure-7. Box plot analysis of the effect of the amount of cocamide-DEA on soap-free alkali content

The median data if the amount of cocamide-DEA is 2% and 6% is the same, namely 0.099, while the median data if the amount of cocamide-DEA is 4% is the same as 6%, namely 0.100. However, the four values for the amount of cocamide-DEA used did not produce symmetric median soap alkaline content data. Meanwhile, the minimum value will be found when using cocamide-DEA 2% and 6%, namely 0.099 and 0.098. However, the minimum value chosen for alkaline content was the addition of 2% cocamide-DEA because the data distribution in this condition was the best, marked by the largest IQR.

The largest IQR, or most extended box, was found at 2% cocamide-DEA, with an IQR of 0.01200, while the other three uses of cocamide-DEA had much smaller IQRs, respectively for 4%, 6%, and 8%. 0.002, 0.003, and 0.001. The boxplot in Figure-7 does not have whiskers overall. The skewness for the amounts of cocamide-DEA 2% and 6% is positive, but it is harmful to the amounts of cocamide-DEA 4% and 8%.

Descriptive Analysis of Water Content

Descriptive analysis using histograms helps provide an overview of the size of central tendency and the symmetry of observational data. There are several types of tests, and the Anderson Darling (AD) Normality Test is used for this observation. AD normality test tests whether a set of continuous data is likely to have come from a normal distribution. The test rejects the hypothesis of normality when the p-value is less than or equal to 0.05.

Figures 8, 9, and 10 show the interpretation of data output to analyze the effect of the amount of pandan leaf extract on the water content of the soap produced. From Figure-8, when 20% of the saw leaf extract was used, it was obtained that the average water content was 53, 260 with a variance of 0.804. Judging from the shape of the distribution, soap that uses 20% pandan leaf extract has a skewness of -0.28257, so the shape of the distribution is skewed to the left.

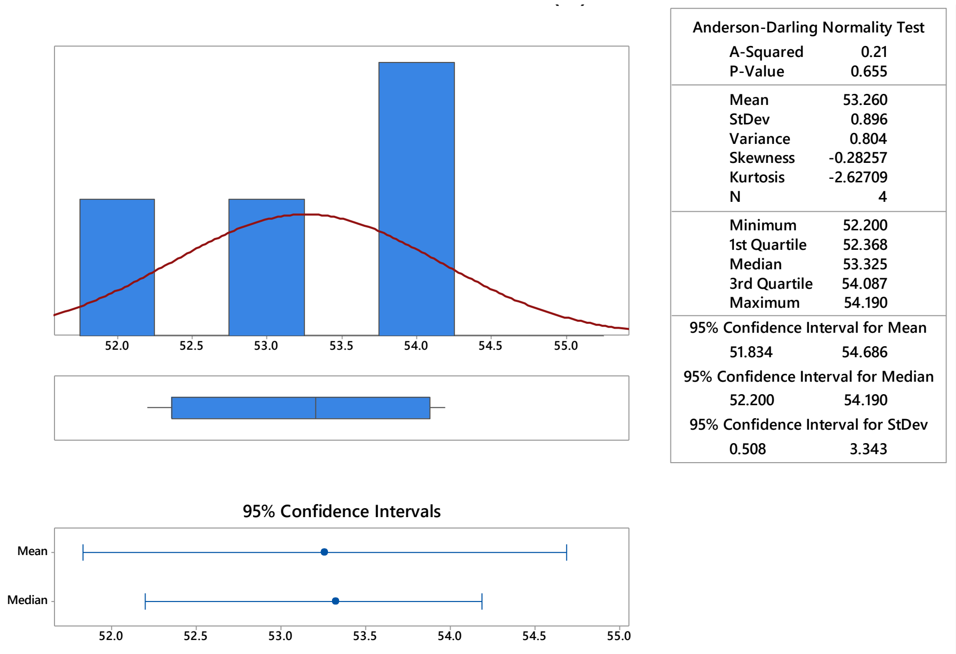

Figure-8. Interpretation of data output on the effect of 20% pandan leaf extract on soap water content.

When using 30% pandan leaf extract, the average water content in soap experienced a slight increase compared to 20% pandan leaf extract, namely 53,508. This observation is shown in Figure-9. The data variance also increased to 1.173, and the skewness changed to a positive value of 0.5838. So, the shape of the data distribution in this condition is skewed to the right.

If the use of viewing leaf extract is increased to 40%, the average water content is the same as the ratio of 30%, namely 53,560, but the variance increases slightly to 1,455. The distribution shape for soap using 40% pandan leaf extract in Figure-10 is that it has a tail that deviates to the right (skewness 0.4831).

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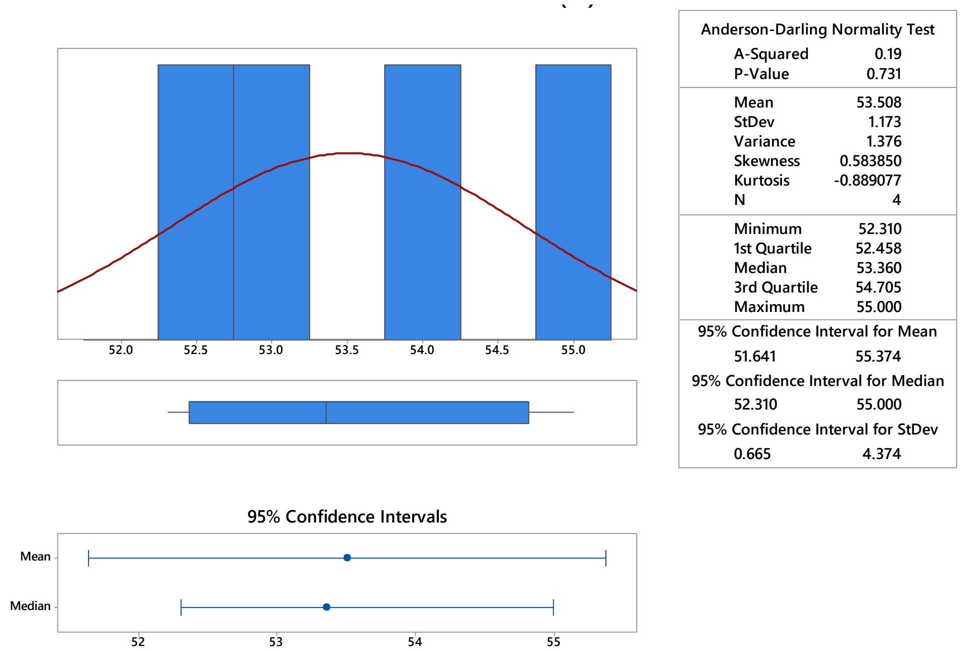

Figure-9. Interpretation of data output on the effect of 30% pandan leaf extract on soap water content.

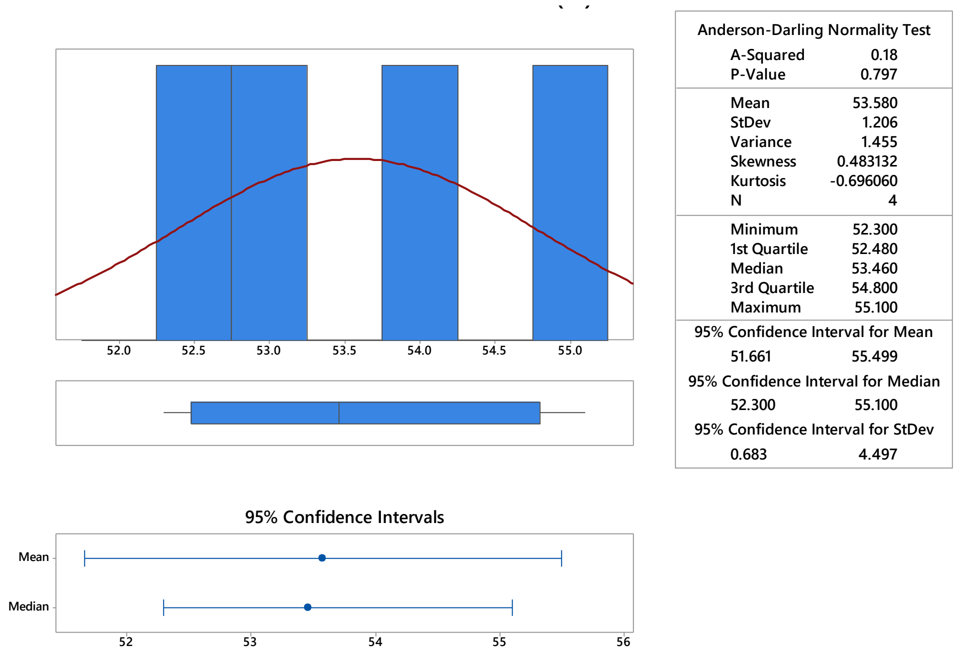

Figure-10. Interpretation of data output on the effect of 40% pandan leaf extract on soap water content.

CONCLUSIONS

Antioxidant liquid soap can be synthesized from pandan leaf extract (Pandanus amaryllifolius Roxb.) and cocamide-DEA. The higher the water content, the softer the soap will be. The added cocamide-DEA also affects the hardness level of the soap by increasing the water content. However, adding pandan leaf extract did not significantly affect the water content. The alkali that is not bound as a compound in the soap produced is no more than 0.14% so that the soap produced does not irritate the skin. The addition of pandan leaf extract slightly affects the free alkali content because pandan leaf extract contains alkaline alkaloid compounds. Large amounts of free fatty acids can affect the ability of soap to bind dirt, oil, grease, and sweat. The free fatty acid analysis results of the liquid soap formula are in the range of 1.20% -1.90%, so it is still good because it is below the standard for free fatty acids in liquid soap, namely < 2.5%.

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