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ANALYSIS OF pH, FOAM STABILITY, AND ANTIOXIDANT ACTIVITY IN SOAP FORMULATION FROM EXTRACT OF PEDADA LEAVES *(Sonneratia caseolaris)* AND PANDAN LEAVES *(Pandanus amaryllifolius)*

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ABSTRACT

Plant-based antioxidant soap formulations need to continue to be developed. Soap formulated from extracts of pedada leaves (Sonneratia caseolaris) and pandan leaves (Pandanus amaryllifolius) has been observed using 5-15 mL acetone or ethanol solvents for pedada leaf extraction, and extract concentrations of 0-40% and cocamide-DEA 2-8% for pandan leaves. The formulation results obtained from observing soap products from pedada leaf and pandan leaf extracts have pH, foam stability, antioxidant activity, and detergency power that comply with standards. Contour plot analysis for both formulations shows that the pH of the soap will decrease as the amount of solvent used decreases. Meanwhile, the addition of cocamide DEA increases the pH of liquid soap. Foam stability increases with increasing solvent amount but slightly decreases with the addition of cocamide-DEA.

Keywords: pedada leaves, pandan leaves, pH, foam stability, antioxidant activity.

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INTRODUCTION

Soap is a cleaning agent used with water to clean and remove dirt. Soap is an alkaline carboxylate salt (RCOONa), where the R group is hydrophobic because it is nonpolar, and COONa is hydrophilic and polar. Soap has a chemical structure with a carbon chain length from C12 to C16, is amphiphilic, has hydrophobic properties in the tail, which can attract dirt and fat, and hydrophilic properties in the head, which absorbs dirt dissolved in water [1, 2]. Soap can be made from oil (triglycerides), free fatty acids, and fatty acid methyl esters by reacting an alkaline base against each substance [3].

The fats or oils commonly used in making soap come from animal fats, vegetable oils, wax, or marine fish oil. Fats mainly contain palmitic and stearic acids, which give soap a rough texture, while oils containing oleic, linoleic, or linolenic acids provide a soft texture and are more soluble. Oils with 12 to 18-carbon chain fatty acids, including olive, coconut, palm, and soybean, can be used as soap formulas [4].

Soap is produced by saponification, namely the hydrolysis of fat into fatty acids and glycerol under alkaline conditions. Alkaline conditioners commonly used are sodium hydroxide (NaOH) and potassium hydroxide (KOH). If the base used is NaOH, the product is solid soap, whereas if the base used is KOH, then the product is liquid soap [5]. The saponification reaction is classified as auto-catalytic because the soap produced can dissolve alkali and is also able to disperse neutral fatty oils into colloidal suspensions [6].

Pedada *(Sonneratia caseolaris)* is a mangrove variety with high nutritional content and potential as an antioxidant. In general, pedada fruit is still underused by the public because it tastes sour and feels astringent when consumed directly. The pedada leaves are not poisonous and can be eaten directly, and the pedada fruit has a sour taste and distinctive aroma. Pedada is often found in brackish water areas where mangrove plants grow [7,8].

Pandan leaves *(Pandanus amaryllifolius)* contain alkaloids, flavonoids, saponins, tannins, and polyphenols, all-natural antioxidants. Polyphenols are phenol derivatives with antioxidant activity-phenolic compounds that absorb and neutralize free radicals or reduce peroxide. Phenolic antioxidants prevent damage due to oxidation reactions. 96% ethanol can extract polyphenolic compounds from pandan [9].

Antioxidants are needed to prevent free radicals. Antioxidants can protect cells from damage caused by unstable molecules called free radicals. Examples of antioxidants include β-carotene, lycopene, vitamin C, vitamin E, and flavonoid compounds [10]. Flavonoid compounds are secondary metabolites from the polyphenol group, which can act as antioxidants by neutralizing free radical compounds. Many studies show the ability of flavonoids to inhibit free radicals [11]. Many plants are effective as antioxidants, namely plants that contain carotenoids and polyphenols, especially flavonoids, which are used as natural antioxidants that can be produced in dosage form and consumed orally as topical vitamins and skin care products. The content of compounds derived from phenols, flavonoids, carotenoids, tocopherols, and vitamin C is usually found in many leaves, fruit, flowers, and tubers (rhizomes), such as flavonoids in noni fruit, isoflavones in soybeans, flavonoids in sandalwood flowers, anthocyanins in leaves, and flavonoids in agarwood leaves [12].

Flavonoid compounds are polyphenolic compounds with 15 carbon atoms arranged in a C6-C3-C6 configuration, meaning that the carbon skeleton consists of two C6 groups (substituted benzene rings) connected by a fatty three-carbon chain [13]. Flavonoids are found in all green plants so they can be found in every plant extract [14]. The activity of flavonoids as antioxidants is based on their ability to directly search for and collect reactive oxygen species and then chelate free radicals by directly donating hydrogen atoms or by single electron transfer. Flavonoids can also act as enzyme inhibitors for forming free radical compounds such as xanthine oxidase, lipoxygenase, and cyclooxygenase [11].

Various plants containing flavonoids have been used in antioxidant soap formulations. Antioxidant soap formulations from papaya leaf extract have been observed, including using 0-40% papaya leaf extract and olive oil. It can be concluded that papaya leaf extract can be used as an antioxidant soap ingredient with a formulation of 20-40% of the raw material preparation [5, 12]. Using tomato extract and turmeric extract combined with coconut oil, it was found that combining the two would produce soap with fewer bacteria [15, 16]. For this reason, it was concluded that the influence of pH, foam activity, and antioxidant activity needed to be observed in soap formulations from pedada leaves and pandan leaves.

MATERIALS AND METHODS

Materials

The main ingredients used in this research were coconut oil from Barco, cocamide DEA, pedada leaves *(Sonneratia caseolaris)*, and pandan leaves *(Pandanus amaryllifolius).* Stearic acid, sodium hydroxide (NaOH), potassium hydroxide (KOH), glycerin, fragrance, ethanol, methanol, acetone, Na-CMC and distilled water are used.

Soap with the Addition of Pedada Leaf Extract

Extraction of pedada leaves is carried out using a maceration process. The fixed variables used were an evaporation temperature of 40oC, a cooling time of 3 days, and a ratio of pedada leaves to solvent (Gr/mL) of 1:6. Making soap with the addition of pedada leaf extract is carried out using 40 mL of coconut oil, 31% NaOH concentration, 125% volume of NaOH solution from the raw material, 50% glycerin volume from the raw material, 37.5% cocamide-DEA volume from the raw material, the volume of fragrance is 1.25% of the raw material, and the mass of stearic acid (Gr) is 37.5% of the raw material at a reaction temperature of 70 ℃. Two solvents were used as changing variables: acetone and 96% ethanol. Two evaporation methods were used: soxhletation extractor and conventional evaporation, with solvent extract variations of 0, 5, 10, and 15 mL. The analyses that will be carried out are Foam Stability Analysis, Acidity Degree (pH) Analysis, and Antioxidant Activity Analysis using the DPPH method.

Soap with the Addition of Pandan Leaf Extract

Extraction of pandan leaves is carried out using a maceration process. The fixed variables used are the evaporation temperature of 80°C and the holding time of 3 days. Soap making with the addition of pedada leaf extract is carried out using 30% coconut oil by volume, 40% KOH concentration, 16% KOH solution volume from the raw material, 13% glycerin volume from the raw material, 1% Na-CMC volume from the raw material, the mass of stearic acid (Gr) is 1% of the raw material, at a reaction temperature of 50°C. As changing variables, four concentrations of pandan leaf extract were used, namely 0%, 20%, 30% and 40%. Four variations of cocamide-DEA concentration were also used, namely: 2%, 4%, 6%, and 8%. The analyses that will be carried out are Foam Stability Analysis, Acidity Degree (pH) Analysis, and Antioxidant Analysis using the DPPH method.

Acidity Degree (pH) Analysis

pH or degree of acidity is used to express the level of acidity or baseness of a substance, solution, or object. Normal pH has a value of 7, while a pH value > 7 indicates that the substance has alkaline properties, while a pH value < 7 indicates acidity. pH 0 indicates a high degree of acidity, and pH 14 indicates the highest degree of alkalinity. Analysis of the degree of acidity was carried out according to the procedure previously carried out by Fatimah and Jamilah (2018), where 5 Gr of the sample was prepared for pH analysis. The sample was dissolved in 10 mL Aquadest. pH is measured by inserting a pH meter washed with Aquadest. The number printed on the pH meter is recorded as the pH of the soap [16].

Foam Stability Analysis

Foam stability analysis can be carried out according to experiments by Agustina et al. (2017), where 1 mL of sample was put into a test tube, then 9 mL of water was added. Stir until dissolved, then shake for 20 seconds. A high foam is formed. Leave it for 5 minutes, then measure the height of the foam again. Then, the foam stability is calculated based on the following equation [15].

$$\text{Foam stability}(\%) = \frac{\text{Final foam height}}{\text{Initial foam height}} 100\%$$

Antioxidant Analysis using the DPPH Method

The procedure for examining antioxidant activity using the DPPH method refers to research conducted by Sasmita *et al*. (2023) and Agustina *et al*. (2018) regarding the antioxidant activity test of liquid soap using the modified DPPH method consisting of several stages as follows [15, 16].

a) Preparation of DPPH reagent. 4.0 mG of the substance was weighed and dissolved in 25 mL of methanol in a volumetric flask to make DPPH with a 160 mG/L concentration. The resulting solution was stored in a dark room and protected with aluminum foil.

b) DPPH Wavelength Optimization (maximum λ). Pipette 1 mL of DPPH solution into a test tube. Then,

VOL. 19, NO. 16, AUGUST 2024 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

4 mL of ethanol was added. The absorption interval reading was homogenized using a UV-Vis spectrophotometer at 517 nm.

c) Preparation of pandan leaf extract liquid soap stock solution. Weigh 100 mG of the fluid body soap preparation, dissolve it with ethanol p.a. to the limit mark of a 100 mL measuring flask, and obtain a concentration of 10,000 ppm. A liquid body soap solution with a concentration of 10,000 ppm was made into a dilution series of 200 ppm, 320 ppm, 440 ppm, 560 ppm, and 800 ppm.

d) Preparation of control liquid soap stock solution. 50 mG of liquid body soap containing pandan leaf extract was weighed. The solvent ethanol p.a. was added until the root flask mark was 100 mL, so the concentration obtained was 10,000 ppm. A liquid body soap solution with a concentration of 10,000 ppm is made in a dilution series of 200 ppm, 320 ppm, 440 ppm, 560 ppm, and 800 ppm.

e) Determination of percent inhibition, IC50 value. The solution that has been made is a liquid soap stock solution with an extract concentration of 20%, 30%, and 40% and a positive control that has been made in 5 dilution series; 1 mL each is taken and mixed with 1 mL of 0.3 mM DPPH solution with a ratio of 1:1 and added 3 mL of ethanol p.a in a 5 mL measuring flask that had been lined with aluminum foil and shaken until homogeneous. The DPPH mixture and sample were incubated for 30 minutes. The inhibition percentage is the percentage that shows the radical's activity. The rate of inhibition of DPPH radicals from each sample solution concentration can be calculated using the formula:

$$\text{Inhibition}(\%) = \frac{\text{Control absorbance} - \text{Sample absorbance}}{\text{Control absorbance}} 100\%$$

The IC50 value is calculated using the linear regression equation from DPPH, Y = a + bx, with the x-axis being the concentration of the test solution and the y-axis being %IC. The IC50 (Inhibition Concentration 50%) value is expressed as the concentration of an antioxidant material that can cause 50% of DPPH free radicals to lose their radical character.

Table-1. Results of pH analysis, foam stability, and antioxidant activity of soap using pedada leaf extract.

Formula	Description*)	Solvent (mL)	pH	Foam Stability (%)	Antioxidant Activity (IC50)
1	MEW	0	9.7	99.42	0.00
2	MEW	5	10.3	99.54	58.29
3	MEW	10	9.8	99.23	68.99
4	MEW	15	10.2	99.61	71.55
5	MAW	0	9.7	99.42	0.00
6	MAW	5	10.5	99.74	171.49
7	MAW	10	10.3	99.23	160.80
8	MAW	15	10.6	99.21	161.89
9	MES	0	9.7	99.42	0.00
10	MES	5	10.5	99.60	78.02
11	MES	10	10.1	99.73	127.24
12	MES	15	10.3	99.61	98.54
13	MAS	0	9.7	99.42	0.00
14	MAS	5	10.0	99.43	67.65
15	MAS	10	10.3	99.50	88.87
16	MAS	15	10.5	99.73	97.64

*)MEW = Maceration, ethanol, and water bath; MAW = Maceration, acetone, and water bath; MES = Maceration, ethanol, and soxhletation; MAS = Maceration, acetone, and soxhletation.

VOL. 19, NO. 16, AUGUST 2024 ISSN 1819-6608
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Table-2. Results of pH analysis and foam stability of soap using pandan leaf extract.

Formula	Pedada Extract (%)	Cocamide DEA (%)	pH	Foam Stability (%)
1	0	2	8.56	70.9
2	0	4	8.56	71.4
3	0	6	8.60	72.7
4	0	8	8.60	78.0
5	20	2	8.60	81.5
6	20	4	9.10	80.0
7	20	6	9.00	77.8
8	20	8	9.10	76.5
9	30	2	8.56	80.7
10	30	4	9.20	80.6
11	30	6	9.00	79.2
12	30	8	9.50	80.6
13	40	2	9.00	81.0
14	40	4	9.80	83.0
15	40	6	9.30	86.0
16	40	8	10.0	85.0

RESULTS AND DISCUSSIONS

The results of observations of the influence of the observed variables on pH, foam stability, and antioxidant activity are given in Table-1 for soap using pedada leaf extract and Table 2 for soap using pandan leaf extract.

Effect of Variables on pH

Soap generally has a pH of around 9 - 10. A relatively safe soap pH is 9 - 11. pH is an indicator of potential irritation in soap. The relatively alkaline pH of soap can help the skin to open its pores, and then the foam from the soap binds the soap and other dirt stuck to the skin. A pH that is too high can cause skin damage if contact lasts a long time, for example, with a washer or if rinsing is not complete. If the skin is exposed to liquid soap, the skin's pH will rise a few minutes after use, even though the skin has been rinsed with water. Acidification occurs again after five to ten minutes; after thirty minutes, the skin pH returns to normal [17].

The contour plot in Figure 1 shows that the total will produce a pH within the allowable range from variations in the amount of solvent used. The smaller the amount of solvent used, the smaller the pH of the soap produced. Formulas 4 to 14 provide a minimum pH range when using a solvent of less than 5 mL, while if the solvent used reaches 15 mL, the pH of the soap is 10-11.

The degree of acidity is an important parameter because it shows whether the soap product is acidic or basic. Soap with high or low acidity can cause skin irritation, such as wounds, itching, or peeling, due to increased absorption capacity [19]. The effect of stirring time influences the pH of the solid soap produced. Increasing the stirring time can cause a decrease in the pH of the soap produced. This is caused by the longer the stirring time, the greater the interaction time between oil and alkali; the reaction will approach equilibrium so that the alkali residue will be lower, which will cause the solid soap product to be less alkaline. The pH quality requirements for bath soap set by SNI have a pH value range of 9-11 [20].

Based on previous studies, making solid soap with the addition of dragon fruit peel extract showed a decreased pH value as the extract concentration increased. Also, in making pedada fruit jam, it was explained that pedada fruit has a low pH value, namely around 3.0-3.2, and shows that pedada fruit has a high acid content. This follows studies that have been carried out, which show that all extracts obtained have a pH of 3. Peda fruit can reduce the pH value of soap as the concentration of the extract given increases [21].

As with making soap using pedada leaf extract, soap that adds pandan leaf extract will also have a low pH if the minimum cocamide is used, namely less than 4%. Even though the entire range of cocamide is used, the pH of the soap produced is still within the permitted limit, namely 8.6-10. This can be a consideration in concluding where the minimum pH results from using cocamide, which is also minimal.

One way to express the acidity level of a solution is through the degree of acidity or pH. The pH parameter has a significant role in beauty products because it can affect the ability of the skin to absorb them. Soap with excessive acidity levels can cause excessive absorption

VOL. 19, NO. 16, AUGUST 2024 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

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into the skin, irritating the skin and causing wounds, itching, and peeling.

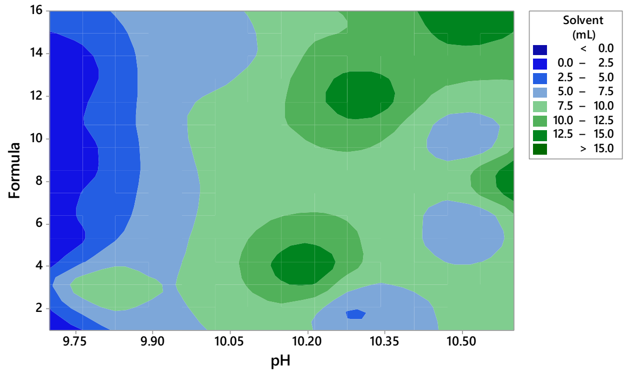

Figure-1. The effect of the amount of solvent on the pH of the detergent formulation from pedada leaves.

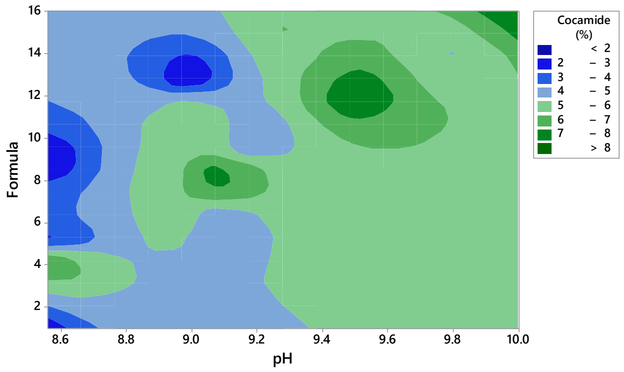

Figure-2. The effect of the amount of cocamide on pH in detergent formulations from pandan leaves.

This can also result in dry skin [10]. The main ingredient in making liquid soap is KOH, which produces a saponification reaction with fats, oils, or synthetic detergents with a pH higher than neutral.

Based on Figure-2, the analysis results for liquid bath soap obtained have a pH of around 8.56- 10. This result shows that the pH value of liquid soap is quite good and meets the soap quality requirements based on SNI. The pH range on the skin surface ranges from 5.5 to 6.0. This value decreases or increases depending on the level of shed horn cells and other contaminants attached to the skin surface. The pH suitable for skin is pH 8-11 for soap [20].

Based on the results obtained, the addition of cocamide DEA increases the pH of liquid soap; this is because cocamide DEA is alkaline, so it increases the pH of liquid soap preparations [21]. In formulas 10 and 11, with the addition of cocamide DEA 6 mL each, the pH decreased. Unstable pH changes can occur due to heating factors due to the sodium ester hydrolysis process, which produces fatty acids that can increase the level of free alkali and change the pH of the soap [22]. This pH value is influenced by the ingredients that make up soap, namely KOH, which is a strong base, resulting in a saponification reaction with fats and oils or synthetic detergents with a pH value above neutral pH [20].

Apart from that, adding pandan leaf extract also affects the pH value of the soap. This is due to the presence of alkaloid compounds in pandan leaf extract. Alkaloids are basic or alkaline organic compounds that increase the pH value of liquid soap, so the more pandan leaf extract added, the higher the pH the soap obtained will increase [23].

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Effect of Variables on Foam Stability

Foam is a dispersed system consisting of gas bubbles covered by a layer of liquid. Foam is one of the most critical parameters in determining the quality of soap. Consumers generally prefer soap with abundant foam. Foam stability refers to the ability of a foam to maintain its main parameters in a constant state over a particular time [24].

One of the exciting things about soap is its high foam content. Foam stability refers to the ability of the bubbles to maintain their size or prevent the inner film from disintegrating. Foam height testing is a method used to monitor liquid soap to maintain its foam consistency. As the level of foam stability increases, the quality of the foam produced also increases. Particle size plays a vital role in directly determining foam stability. As the particles become more numerous and more significant, the strength of the foam can decrease. If the foam produced is large enough and consistent, consumers will prefer it over small and inconsistent foam [25].

This stability test aims to identify the level of stability that can be measured based on the height of the foam formed in the test tube over a specified time scale and to see the extent to which the surfactant can create foam. The decrease in the fluid flow from the foam after a certain period after the foam breaks down and disappears is expressed in volume-percentage form. The durability of foam can be measured as its stability after five minutes, where the foam is expected to remain between 60-70% of its initial volume [26, 27].

The counter-plot in Figure-3 shows the results of observations of foam stability at various variations in the amount of solvent added to the extraction of pedada leaves. The presence of solvent will slightly increase the strength of the foam, and the overall formula will have good foam stability, which is more than 99%. Extraction using a minimum solvent will produce foam stability in the range of 99.3 to 99.5% while adding solvent can increase foam stability up to 99.7%. The stability of soap foam without the addition of extracts is 99.42%. Then, after adding the antioxidant extract with various solvents, namely acetone and ethanol, using a shovel and water bath.

VOL. 19, NO. 16, AUGUST 2024 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

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Foam is a colloidal system with a dispersed phase in the form of a gas and a dispersing medium in the form of a liquid. The foaming agent keeps the dispersed gas contained in the formed covering layer. Stable foam can help clean the body and shows soap has good cleaning power. Consumers also like soap that can produce stable foam that lasts a long time. In manufactured soap, the foam formed tends to be stable [28].

The decrease in foam stability can be influenced by increasing water content, so the active ingredients in soap that produce foam decrease because they dissolve in water and come out in the soap-making process [29]. Free fatty acids also influence the stability of soap foam. The more extract added causes an increase in free fatty acids in soap, which has free fatty acids ranging from 0-0.43%. The high level of free fatty acids in soap will inhibit the cleaning power of the soap, which is indicated by the small amount of foam produced [30].

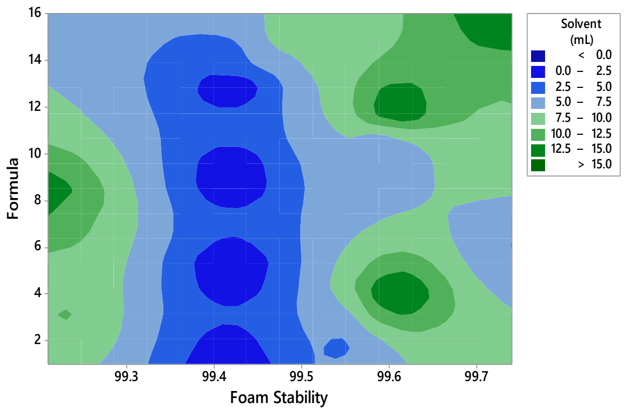

Figure-3. The effect of foam stability on detergent formulations from pedada leaves.

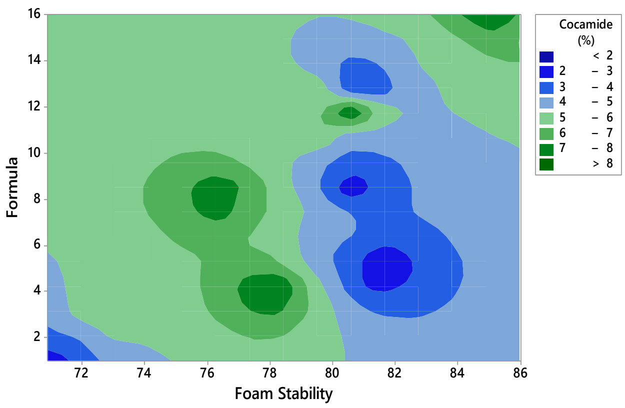

Figure-4. The effect of foam stability on detergent formulations from pandan leaves.

Based on Figure-4, the foam stability results for each liquid soap formula using pandan leaf extract were obtained, ranging from 70.9% -to 85.0%. This aligns with the expected good foam stability for liquid soap, which is 60-70%. The foam in soap prevents dirt particles from dissolved in water from settling again, so the dirt can be removed with the soapy water [31]. A long-lasting foam will form if water is mixed with active soap ingredients. The gas bubbles that are formed are difficult to break because they have a thin layer that is made very strongly [20].

Figure-4 shows the foam stability when adding cocamide to soap with added pandan leaf extract. The foam stability range is 72 to 86%. The addition of cocamide appeared to reduce foam stability, and the best foam stability was found with the addition of 4-5% cocamide.

Based on Figure 4, it can be seen that the results of adding cocamide DEA to formulas 1, 2, 3, and 4 provide foam stability results of 70.9%, 71.4%, 72.7%, and 78.0% in formulas 5,6 and 7 with the addition of 2 mL cocamid DEA and the addition of pandan leaf extract levels of 20 grams, 30 grams, and 40 grams, providing foam stability results of 81.5%; 80.7% and 81.0%, in formulas 8.9 and 10 with the addition of cocamide DEA 4 mL and the addition of pandan leaf extract of 20 grams, 30 grams, and 40 grams, the result was a foam stability level of 80.0%; 80.6% and 83.0%, in formulas 11, 12 and 13 with the addition of 6 mL of cocamide DEA and the addition of pandan leaf extract of 20 grams, 30 grams and 40 grams, providing foam stability results of 77.8%; 79.2%; and 86.0%, in formulas 14, 15 and 16 with the addition of 8 mL of cocamide DEA and the addition of pandan leaf extract of 20 grams, 30 grams and 40 grams, providing foam stability results of 76.5%; 80.6% and 85.0%.

Based on the results obtained, the stability of the foam is influenced by the concentration of cocamide DEA. Adding cocamide DEA concentrations of 2 mL, 4 mL, 6 mL, and 8 mL increases foam stability in liquid soap. Cocamide DEA can increase the stability of liquid soap foam in soap so that the foam produced is more abundant and stable. Cocamide DEA is a foam stabilizer that can maintain foam stability ([21, 32]. Foam stability is also influenced by the soap-making ingredients. The soap-making ingredient which also plays a role in stabilizing the foam is stearic acid. Stearic acid has the potential to act as a soap-hardening agent and also a foam stabilizer [23]. Apart from that, the stability and character of the foam produced can be influenced by the type of oil used when making soap. Coconut oil contains lauric acid, which can produce abundant and soft foam; it also plays a role in maintaining stable foam. Meanwhile, palm oil contains palmitic acid, which can increase the hardness of the soap, resulting in hefty (not acceptable) foam [26].

It is thought that adding pandan leaf extract does not affect the stability of the foam produced because pandan leaf extract does not contain saponin compounds. Saponin causes foam when stirred in water because it resembles soap [23]. Saponins are triterpenoid and sterol compounds that exist in the form of glycosides. Saponin is an active surface compound with properties similar to soap. It can be detected based on its ability to form foam. The foam produced by saponin compounds is caused by glycosides, which can form foam in water and hydrolyze into glucose [9].

Effect of Variables on Antioxidant Activity (DPPH)

Antioxidants are compounds that can inhibit and prevent the oxidation process. They work by stopping free radical reactions from metabolism in the body or the environment. In this study, antioxidant activity analysis was carried out quantitatively on extracts with solvents and was related to the presence of a flavonoid compound as a metabolite. Secondary so that the suitable solvent attracts active compounds in the raw material [33].

Measuring antioxidants using the DPPH method is one method for determining how much antioxidant activity is in the test solution. DPPH, a purple free radical, will react with samples containing antioxidants so that the purple color of DPPH will change to yellow. This color change to yellow is caused by the hydrogen donor carried out by the antioxidant to the DPPH compound and causes a reaction that reduces the double bond from DPPH to stable DPPH. This color change occurs when the DPPH radical's odd electron reacts with the antioxidant compound's hydrogen and forms reduced DPPH [34].

According to Yoong and Rozaina (2021), the 50% Inhibition Concentration (IC50) value is half the maximum inhibitory concentration value, inversely proportional to antioxidant activity. The amount of antioxidants needed to reduce 50% of the antioxidant activity is obtained from interpolation with linear regression [29].

The effect of antioxidant activity on detergents from pedada leaves is given in Figure 5. Increasing the amount of solvent increases antioxidant activity. It was also illustrated that the solvent had a good effect in increasing antioxidant activity. If less than 5 mL of solvent is used, the antioxidant activity is low for all soap formulations observed. The best AA is found if more than 12.5 mL of solvent is used.

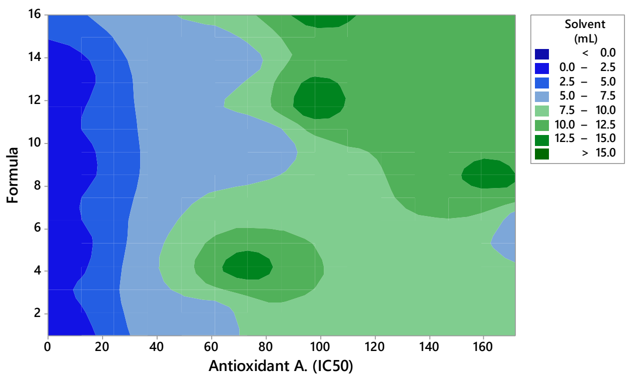

Figure-5. Effect of antioxidant activity on detergents from pedada leaves.

The IC50 of the extracts obtained, namely MAW, MEW, MES, and MAS, is 97.0716, 82.7433, 110.9067, and 108.5543 ppm. Then, after adding 5, 10, and 15 mL of antioxidant extract, the resulting product had an IC50 value for the MAW variation of 171.489, 160.809, and 161.89 ppm. In the MEW variation, the IC50 values are 58.2486, 68.999, and 71.5561 ppm. The MES variation produces an IC50 of 78.0205, 127.2372, and 98.53724 ppm. The MAS variation produces data 67.6524, 88.8745, and 97.6442 ppm, respectively.

Based on the data that has been processed, it was found that the most robust IC50 value for the pure extract was the ethanol maceration treatment with a shock evaporation device, namely 82.7433 ppm. From the study cited by Santoso *et al*. (2010), it is shown that a compound is a powerful antioxidant if the IC50 value is < 50 µg/ml, strong if the IC50 value is between 50-100 µG/mL, and moderate if the IC50 value is between 100-150 µG/mL, and weak if the IC50 value is 150-200 µG/mL. Based on this classification, it can be concluded that some of the pada leaf extracts in the products produced are included as strong antioxidant extracts. However, some still have moderate or weak antioxidant values. Based on this classification, the methanol extract of pedada fruit produced is included in the potent antioxidant extract compared to what previous researchers have done.

Yim *et al*. (2013) explained a study on the effect of time and temperature on antioxidant activity. It was found that antioxidant activity was directly proportional to extraction time, where antioxidant activity increased as extraction time increased. However, the temperature used during extraction provides an inverse relationship; the higher the temperature, the weaker the antioxidant activity produced. In this study, different deep evaporation tools produced extracts that showed significant differences. In using a water bath, an extract with higher antioxidant activity is created compared to the evaporation method using a shock device [30].

Another cause of the weak antioxidants obtained in soap with other variations is storing the samples at room temperature, which affects the decrease in antioxidant activity. Pedada fruit contains flavonoids such as luteolin 7-O-β-glucoside, which is included in various parts of the pedada plant, including the skin and ripe pedada fruit. Then, flavonoid instability influences the sample during the manufacturing and storage processes. This causes a less good IC50 value for the soap obtained. During the manufacturing process, NaOH solution is used as one of the ingredients to carry out the saponification process [35]. When NaOH is dissolved, it produces a large amount of dissolution heat energy. In addition, reaction heat is produced during the saponification process. These two things may damage the antioxidants provided during the production process. This heat damage increases the speed of the initiation reaction, thereby reducing the activity of the added antioxidant [36].

Antioxidant activity is the ability of a material to ward off free radicals. In this study, the DPPH (2, 2-diphenyl-1-picryhydrazyl) method was used [26]. The DPPH method was chosen because it has several advantages, including being simple, accessible, fast, sensitive, and requiring small samples. The parameter used to determine antioxidant activity is IC50, defined as the concentration of antioxidant compounds that causes a loss of DPPH activity of 50%. Compounds classified as natural antioxidants are from phenolic compounds, such as simple phenolic compounds, flavonoids, and tannins. Flavonoid compounds, simple phenolics, and tannins are antioxidant

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compounds that contain phenol structures and have several hydroxy functional groups in many plants. Non-phenolic compounds with antioxidant activity include alkaloids, essential oils, and saponins [33].

In principle, measuring antioxidants using the DPPH method is measuring the color fading of DPPH radicals due to the presence of antioxidants, which can neutralize free radical molecules. So, the DPPH radical, which was previously colored, will lose its color if there is an antioxidant because the antioxidant will donate its electrons to the DPPH radical so that the previously unstable radical (due to the presence of an unpaired electron) becomes stable (the electron in the free radical becomes paired due to the electron donation from antioxidants). The characteristic of an antioxidant is that it is easy to donate electrons; the easier it is to donate electrons, the stronger the antioxidant properties [35].

Liquid soap with green pandan leaf extract is expected to have antioxidant abilities, so antioxidant ability is one of the main things in this research. Absorbance measurement results of pandan leaf extract liquid soap test samples are shown in Table-3.

Table-3. Absorbance measurement results of pandan leaf extract liquid soap test samples.

Formula	Concentration (ppm)	Control Absorbance	Sample Absorbance	Inhibition (%)	Antioxidant Activity (IC50, µG/mL)
20% of pandan leaf extract	200	0.59	0.242	59.0524	116.305
	320		0.223	62.2673	
	440		0.177	70.0507	
	560		0.144	75.6345	
	800		0.133	77.4957	
30% of pandan leaf extract	200	0.59	0.223	62.2673	99.113
	320		0.245	58.5448	
	440		0.198	66.4974	
	560		0.146	75.2961	
	800		0.111	81.2182	
40% of pandan leaf extract	200	0.59	0.160	72.9272	20.356
	320		0.128	78.3417	
	440		0.112	81.0490	
	560		0.105	82.2335	
	800		0.073	87.6480	

The antioxidant activity of pandan leaf extract liquid soap is determined by the amount of inhibition of DPPH radical absorption by calculating the percentage of DPPH absorption inhibition. In deciding the % inhibition of the test sample, liquid soap with 20%, 30%, and 40% pandan leaf extract was made into a sample solution with a concentration of 10,000 ppm, then diluted serially to several concentrations, namely 200 ppm, 320 ppm, 440 ppm, 560 ppm, 800 ppm, then the absorbance of the sample was measured with a spectrophotometer-UV-Vis with a wavelength of 517 nm.

Based on figures 6, 7, and 8, a linear regression equation was obtained at a concentration of 20% pandan leaf extract, namely $y=14.8x-20.392$ with R2=0.9416 where x is the flavonoid content and y is the absorbance (A). This equation is used to calculate the IC50 value. Based on the linear regression equation obtained from the relationship curve between concentration and % inhibition, the IC50 value was 116.305 µG/mL. This shows that there is antioxidant activity in liquid soap with 20% pandan leaf extract. At a pandan leaf extract concentration of 30%, the linear regression equation was obtained, namely $y=15.474x-24.596$ with $R^2=0.77012$, so that the IC50 value from the linear regression equation was 99.113 µG/mL. This also shows that liquid soap with 30% pandan leaf extract has antioxidant activity. At a pandan leaf extract concentration of 40%, a linear regression equation was obtained, namely $y=10.081x+19.622$ with $R^2 = 0.9816$, so the IC50 value from the linear regression equation was 20.356 µG/mL.

Based on the IC50 value that has been obtained, antioxidant activity with an IC50 value < 10 µG/mL is in the very strong category, an IC50 value of between 10-50 µG/mL is in a strong category, an IC50 value of between 50-100 µG/mL is in the medium category, the IC50 value between 100-250 µG/mL is in the weak category and IC50 values above 250 µG/mL do not have antioxidant activity [30].

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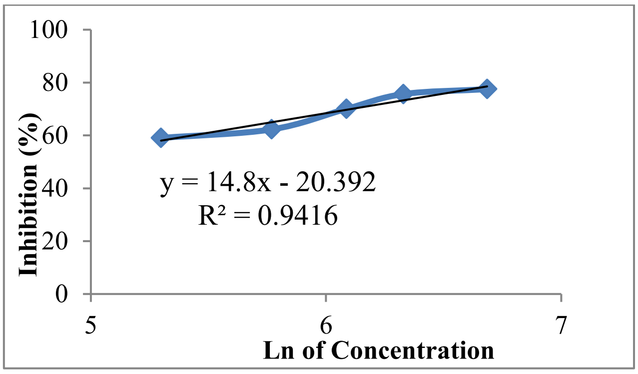

Figure-6. Relationship between concentration and % Inhibition of 20% Pandan Leaf Extract.

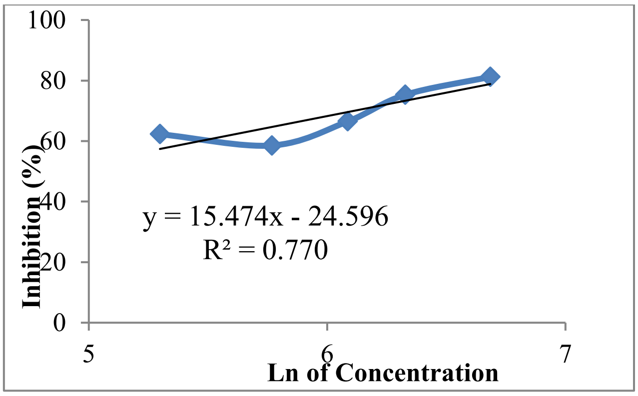

Figure-7. Relationship between concentration and % Inhibition of 30% Pandan Leaf Extract.

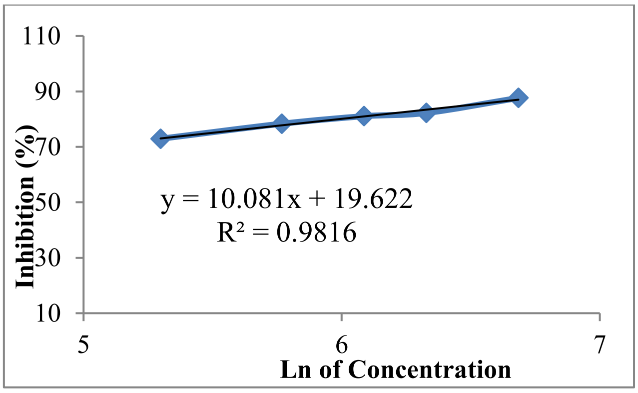

Figure-8. Relationship between concentration and % Inhibition of 40% Pandan Leaf Extract.

CONCLUSIONS

Pedada leaf extract can reduce the pH value of the soap, as per the standards permitted by SNI 3531:2016, which is in the range of 10 - 10.8. Analysis of the stability of soap foam showed that the foam became stable with the addition of pedada leaf extract. Pedada leaves *(Sonneratia caseolaris)* have the potential to be antioxidants because the extract obtained from them has antioxidant activity and can increase the IC50 strength of the soap produced. The addition of pandan leaf extract also affects the resulting pH due to the presence of alkaline alkaloid compounds. The effect of adding cocamide DEA on foam stability is that the more cocamide DEA added, the higher the stability of the foam produced. At the same time, adding pandan leaf extract does not affect the stability of the foam produced. The effect of pandan leaf extract on antioxidant activity is that the more concentration of extract added to liquid soap, the more the antioxidant activity of liquid soap will increase. Based on experiments, vigorous antioxidant activity was obtained by adding 40% pandan leaf extract with an IC50 value of 20.3563 µG/mL. The formulation of antioxidant liquid soap with pandan leaf extract and the addition of cocamide DEA meet the SNI requirements for liquid soap.

It can be concluded that the antioxidant activity of pandan leaf extract liquid soap with a concentration of 20% extract with an IC50 value = 116.305 µG/mL is in the weak category then, pandan leaf extract liquid soap with a concentration of 30% extract with an IC50 value = 99.1132 µG/mL including the moderate category and pandan leaf extract liquid soap with a concentration of 40% extract with an IC50 value = 20.3563 µG/mL including the strong category. Based on the results obtained, the more pandan leaf extract that is added, the smaller the IC50 value obtained, indicating that the more concentration of extract added, the stronger the antioxidant activity of liquid soap.

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