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Research Article

Formulation of Soapberry Extract (*Sapindus rarak* DC) and Aloe Extract (*Aloe vera* Linn) as Paper Hand Soap: Application of Factorial Design

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ABSTRACT

Soapberry contains saponin compounds and can be used as a surfactant in a soap. Aloe leaves contain lignin compounds as an emollient. Soapberry extract and aloe extract can be formulated into paper hand soap. This study aims to determine the optimum composition of soapberry extract and aloe extract in paper hand soap formulation. Quasi-experimental research was conducted using a 2-factor and 2-level factorial design. Physical property tests were done including organoleptic tests, pH, washing time, moisture content, foam height, reduction in Trans Epidermal Water Loss (TEWL) values and freeze-thaw physical stability tests. Data analysis used Design Expert version 13 (free-trial version) software with a two-way ANOVA test and 95% confidence level. The overlay plot obtained was used to determine the optimum composition area. The results found that the combination of soapberry extract and aloe extract had an effect on physical properties in the form of foam height and reduced TEWL and the optimum formula composition for soapberry extract was 63.5224 grams and aloe extract was 20.1866 grams.

INTRODUCTION

Hands are parts of the body that can become a medium which carries germs, causing various diseases. It is necessary to have a healthy lifestyle, such as washing hands regularly with soap. Using soap in handwashing can kill microorganisms. Hand soap in the community has various types, such as solid, liquid, and paper soap. Paper soaps are considered lighter, more hygienic in their storage, and practical when carried (Gusviputri *et al.*, 2013). The use of paper soap is also considered environmentally friendly when viewed from a packaging perspective (Verawaty *et al.*, 2020).

Soapberry (*Sapindus rarak* DC) contains active compounds such as saponins, alkaloids, polyphenols, flavonoids, tannins, and antioxidants. The saponin content in soapberry can produce foam when reacted with water (Wijayanti *et al.*, 2020). The saponin in soapberry has hydrophilic and lipophilic parts, so it can be used as a surfactant in soap formulation (Fatmawati, 2014). The saponin in soapberry influences the high response of the foam produced. Soapberry also has antibacterial activity against Staphylococcus aureus bacteria. The lipophilic part of the saponins of soapberries can damage microbial membranes. This can happen because the saponin in the soapberry has the ability to slice the membrane of the bacterial cells and inhibit the work of DNA polymerase so that the synthesis of nucleic acid becomes disrupted (Putri *et al.*, 2017). Aloe (*Aloe vera* Linn) contains saponins, anthraquinone, tannin, polysaccharides, flavonoids, and lignin or cellulose (Rahardjo *et al.*, 2017). The content of saponins in aloe can cause a saponification reaction and lignin is able to maintain skin moisture content (Mardiana and Solehah, 2020). The lignin in aloe can suppress the loss of moisture from the skin surface, so it can affect the decrease of Trans Epidermal Water Loss (TEWL).

Paper soap can be chosen for the formulation of hand soap because it has a thin sheet shape with a small size and can maintain the quality of the soap due to its use of one sheet for one use (Verawaty *et al*., 2020). In paper hand soap formulations, soapberry extract and aloe extract influence the physical properties of the soap, such as foam height and decreased TEWL. Such influences can be seen by the method of factorial design. A factorial design is a regression equation that gives a model of the relationship between a response variable and one or more process improvements (Hidayat *et al*., 2020). The use of factorial design has advantages such as being more efficient, studying the main influence of the interaction that occurs, and using experimental results after studying a combination of various factors (Salomon *et al*., 2015). In addition, factorial design can be used to predict a good composition in a formula (Sugiyono *et al*., 2016). Therefore, a study on the formulation of paper hand soap from soapberry extract and aloe extract with factorial design methods is needed. This study aims to determine the optimum composition of soapberry extract and aloe extract in paper hand soap formulation.

METHODS

Materials

The materials used in this study are soluble paper, soapberry, aloe liquid extract (JAKA Biotech CO), glycerine (Pharmaceutical grade - Brataco), Na-CMC (Pharmaceutical grade - Brataco), essential oil green tea (Java Soap), distilled water, and commercial paper soap (Mmtoys Indonesia – as positive control).

Instrumentations

Tewameter®(TM-300), pH meter (Ohaus ST10), analytical scale (Ohaus), a set of glass tools (Pyrex), hotplate (Thermo), stirring road, mortar, stamper, brush, ruler, stopwatch, petri dish, reaction tubes, oven and freezer.

Preparation of Soapberry Extract

Soapberry used in this study has been determined in the Pharmaceutical Plant Garden Laboratory of the Faculty of Pharmacy of Sanata Dharma Yogyakarta University with letter No. 06/LKTO/Far-USD/IX/2023. The soapberry extract is made using an infundation extraction method with a concentration of 34% w/v in the infusion. Soapberry was prepared in fresh condition, and the flesh was separated from the seeds and been cut into small size. Then 85 g soapberry was added into 250 mL of hot distilled water then being 90°C for 15 minutes until the solution changes color to brown-yellow. The extract was then cooled to room temperature and finally filtered using filter paper (Wijayanti *et al*., 2020; Fatmawati, 2014).

Preparation of Aloe Extract

The preparation of aloe extract is done by purchasing the liquid extract of cocoa tongue from JAKA Biotech CO and displaying it with a Certificate of Analysis (COA), indicating that the extracts used have good quality and can be used in this research.

Formulation of Paper Hand Soap

The paper soap formulation (Table 1) was developed by combining Na-CMC (Carboxy Methyl Cellulose Sodium) in 120 mL of hot distilled water to form a gel base. Soapberry extract, aloe extract, glycerin, essential oil, and distilled water were mixed in a beaker (Mixture A). The mixture A was added gradually into Na-CMC gel base. A total of 50 grams of liquid soap was then applied evenly using a brush on A4 soluble paper. After the entire part of the soluble paper was wet, it was removed and dried in the oven at 50°C. After the paper soap is formed, it can be put into a tightly closed container (Awaluddin *et al*., 2022; Verawaty *et al*., 2020).

Table 1. Formulation of Paper Soap Soapberry Extract and Aloe Extract

Composition	Formula (g)				
	Control (–)	1	A	B	AB
Soapberry Extract	-	50	70	50	70
Aloe Extract	-	15	15	20	20
Glycerin	5	5	5	5	5
Na-CMC Gel	10	10	10	10	10
Essential Oil	2	2	2	2	2
Distilled water	83	5	5	5	5

Paper Hand Soap Evaluation

The evaluations of paper hand soap involved organoleptic test, pH test, moisture content test, washing time test, foam height test, and decreasing of TEWL. The organoleptic testing involved color, smell, consistency, and physical homogeneity tests (Adlina *et al*., 2023). The pH test is done using a calibrated pH meter. One sheet of paper soap was dissolved in 10 mL of distilled water, then measurements were taken into solution (Awaluddin *et al*., 2022). The moisture content test was done with one sheet of paper soap placed in a petri cup, then put into the oven at 105°C for 2 hours. The weight of paper hand soap before and after treatment were compared to obtain moisture content (Fiskia and Maia, 2021). The washing time test was done by dissolved one sheet of paper soap into water and then applied to both hand palms until foaming. The time the soap takes to form foam is calculated using a stopwatch (Verawaty *et al*., 2020). Foam height testing was conducted by dissolving one sheet of paper soap in 10 mL of distilled water and then shaking by turning the tube. The height of the foam formed is measured using a ruler (Verawaty *et al*., 2020). The TEWL test was carried out after obtaining ethical approval from the Health Research Ethics Commission, Faculty of Health Sciences, Respati University, Yogyakarta with letter number 0217.3/FIKES/PL/IX/2023. The test is done by measuring the initial TEWL value of the backs of six adults' hands before treatment (pre-treatment) using a TEWA meter. The pre-treatment was carried out by washing the hands of six volunteers with water, then drying and leaving for 30 minutes, and then measuring with a TEWA meter. After the initial measurement, the palms of the six volunteers were washed with paper soap then dried and left for 30 minutes, then measured again with a TEWA meter (Husein and Lestari, 2019; Febriaty *et al*., 2020).

Stability Test

The physical stability test was carried out by storing paper soap in a freezer at -10°C for 24 hours, then the soap was stored in an oven at 45°C for 24 hours and then organoleptic changes were observed (1 cycle). The test was conducted for 3 cycles and each cycle observed organoleptic and pH changes. Recording of organoleptic and pH changes was carried out before and after the cycle treatment (Rusli dkk., 2019).

Result Analysis

The results were analyzed using a two-way ANOVA with a 95% confidence interval (CI) with the Design Expert software version 13 (free trial version) to determine the factors that have a significant effect on the observed response. After that, we proceeded with combining the plot contours with the superimposed plot contour to find out the optimum composition area on the paper soap. Validation of the paper soap was carried out by randomly selecting one of the optimum areas and then performing a T-test using JAMOVI 2.3.28 software.

RESULTS AND DISCUSSION

Soapberry Infusion Extract

Soapberry extract was prepared using the infusion method with an extract concentration of 34% w/v. The infusion method is chosen because it has a very simple method and can be used to extract substances that have a water-soluble active content from plant ingredients (Sariyem *et al*., 2015). The extraction process uses distilled water as a solvent. Distilled water was chosen as a solvent because it has polar compounds, easy-to-obtain, low-cost, non-evaporative, and non-toxic properties (Risfianty and Indrawati, 2020).

Formulation of Paper Soap with Soapberry Extract and Aloe Extract

The paper soap is made into four formulas, paper soap with a combination of a concentration of soapberry extract (*Sapindus rarak* DC) and aloe extract (*Aloe vera* Linn) as seen in Table 1. The formulation of paper soap with various concentration variations was conducted to see the effect of adding soapberry extract as a surfactant and aloe as an emollient. Formulation using the four formulas was carried out to find the optimal composition through the calculation of the factorial design. Apart from that, negative control preparations were also made without the addition of soapberry extract and aloe extract.

Evaluation of Paper Soap

Evaluation of paper soap includes organoleptic tests, pH, moisture content, washing time, foam height, TEWL, and stability tests. Evaluations of paper soap are shown in Table 2. Evaluations were conducted on the four formulas, as well as positive controls and negative controls. From the organoleptic test results, it can be seen that the paper soap preparation has a paper-like shape with a fresh smell. Based on color research conducted on paper soap, F1, FA, FB, and FAB have a slightly brownish-white color. The white-brown color occurs due to the addition of extracts, which have a brown color. The increasing amount of extract causes the color of the paper soap to become dark. The positive and negative controls were white because there is no addition of soapberry or aloe extract.

The next evaluation is the pH test. The pH testing is conducted to determine the pH of paper soap which is related to the sensitivity of the skin. The pH requirement for the preparation of hand soap is 4–10. If the pH is too acidic, it could irritate the skin, however if the pH is too alkaline, it could make the skin become dry (Iskandar *et al*., 2021). From the pH test results presented in Table 2, the four paper soap formulas have an appropriate pH between 4-10. The higher the concentration of soapberry added, the lower pH will be due to the acidic compounds of the soapberry (Hawa *et al*., 2023). The addition of more aloe will also make the paper soap more acidic due to the aloe extract has an acidic pH value. The negative control preparation has an alkaline pH value due to the use of alkaline ingredients such as glycerine and Na-CMC, and there is no addition of extracts that have acidic compounds (Eryani *et al*., 2022). The pH of positive control meets the requirements; this is appropriate because commercial products must meet the requirements for a good paper soap.

The next paper soap evaluation test is the moisture content. The moisture content results presented in Table 2. All formulas met the moisture content requirements in paper soap, which is a maximum of 60% (Fiskia and Maia., 2021). A high percentage of moisture content can be caused by the addition of hygroscopic materials. Meanwhile, a small percentage of moisture content can be caused by the use of increasing concentrations of extracts.

Evaluation of washing time is also carried out to find out how long it takes for the soap to dissolve and produce foam (Verawaty *et al*., 2020). Based on the washing time results shown in Table 2, the four formulas have different duration of washing time. FA and FAB which contain soapberry extract at high concentrations have a faster washing time compared to F1 and FB. Meanwhile, the negative control had a faster wash time compared to the four formulas. This can happen because the faster washing time can be caused by the addition of hygroscopic materials. The hygroscopic material can make paper soap quickly soluble when washed because it has the ability to bind and absorb water (Eryani *et al*., 2022).

A foam height evaluation test was performed to determine the foam strength produced from paper soap.

Table 2. Evaluation of Paper Soap

Evaluation	Formula ($\bar{x}$ ± SD)					
	Control (-)	Control (+)	1	A	B	AB
Organoleptic	 Paper-shaped, white color, fresh smell	 Paper-shaped, white color, odorless	 Paper-shaped, slightly brownish white color, fresh smell	 Paper-shaped, slightly brownish white color, fresh smell	 Paper-shaped, slightly brownish white color, fresh smell	 Paper-shaped, slightly brownish white color, fresh smell
pH (Cycle 0)	10.43 ± 0.04	6.64 ± 0.19	6.68 ± 0.02	5.81 ± 0.02	6.31 ± 0.04	6.65 ± 0.11
pH (Cycle 3)	9.80 ± 0.04	5.80 ± 0.05	5.32 ± 0.04	5.36 ± 0.03	5.01 ± 0.08	5.90 ± 0.03
Moisture Content (%)	33.80 ± 2.59	39.04 ± 3.33	50.34 ± 0.68	36.08 ± 5.79	36.74 ± 7.74	30.25 ± 1.01
Washing Time (s)	13.69 ± 0.60	7.61 ± 0.53	21.53 ± 2.32	16.44 ± 1.05	20.78 ± 0.98	16.6 ± 1.93
Foam Height (mm)	0.00 ± 0.00	90.67 ± 4.51	18.33 ± 4.51	25.33 ± 1.53	19.33 ± 3.06	28.00 ± 3.00
TEWL Decrease (%)	21.98±15.84	15.97±11.32	27.01±18.47	30.73±17.02	44.55±15.20	39.86±12.15

The high requirement of foam in the preparation of hand soap is 13-220 mm, where the more foam produced, the higher the foam height produced (Adlina *et al*., 2023). Based on the results of the foam height tests in Table 2, FA and FAB have higher foam heights compared to F1 and FB. Meanwhile, the negative control did not have foam height because there was no addition of soapberry as a surfactant. The use of soapberry extract in large concentrations can produce increasingly foam height. This is because the saponins can produce foam when reacted with water (Wijayanti *et al*., 2020).

Paper soap was also evaluated for TEWL to determine the amount of moisture lost from the surface of the skin. The ability of paper soap to have an effect as a moisturizer can be seen from a percentage reduction in TEWL ≥ 8% (Husein and Lestari, 2019). From the TEWL test in Table 2, the four formulas have a percentage reduction of ≥ 8%. FB and FAB had a greater reduction percentage because they contained aloe extract at a high concentration. The high water content in aloe extract can maintain skin moisture. Apart from that, aloe can bind and attract water because it has hygroscopic polysaccharide components, so it can maintain sufficient amounts of water (Hapsari *et al*., 2018).

Evaluation of paper soap was also carried out for physical stability, organoleptic and pH. Physical stability testing was conducted using the freeze and thaw method in three cycles. The organoleptic results showed that the shape and color of the paper soap did not change. However, there was a change in the smell of the paper soap. After testing, the smell of the paper soap disappeared because the essential oil evaporated when heated in the oven. Therefore, paper soap is unstable if stored at extreme temperatures between -10°C and 45°C. A physical stability assessment is also performed for pH. Based on observations after a physical stability test with the freeze and thaw method, the paper soap experienced a decrease in pH. The decrease in pH occurs because the basic ingredients that make up this paper soap are soapberry and aloe, which have acidic compounds. In addition, pH decreases can also occur because of the interaction between the water content in the paper soap and the CO_2 gas, thus forming acids on the paper soap (Sumbung *et al*., 2023).

Optimization with Factorial Design

Optimization of paper soap was conducted using factorial design. Factorial design is carried out with two factors and two levels. A factorial design was used to optimize the formula of paper soap by looking at the effects and interactions produced by each factor soapberry extract and aloe extract, at high and low levels. The effect of the response to physical properties, especially foam height and TEWL can be seen through the Design Expert version 13 (free trial version) software to obtain the optimum composition of soapberry extract and aloe extract.

Research data in the form of foam height entered into Design Expert version 13 (free-trial version) software obtained effects, contributions, and ANOVA which can be seen in Table 3. Based on Table 3, the results show that soapberry extract and aloe extract have an effect and percent contribution in the response of foam height. Soapberry extract and aloe extract gave positive values, indicating that both factors had an effect on increasing foam height. Soapberry contributed the most, 66.16% with an effect of 7.83. In paper soap preparations, soapberry extract has a large contribution to increasing foam height because it acts as a surfactant and foaming agent (Hawa *et al*., 2023). Aloe extract also contributes to the foam height response because the saponin content in aloe functions as a cleanser and has antiseptic properties. In addition, the saponin content in aloe can also increase the amount of foam formed (Gusviputri *et al*., 2013). The interaction of the two factors, namely soapberry extract and aloe extract, has a positive value, indicating that the interaction of the two factors has a significant effect on the response of foam height with a p-value of ANOVA test results of 0.0162 (<0.05). The results of foam height entered into the Design Expert version 13 (free trial version) software also produced a contour plot, which can be seen in Figure 1a. Figure 1a shows the level of foam height response resulting from the composition of the factors used. Increasing the concentration of soapberry can increase the foam height of the paper soap preparation. This is interpreted by the color sequence found in the figure. The blue-green color shows the lowest foam height, and if the foam height increases, the color will change from green to yellowish green to yellow along with the increase in foam height on paper soap.

Further research data in the form of a decrease in TEWL values entered into the Design Expert version 13 (free-trial version) software obtained effects, contributions, and ANOVA which can be seen in Table 3. Table 3 shows that aloe provides the largest contribution of 45.10%, with the effect of 574.08. Aloe has a significant effect on reducing the value of TEWL because aloe acts as an emollient so that it can withstand the loss of fluid from the skin surface (Damhas

Table 3. Results of Effect Analysis and ANOVA Test of Foam height and Trans Epidermal Water Loss

Evaluation	Factor	Effect	% Contribution	p-value	p-value model
Foam Height	Soapberry	7.83	66.16%	0.0028	0.0162 (Significant)
	Aloe	1.83	3.52%	0.3503	
	Interaction	0.83	0.75%	0.6641	
TEWL Decrease	Soapberry	90.75	7.13%	0.2600	<0.0463 (Significant)
	Aloe	574.08	45.10%	0.0158	
	Interaction	114.08	8.96%	0.2111	

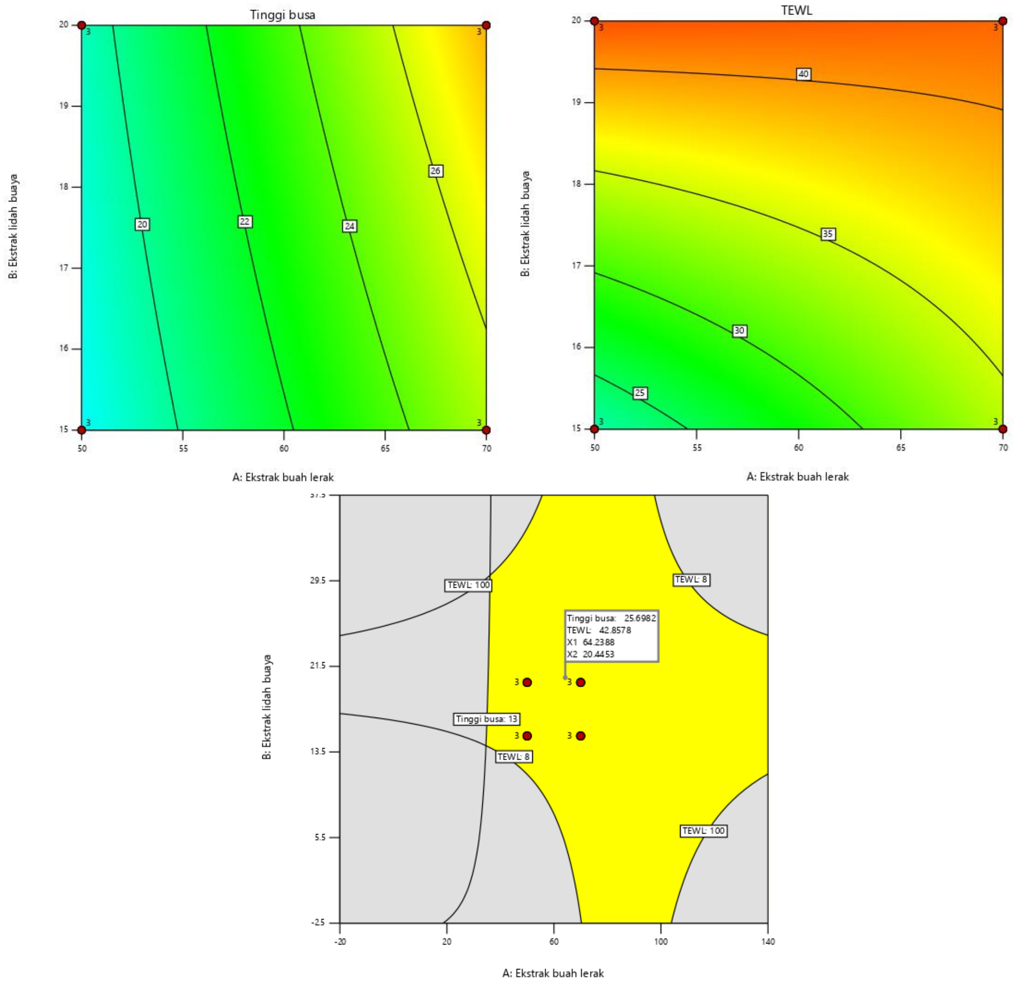

Figure 1. Contour plot and overlay plot (a) Foam Height Response, (b) TEWL Decrease Response, (c) Foam Height and TEWL Decrease

and Widayati, 2015). The interaction that occurred between the two factors contributed 8.96%, with an effect of 114.08. The interaction between soapberry and aloe has a significant effect because the p-value is <0.05. The results of TEWL entered into the software Design Expert version 13 (free-trial version) also produced a contour plot which can be seen in Figure 1b.

Figure 1b shows that the addition of soapberry extract and aloe extract can increase the response to the decrease in TEWL value. The increase in TEWL value reduction response can be seen in the color sequence changes that occur. The green color shows a low decrease in TEWL value, and if the decrease in TEWL value increases, there will be a color change from -

Table 4. Response Equation Validation Calculation

Response	Theoretical	Actual ($\bar{x}$ ± SD)	p-value
Foam Height	25	25.67 ± 1.53	0.529
TEWL Decrease	42	40.98 ± 0.20	0.065

yellowish green to yellow to orange. The changes that occur are because aloe extract has a role as an emollient that can withstand the loss of fluid from the skin surface (Damhas and Widayati, 2015).

Contour plots testing foam height and TEWL are combined to form the plot overlay to determine the optimal area. Figure 1c shows an overlay plot of the foam height and TEWL responses. The yellow areas in the overlay plot show formulas that are included in the optimum area with responses that meet the acceptance requirements, while the gray areas are not included in the optimum area because they do not meet the predetermined acceptance requirements. In the research that has been conducted, formula 1 (F1), formula A (FA), formula B (FB), and formula AB (FAB) are in the yellow area so that the four formulas are included in the optimum area. From the results of the overlay plot, the optimum area was selected with a composition of 63.5224 grams of soapberry extract and 20.1866 grams of aloe extract. Determination of the optimum area is expected for the formulation of paper soap preparations with physical properties that meet good requirements.

Validation of Response Equations

Validation is done by making paper soap with the optimum formula selected from the optimum area. After that, foam height and TEWL tests were conducted. The actual results of the physical properties test that have been obtained are compared with the results of the theoretical calculation using the One Sample T-test. Equation validation calculation data can be seen in Table 4. Based on Table 4, the p-value in the response of foam height and TEWL value reduction has a p-value > 0.05, which indicates there is no significant difference. It can be used as a prediction of foam height and TEWL response in the formulation of soapberry and aloe extract paper soap.

CONCLUSIONS

Based on the results of the study, it can be concluded that soapberry extract affects the foam height with a contribution percentage of 66.16%. Meanwhile, aloe extract affects Trans Epidermal Water Loss (TEWL) with a percentage contribution of 45.10%. In this study, the optimum composition of soapberry extract was 63.5224 grams and aloe extract were 20.1866 grams.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Adlina, S., Bachtiar, K. R., and Nurhasanah, B., 2023. Formulasi Dan Uji Aktivitas Sediaan Sabun Kertas Ekstrak Etanol Daun Pandan (Pandanus amaryllifolius) Sebagai Antibakteri. *Pharmacoscript*, 6(1), 22-30.

Awaluddin, N., Hamka, Awaluddin, S.W., Awaluddin, A., Kulsum, U., and Parwati, N.L.G., 2022. Formulation, Antibacterial Test, And Stability Testof Paper Soap Preparations Combination Ofgardenia Flower Extract (*Gardenia augusta* Merr) Andlemon Peel (*Citrus limon* L.). *Medical Sains : Jurnal Ilmiah Kefarmasian*, 7(2), 283–292.

Damhas, U.K., and Widayati, R.I., 2015. Efektivitas Campuran Ekstrak Aloe dan Tea Tree Dalam Formulasi Pelembab Pada Kekeringan Kulit. *Jurnal Kedokteran Diponegoro*, 4(4), 539–545.

Eryani, M.C., 2022. Pengaruh Variasi Konsentrasi Cmc-Na Sebagai Viscosity Agent Terhadap Sifat Fisik Sheet Mask Gel Ekstrak Daun Bidara (*Ziziphus spina-christi* L.).

MEDFARM: Jurnal Farmasi dan Kesehatan, 11(1), 9–15.

Fatmawati, I., 2014. Efektivitas Buah Soapberry (*Sapindus Rarak* De Candole) sebagai Bahan Pembersih Logam Perak, Perunggu, dan Besi. *Jurnal Konservasi Cagar Budaya*, 8(2), 24–31.

Febriaty, I. R., Usman, T., and Alimuddin, A. H., 2020. Perbandingan Nilai Trans Epidermal Water Loss Dari Sediaan Losion Minyak Tengkawang dan Minyak Biji Durian. *Jurnal Natur Indonesia*, 18(1), 24.

Fiskia, E., and Maia, C. D. F. U., 2021. Formulasi dan Evaluasi Sediaan Sabun Kertas Ekstrak Etanol Fuli Buah Pala (*Myritica fragrans* Houtt). *Kieraha Medical Journal*, 3(2), 120-126.

Gusviputri, A., Meliana, N. P. S., and Indraswati, N., 2013. Pembuatan Sabun Dengan Lidah Buaya (Aloe) Sebagai Antiseptik Alami. *Widya Teknik*, 12(1), 11- 21.

Hapsari, P.N., Prajoko, Y.W., Budijitno, S., 2018. Efektifitas Aloe (*Aloe barbadensis* Milleer) Dalam Penanganan Hand Foot Syndrome Pada Pasien Kanker Payudara Yang Mendapat Kemoterapi Capecitabine Per Oral. *Diponegoro Medical Journal (Jurnal Kedokteran Diponegoro),* 7(2), 451–461.

Hawa, L.C., Nada, U.Q., and Sumarlan, S.H., 2023. Karakteristik sifat fisikokimia sabun cuci cair menggunakan sari soapberry sebagai surfaktan alami. *Agrointek : Jurnal Teknologi Industri Pertanian*, 17(1), 213–223.

Hidayat, I.R., Zuhrotun, A., and Sopyan, I., 2020. Design-Expert Software sebagai Alat Optimasi Formulasi Sediaan Farmasi. *Majalah Farmasetika,* 6(1), 99–120.

Husein, E., and Lestari, A.B.S., 2019. Optimasi Formula Sediaan Krim Sunflower (Helianthus annuus L.) Oil. *Jurnal Ilmu Kefarmasian Indonesia,* 17(1), 62.

Iskandar, B., Sidabutar, S.E.B., and Leny, L., 2021. Formulasi dan Evaluasi Lotion Ekstrak Alpukat (Persea Americana) sebagai Pelembab Kulit. Journal of Islamic Pharmacy, 6(1), 14–21.

Mardiana, U., 2020. Pembuatan Sabun Berbahan Dasar Minyak Jelantah Dengan Penambahan Gel Lidah Buaya Sebagai Antiseptik Alami. *Jurnal Kesehatan Bakti Tunas Husada*, 20(2), 252–260.

Putri, D. E., Utomo, E. P., Iftitah, E. D., 2017. Prototipe Hand Sanitizer Nanoemulsi Berbasis Surfaktan Alami Lerak (*Sapindus rarak)* Sebagai Antibakteri. *Indonesian Journal Of Essential Oi*l, 2(2), 28-38.

Rahardjo, M., Koendhori, E.B., and Setiawati, Y., 2017. Uji Aktivitas Antibakteri Ekstrak Etanol Lidah Buaya (Aloe) Terhadap Bakteri *Staphylococcus aureus*. *Jurnal Kedokteran Syiah Kuala,* 17(2), 65–70.

Risfianty, D.K. and Indrawati, I.,2020. Perbedaan Kadar Tanin Pada Infusa Daun Asam Jawa (*Tamarindus indica* L.) Dengan Metoda Spektrofotometer Uv-Vis. *Lombok Journal of Science* (LJS), 2(3), 1–7.

Rusli, N., Nurhikma, E., and Sari, E.P., 2019. Formulasi Sediaan Sabun Padat Ekstrak Daun Lamun (*Thalassia hemprichii*). *Warta Farmasi*, 8(2), 53–62.

Salomon, L., Kosasih, W., and Oscar Angkasa, S., 2015. Perancangan Eksperimen untuk Meningkatkan Kualitas Ketangguhan Material dengan Pendekatan Analisis General Factorial Design (Studi Kasus: Produk Solid Surface). *Jurnal Rekayasa Sistem Industri,* 4(1), 1–7.

Sariyem, S., Sadimin, S., Sunarjo, L., and Haniyati, M., 2015. Efektifitas Ekstrak Daun Sukun Hasil Perebusan Terhadap Pertumbuhan Koloni Bakteri *Streptococcus mutans*. *Jurnal Kesehatan Gigi*, 2(2), 104–109.

Sugiyono, Iftitah, A.O.E., and Windriyati, Y.N., 2016. Optimasi Formula Tablet Ekstrak Daun Sirih Merah (*Piper crocotum* Ruiz & Pav) dengan Metode Kempa Langsung menggunakan Desain Faktorial. *Pharmauho Majalah Farmasi, Sains dan Kesehatan*, 2(1), 6–9.

Sumbung, N., Nopiyanti, V., Aisiyah, S., and Harjanti, R., 2023. Formulasi Sabun Mandi Padat Ekstrak Daun Jeruk Bali (Citrus Maxima Merr.) sebagai Antibakteri terhadap Staphyloccous aureus. *Journal Syifa Sciences and Clinical Research* (JSSCR), 5(1), 44–53.

Verawaty, V., Dewi, I. P., and Wela, W. 2020. Formulasi dan Evaluasi Sabun Kertas Katekin sebagai Antiseptik [Formulation and Evaluation of Catechin Paper Soap as an Antiseptic], *Pharmaceutical Journal of Indonesia,* 17(2). 514-523.

Wijayanti, F., Sari, M., Suprayitno, R., and Aminin, D., 2020. The Gel Soap with Raw Materials of Soapberry Fruit (*Sapindus rarak* DC). *Stannum: Jurnal Sains dan Terapan Kimia*, 2(1), 1–6.