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Formulation of Solid Body Wash From Dragon Fruit Peel Waste With Pandan Leaf Extract

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Abstract

This paper highlights the formulation of dragon fruit waste material for a solid body wash, which arguably contain better substance for skin health. The result of this experiment opens up a possibility to be applied as part of community project, contributing to sustainable environment and healthier lifestyle. Red dragon fruit (*Hylocereus polyrhizus*) is a plant originating from a dry tropical climate with a fairly thick peel that accounts for 30%–35% of the fruit's total weight. The peel is rarely used or reprocessed and thus often becomes waste. The peel's polyphenol and other important substances component makes it rich in antioxidants. Owing to these contents, dragon fruit peel is a suitable ingredient for making bath bar soap. In this study, pandan leaf extract was used as an additive as its contents help increase antioxidant levels in solid body wash. This study aimed to determine the best bar soap formulation using dragon fruit peel and pandan leaf extract and the most effective method (FTC versus DPPH), as well as moisture content and pH levels analysis. Results showed that the samples with dragon fruit peels have the highest moisture content, pH, and antioxidant activity. In conclusion, dragon fruit peel can be reused as a supporting ingredient in bar soap. Dragon fruit peel and pandan leaf extract are highly effective for increasing the antioxidant activity and consequently improve the quality of solid body wash.

Keywords: formulation of solid body wash; bar soap; dragon fruit peel; pandan leaves extract

1. Introduction

This paper discusses the formulating of dragon fruit waste material for a solid body wash or bar soap material, a potential product that contributes to sustainability movement and promote a healthier lifestyle. The results of this research are very useful to be developed as a product that can be produced by a community. Dragon fruit peel contains high antioxidants due to its content of polyphenols and other essential substances that are beneficial for health. The content of this dragon fruit peel is very suitable to be used as an ingredient in making bar soap. Currently, there is an increase of interest in the formulation of soap based on waste material, as an attempt to develop a healthier product (Hennessey-Ramos et al., 2019; Thirunavukkarasu et al., 2023; Wahyuni, 2021) and other dragon fruit-based products (Dewi et al., 2020; Madane et al., 2020). The soap can be produced through saponification and the oil neutralization in a relatively short time (2 days), a process that can be learned by a community. The results of this experiment can be a reference for researcher and community entrepreneurs as a product with economic value and a product that complies with standards.

Arsa and Achmad (2021) describe the characteristics of soap and its molecules. In general, a soap molecule is not completely soluble in water. A soap molecule becomes hydrophobic (soluble in non-polar substances) due to a long hydrocarbon chain. But at the same time, it is hydrophilic (soluble in water) due to the ionic end of the hydrocarbon chain. Furthermore, soap is easily suspended in water due to the micelles generated from group of molecules whose hydrocarbon chains are clustered with the ends of the ions facing the water.

Soap is composed of fatty acids, oils, and waxes containing unsaturated bonds that oxidize easily. The reaction is characterized by the discharge of rancid odor in the soap. Antioxidant-rich ingredients are needed to protect soap from oxidation (BSN, 1994). Antioxidants inhibit the reaction of free radicals that are released by pollution, radiation, and cigarette smoke, which cause carcinogenesis, cardiovascular illness, and aging-related diseases in humans.

In this study, natural antioxidants extracted from dragon fruit peel were used. The peel of dragon fruit contains high levels of anthocyanin, a natural dyestuff that provides the red color to the fruit. It has the potential to become a natural dye for food and can be used as an alternative to synthetic dyes that is safe for health. Dragon fruit peel also contains polyphenols that is rich in antioxidants. Other important compounds include betalain compounds, vitamin C, vitamin E, vitamin A, alkaloids, terpenoids, flavonoids, thiamine, niacin, pyridoxine, cobaltamine, phenolic, carotene, and phytoalbumin (Utami et al., 2020). The contents of dragon fruit peel are listed in Table 1 (Jamilah et al., 2011).

Table 1. Content of dragon peel fruit (per 100 g)

Compounds	Nutritional Contents
Protein (g)	0,53
Fat (g)	2,00
Fibrous of Fruit (g)	0,71
Vitamin C (mg)	9,40
Carbohydrate (g)	11,5
Phosphorus (mg)	8,70
Phenol (mg)	1.049,18
Flavonoid (mg)	1.310,10
Pectin (%)	10,79%
Antosyanin (mg)	186,90

Source: Jamilah et al., 2011

Additionally, pandan leaves can be added to improve the soap's quality. Pandan leaves are widely used to enhance aromas and flavors and applied as dye for Indonesian snack foods. In Malaysia, pandan leaves are broadly utilized as an ingredient in traditional medicine for diabetics. Dietary factors, including antioxidants, have a great effect in the treatment of diabetics and their complications. Pandan leaves contain compounds, such as polyphenols, tannins, alkaloids, saponins, and flavonoids and some of these compounds are responsible for the antioxidant and hypoglycemic activities (Suryani et al., 2017).

Ayun (2019) aimed to determine the most suitable solvent level to extract antioxidants such as vitamin C from dragon fruit peel for soap formulation. Their research focused on solvent selection, alkalinity test, moisture content, and pH level. The results showed that a good solvent for extracting vitamin C (antioxidants) is 30 mL of distilled water with a maceration time of 2 hours and a temperature of 40°C. Among the treatments, the best soap formulations are as follows: 50 µL of solvent extract, 6 g of coconut oil, 12.5 mL of 15% NaOH, 3 g of stearic acid, 10 mL of ethanol 96%, 6.5 g of glycerin, 7.5 g of granulated sugar, 500 µL of coco-DEA, 0.1 g of NaCl, and 45 µL of fragrance oil. Their study still had some deficiencies, such as the analysis of vitamin C or antioxidants in dragon fruit peel was not performed in accordance with the method used. Additionally, the antioxidant analysis was carried out during maceration, so the results were not clearly visible.

This study presents a soap formulation that is in accordance with SNI (Indonesian National Standard, abbreviated SNI) for solid body wash or bar soap standards (BSN, 2016). The soap quality is also better and antioxidant rich as compared with soaps sold in market. This study used dragon fruit peel waste whose high antioxidant content is expected to improve the quality of the soap formulation. The addition of pandan leaf extract containing vitamin A, vitamin C as antioxidants, and antibacterial agents will further enhance the quality of the soap formulation. For soap quality testing, ferric thiocyanate (FTC) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) methods were compared with the final result to ensure that the content and quality of the bar soap formulation is in accordance with SNI (BSN, 2016).

2. Materials, Methods, and Process of Formulation

The ingredients for soap making are as follows: palm oil and stearic acid as an oil group, dragon fruit peel extract (based on variables), pandan leaf extract (based on variables), NaOH 30%, glycerin, alcohol 96%, NaCl, and essence. The materials for the antioxidant analysis using FTC and DPPH methods are as follows: linoleic acid 2.5%, phosphate buffer 0.05 M pH 7, butylated hydroxytoluene (BHT) compound, ammonium thiocyanate 30%, and ethanol 70%.

The tools used in this study included ovens, desiccators, digital balance sheets, centrifuges, measuring flasks, hot plates, stirrers, weighing bottles, pH paper, ultraviolet (UV)-vis spectrophotometry, cuvettes, mixers, blenders, pipettes, measuring cups, beaker cups, watch glass, and filter paper. This study was conducted at a vocational school laboratory in Central Java, Indonesia. The main method for antioxidant analysis was FTC. This technique measures the amount of peroxide in the initial fat peroxidation, and the formed FTC reaction complex is read at a wavelength of 488.5 nm. Unsaturated fats lose hydrogen atoms in the CH_2 group to produce unpaired carbon atoms (CH•), followed by a chain reaction that is disrupted by antioxidants by donating hydrogen atoms (Muhtadi et al., 2014). The lower the peroxide concentration, the stronger is the antioxidant activity. Absorbance was measured at a wavelength of 488.5 nm every 24 hours until the control absorbance reached the maximum absorbance.

Soap making starts with mixing fat fractions (stearic acid and palm oil) and alkali (NaOH 30%) as soap stock. After the formation of soap stocks by stirring, other ingredients were added, namely, glycerin, 96% alcohol, NaCl, fragrance, dragon fruit peel extract (0, 4, and 8 mL), and pandan leaf extract (0, 4, and 8 mL). Stirring was carried out again at 80°C until the mixture was homogeneous or evenly mixed. After the soap thickened, it was transferred into a mold that was tightly shut to prevent contact with air and placed at room temperature for 24 hours until the soap solidified.

Analysis of water content, acidity degree, and antioxidant activity by FTC and DPPH methods was performed for all experimental variables. These four analyses were conducted and measured based on the experimental variables below (Table 2 and Table 3).

Table 2. Factorial design

En (mL)	Ep (mL)											
	0				4				8			
	Analysis test											
	KA	pH	AFTC	ADPPH	KA	pH	AFTC	ADPPH	KA	pH	AFTC	ADPPH
	V	pH	A	B	V	pH	A	B	V	pH	A	B
	V	pH	A	B	V	pH	A	B	V	pH	A	B
0	V	pH	A	B	V	pH	A	B	V	pH	A	B
	V	pH	A	B	V	pH	A	B	V	pH	A	B
	V	pH	A	B	V	pH	A	B	V	pH	A	B
	V	pH	A	B	V	pH	A	B	V	pH	A	B
4	V	pH	A	B	V	pH	A	B	V	pH	A	B
	V	pH	A	B	V	pH	A	B	V	pH	A	B
	V	pH	A	B	V	pH	A	B	V	pH	A	B
	V	pH	A	B	V	pH	A	B	V	pH	A	B
8	V	pH	A	B	V	pH	A	B	V	pH	A	B
	V	pH	A	B	V	pH	A	B	V	pH	A	B

Table 3. Solid bath bar soap

No.	Description	Value
1	Moisture Content, %	Max. 15 %
2	Degree of Acidity, pH	Between 8–10
3	Fatty Acids, %	< 70 %

Source: BSN, 1994

3. Results and Discussion

As mentioned above, there were series of analysis conducted in this experiment: the moisture content analysis, pH analysis, analysis of antioxidants by the FTC method, and analysis of antioxidants by the DPPH method. At the end, the result of FTC and DPPH method were compared.

3.1. Moisture content analysis

The moisture content can affect the soap's characteristics, such as hardness. The bar soaps in the market have a variety of textures. Hardness is influenced by the amount of water in soap and can adversely affect the product's shelf life. In this study, the water content of body soap was analyzed in accordance with SNI 06-3532-1993 (BSN, 2016). The results are listed in Table 4.

Table 4. Moisture contents

Research Sample			
No.	**Dragon Fruit Peel Extract (mL)**	**Pandan Leaf Extract (mL)**	**Moisture Contents (%)**
1.	0	0	15.01
2.	0	4	12.97
3.	0	8	13.49
4.	4	0	14.67
5.	4	4	14.49
6.	4	8	15.21
7.	8	0	16.39
8.	8	4	16.68
9.	8	8	17.03

This study analyzed nine samples of bar soap. Water content was calculated using a formula from SNI 06-3532-1994 (BSN, 1994). The results showed that the water content was in the range of 12%–17%. According to BSN (2016), a solid body wash must have a maximum moisture content value of 15%. Therefore, some of this study's bar soap samples met the requirements of SNI 3532:2016.

The more dragon fruit peel extract added, the higher the water content. This result was in accordance with previous research conducted by the authors on soap samples added with 8 mL of dragon fruit peel extract. It is found that samples 7–9 had a greater moisture content than other samples. Jamilah et al. (2011) reported that red dragon fruit peel contains a fairly high amount of pectin compound and a moisture content of around 90.20%. Pectin forms a gel with sugar to trap water, thereby increasing the water content. Moreover, Setiawati and Ariani (2020) reported that a soap with a high-water content rapidly shrinks. The amount of water added affects the solubility of the soap. Soap easily shrinks when used, especially when its water content is high. This parameter affects the economic value of the soap, which is important to be noted for the potential of community project.

3.2. pH analysis

pH analysis for bar soaps is necessary to ensure that they are safe to use. If the pH of a solid body wash does not comply with the feasibility standards, then it can cause incompatibility to the human skin, such as itching and even irritation of the peel. In this study, the pH of solid shower gel was analyzed using pH paper. The results are listed in Table 5.

Table 5. pH analysis results

Research Sample			
No.	**Dragon Fruit Peel Extract (mL)**	**Pandan Leaf Extract (mL)**	**Degree of Acidity (pH) in Soap**
1.	0	0	8
2.	0	4	9
3.	0	8	10
4.	4	0	10
5.	4	4	9
6.	4	8	8
7.	8	0	9
8.	8	4	9
9.	8	8	9

pH analysis was carried out on nine samples using pH paper. The results showed that the pH was in the range of 8 to 10. According to SNI 06-3532-1994 (BSN, 1994) and ASTM D 1172-95 (D12 Committee, 2016), the pH of solid body washes must range from 9 to 11. Therefore, the pH levels measured in this study were in accordance with the standard pH for solid body wash, implying that the prepared samples are feasible and safe to be used.

Jamilah et al. (2011) reported that dragon fruit peel extract has a fairly high phenol content. Phenol is a benzene-derived compound that has more acidic properties than other aliphatic alcohols. Therefore, the more dragon fruit peel extract is added, the lower the pH of the soap and the higher its acidity. The measure pH levels in this study were in accordance with previous research on samples added with 8 mL of dragon fruit peel extract. They found that samples 7–9 had the lowest pH among all the samples.

Setiawati and Ariani (2020) showed that the pH of soap should be in accordance with the feasibility standard. The pH of the soap can affect the pH of the human skin. Alkaline substances in soap can neutralize or even damage (if the pH of the soap is highly alkaline) the acidic mantle on the skin, which acts as a barrier to bacteria and viruses. It also causes dry skin because of water loss, thereby enabling potential irritation and allergies. When the soap is in contact with water, it undergoes hydrolysis, thereby releasing its alkali contents and increase the peel pH to 10–11. Healthy skin generally has pH 5.4 to 5.9. Therefore, the pH of soap is important for healthy skin, another notable aspect if the formulation to be used for a product that promotes a healthy life.

3.3. Analysis of antioxidants by FTC

One of the methods for determining antioxidant activity is FTC technique, which measures the amount of peroxide in the early stages of fat peroxidation. In the FTC method, linoleic acid is used as a source of peroxide. The formed peroxide reacts with $FeCl_2$ to form Fe^{3+} ions, which then react with ammonium thiocyanate (SCN) to form a red ferrithiocyanate ($Fe(SCN)_3$) complex. Absorbance was measured using a UV-vis spectrophotometer at a theoretical wavelength of 488.5 nm. The following reactions occurred in the antioxidant analysis using the FTC method.

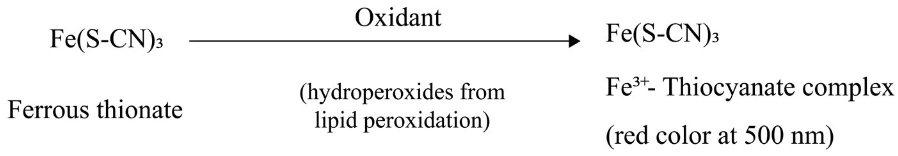

Figure 1. Fe^{3+} Thiocyanate complex production reaction

Antioxidant analysis using the FTC method aims to determine the effectiveness and stability of inhibiting the formation of free radicals that reduce ferries. FTC analysis reveals the degree of inhibition of free radical formation over a certain time interval. This value indicates the antioxidant activity in the sample. Figure 2 shows the results of antioxidant analysis using the FTC method.

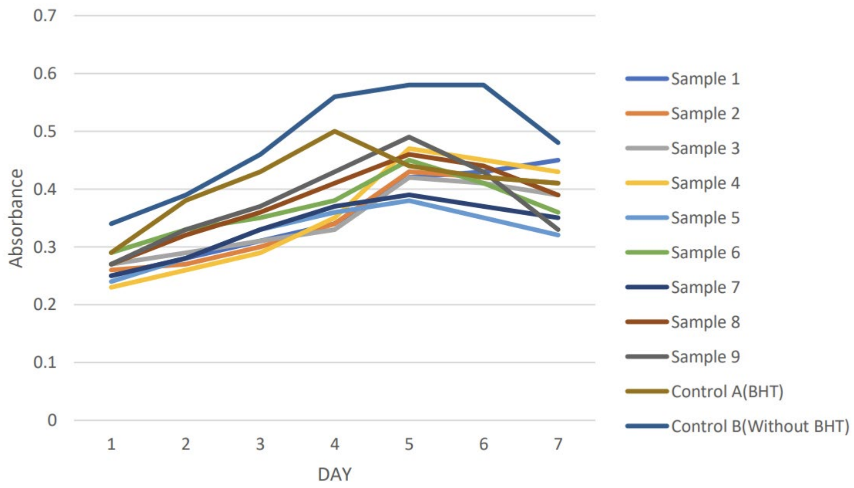

Figure 2. Antioxidant activity analysis by FTC

The antioxidant activity of nine samples was determined at a wave of 488.5 nm using FTC for 7 days with a sample reading range every 24 hours. Control solution A (with the addition of BHT) and control solution B (without the addition of BHT) were used as standards for determining antioxidant activity.

Control solution B showed maximum absorbance on day 6 as indicated by a red solution resulting from the formation of an increasingly concentrated FTC complex. This phenomenon indicated that the lipid peroxidation of linoleic acid is already running optimally, and that additional peroxides or free radicals are being formed. As shown in Figure 2, the absorbance of control solution B was higher than that of other samples because the former does not have antioxidant compounds or BHT compounds that could inhibit lipid peroxidation. This phenomenon causes a more intense red color for control solution B compared with that for control solution A, which was added with BHT and sample solution.

In this study, control solution A was added with BHT compound as the standard solution. BHT compounds are antioxidants resembling vitamin E and are widely used by the food industry as preservatives. They are often added to cooking oil and butter to prevent rancidity (Moon & Shibamoto, 2009). In this study, BHT compounds were used as standards in analyzing the antioxidant activity of the samples. The results showed that BHT compounds had a maximum absorbance on day 4, which was indicated by a decrease in absorbance value on day 4. This finding stated that control solution A has an extremely high and constant antioxidant activity and therefore can be used as a standard for determining antioxidant activity.

The average sample had a maximum absorbance on day 5 as indicated by a decrease in the absorbance value. Sample 9 had the closest activity to the BHT solution as indicated by its smallest absorbance value on day 7 and its maximum absorbance value on day 5. Therefore, sample 9 added with 8 mL of dragon fruit peel extract and 8 mL of pandan leaf extract has the closest antioxidant activity to control solution A (standard) and can inhibit lipid peroxidation and free radical formation to the maximum.

3.4. Analysis of antioxidants by the DPPH method

The DPPH method is used to determine antioxidant activity in a sample by looking at its ability to ward off DPPH free radicals. A soap's ability to absorb free radicals is classified according to its antioxidant value. Plongpaichit et al. (2007) proposed the following standards for assessing antioxidant analysis using the DPPH method.

Table 6. Classification of antioxidant activity with DPPH method

No.	Antioxidant Groups	Value (ug/mL)
1.	Very Weak	IC50 200–1000
2.	Weak	IC50 150–200
3.	Normal	IC50 100–150
4.	Strong	IC50 50–100
5.	Very Strong	IC50 < 50

The DPPH method observes the mechanism of free radical capture activity when the sample to be analyzed is mixed with DPPH solution, it will exhibit a change in color, such as from originally bright to pale purple, which indicates that the sample has antioxidant activity. The results are listed in Table 7.

Table 7. Results of antioxidant analysis with DPPH method

Research Sample			
No.	Dragon Fruit Peel Extract (mL)	Pandan Leaf Extract (mL)	Value (IC50)
1.	0	0	196
2.	0	4	89
3.	0	8	114
4.	4	0	123
5.	4	4	109
6.	4	8	117
7.	8	0	101
8.	8	4	97
9.	8	8	81

The antioxidant activity of nine samples was measured using the DPPH method at a wavelength of 517 nm. The lowest DPPH value was obtained for sample 9 with a score 81, and the highest was recorded for sample 1 with a score of 196. This finding showed that sample 9 can optimally capture DPPH free radicals. According to Plongpaichit et al. (2007), sample 9 is categorized as a strong antioxidant because it has an IC50 value (81) between 50 and 100. Therefore, sample 9 added with 8 mL of dragon fruit peel extract and 8 mL of pandan leaf extract has the highest antioxidant activity and can optimally capture DPPH free radicals among all the samples.

3.5 Comparison of antioxidant analysis using FTC and DPPH methods

The FTC method measures the amount of peroxide in the early stages of fat peroxidation and aims to measure the ability of the sample to inhibit the formation of lipid peroxides and free radicals. Meanwhile, the DPPH method determines the antioxidant activity of a sample by looking at its ability to counteract DPPH free radicals.

In this study, the antioxidant analysis using the FTC method was carried out in seven days at a wave of 488.5 nm to produce data in the form of graphs, which represent the antioxidant activity of each sample. Meanwhile, the DPPH method was performed at a wave of 517 nm, and the data were calculated with a linear regression equation to obtain the IC_{50} value of each sample.

Compared with the DPPH method, the FTC method has a greater advantage in examining the antioxidant activity of each sample. The results of the FTC method are in the form of graphs, which allow the comparison of antioxidant activity between the samples and against BHT compounds acting as antioxidant standards often used in the food industry.

4. Conclusion

In this study, the following conclusions were drawn, which are important for the formulation of dragon fruit peel waste as a basis for a SNI complied product of solid body wash:

a. Water content analysis showed that some samples satisfied the requirement of SNI 3532:2016, that is, a solid body wash must have a maximum water content of 15%. Sample 9 added with 8 mL of dragon fruit peel extract had the highest moisture content;
b. pH analysis showed that the pH of the samples is suitable with SNI 1994 and ASTM D 1172-95, which state that the pH of bar soap must range from 9 to 11;
c. Antioxidant analysis using the FTC method revealed that the average sample had a maximum absorbance value on day 5. Sample 9 added with 8 mL of dragon fruit peel extract and 8 mL of pandan leaf extract had the closest activity to BHT solution, which showed a decrease on day 5 and the smallest absorbance value on day 7;
d. Antioxidant analysis using the DPPH method revealed that sample 9 had the smallest IC50 value with a score 81. Therefore, sample 9 added with 8 mL of dragon fruit peel extract and 8 mL of pandan leaf extract can capture DPPH free radicals to the maximum. Sample 9 is included in the group of strong antioxidants because its IC50 value is between 50 and 100;

e. Antioxidant analysis using the FTC method has advantages in data processing over the DPPH method. The data from FTC method were in the form of graphs, allowing the visualization of the antioxidant activity of each sample and its comparison with antioxidant compounds that have been recognized as antioxidant standards in the industry, especially BHT compounds.

The results of this research are useful in developing science for society, particularly as part of promoting sustainable movement and a healthy lifestyle. Learning from the study above, the solid body wash can be successfully formulated from organic waste material—dragon fruit skin—along with the pandan leaf extract. Based on the characteristics of the basic material, dragon fruit skin and pandan leaf extract are very effective for increasing antioxidant activity as an important aspect in developing a healthy-for-skin solid body wash product. The findings can be incorporated to community knowledge so the community knows the economic value and health standards of soap.

Author Contribution

Anggun Puspitarini Siswanto: conceptualization, formatting and review; Georgius Aldo: formulation of idea, methodology, and writing.

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Declaration of Conflicting Interest

The author declares no conflict of interest in the conduct of the study

References

Arsa, A. K., & Achmad, Z. (2021). Making soap from durian fruit peel extract. *TECHNO Jurnal Ilmu Pengetahuan dan Teknologi*, *7*(2), 163–182.

Ayun, Q. (2019). Formulasi sabun mandi padat dari ekstrak limbah kulit buah naga merah (*Hylocereus costaricensis*). *Jurnal Biosense*, *2*(01), 18–27. https://doi.org/10.36526/biosense.v2i01.357

Badan Standar Nasional. (1994). Sabun mandi. SNI 06-3532-1994.

Badan Standar Nasional. (2016). Sabun mandi padat. SNI 3523:2016.

D12 Committee. (2016). *Guide for pH of Aqueous Solutions of Soaps and Detergents*. ASTM International. https://doi.org/10.1520/D1172-15

Dewi, N. P. B. T., Singapurwa, N. M. A. S. & Mangku, I G. P. (2020). Extraction and stability of natural dyes from the skin of red dragon fruit. *SEAS, 4*(2), 130–141. https://doi.org/10.22225/seas.4.2.2622.130-141

Hennessey-Ramos, L., Murillo-Arango, W., & Guayabo, G. T. (2019). Evaluation of a colorant and oil extracted from avocado waste as functional components of a

liquid soap formulation. *Revista Facultad Nacional de Agronomía Medellín*, *72*(2), 8855–8862. https://doi.org/10.15446/rfnam.v72n2.74573
Jamilah, B., Shu, C. E., Kharidah, M., Dzulkifly, M. A., & Noranizan, A. (2011). Physico-chemical characteristics of red pitaya (*Hylocereus polyrhizus*) peel. *International Food Research Journal*, *18*(1), 279–286.
Madane, P., Das, A. K., Nanda, P. K., Bandyopadhyay, S., Jagtap, P., Shewalkar, A., & Maity, B. (2020). Dragon fruit (*Hylocereus undatus*) peel as antioxidant dietary fibre on quality and lipid oxidation of chicken nuggets. *Journal of Food Science and Technology*, *57*, 1449–1461. https://doi.org/10.1007/s13197-019-04180-z
Moon, J. K., & Shibamoto, T. (2009). Antioxidant assays for plant and food components. *Journal Agriculture Food Chemical, 57*(5), 1655–1666. https://doi.org/10.1021/jf803537k
Muhtadi, Hidayati, A. L., Suhendi, A., Sudjono, T. A., & Haryoto. (2014). Pengujian daya antioksidan dari beberapa ekstrak kulit buah asli Indonesia dengan metode FTC. *Simposium Nasional RAPI XIII*, 50–58.
Plongpaichit, S., Nikom, J., Rungjindamai, N., Sakayaroj, J., Hutadilok-Towatana, N., Rukachaisirikul, V., & Kirtikara, K. (2007). Biological activities of extracts from endophytic fungi isolated from *Garcinia* plants. *FEMS Immunology and Medical Microbiology, 51*(3) 517–525. https://doi.org/10.1111/j.1574-695x.2007.00331.x
Setiawati, I., & Ariani, A. (2020). Kajian pH dan kadar air dalam SNI sabun mandi padat di Jabedebog, *Pertemuan dan Presentasi Ilmiah Standardisasi*, 293–300. https://doi.org/10.31153/ppis.2020.78
Suryani, C. L., Murti, S. T. C., Ardiyan, A., & Setyowati, A. (2017). Aktivitas antioksidan ekstrak etanol daun pandan (*Pandanus amaryllifolius*) dan fraksi-fraksinya. *agriTECH*, *37*(3), 271–279. https://doi.org/10.22146/agritech.11312
Thirunavukkarasu, A., Nithya, R., Sivashankar, R., Sathya, A. B., Rangabhashiyam, S., Pasupathi, S. A., Prakash, M., & Nishanth, M. (2023). Green soap formulation: An insight into the optimization of preparations and antifungal action. *Biomass Conversion and Biorefinery*, *13*, 299–310. https://doi.org/10.1007/s13399-020-01094-1
Utami, W., Maradawati, E., & Putri, S. H. (2020). Pengujian aktivitas antioksidan kulit buah naga merah (*Hylocereus polyrhizus*) sebagai masker gel *peel off. Jurnal Industri Pertanian*, *2*(1), 95–102.
Wahyuni, T. (2021). The potential and application of *Eucheuma* sp. for solid soap: A review. *IOP Conference Series: Earth and Environmental Science*, *750*(1), 012048. https://doi.org/10.1088/1755-1315/750/1/012048

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Georgius Aldo is a student at Vocational School, Diponegoro University, Indonesia. He is interested in public health development, finding a new ideas, and waste processing into products that have good value and quality.