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Efforts to Utilize Banana Peel (Musa paradisiaca L) for Making Anti-Dandruff Shampoo Formulations

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ABSTRACT
Banana peel is an organic waste that is often overlooked, even though it contains beneficial compounds such as potassium and flavonoids that have the potential to act as active anti- dandruff agents. If not properly utilized, this waste can pollute the environment. This research aims to utilize banana peel extract (Musa paradisiaca L.) as the main ingredient in the formulation of a natural and environmentally friendly anti-dandruff shampoo. The method used was a laboratory experiment involving three variations of banana peel extract concentrations: F1 (10%), F2 (20%), and F3 (30%). Each formulation was evaluated through pH test, homogeneity, foam height, viscosity, and antibacterial activity against dandruff-causing fungi. The results showed that all formulations met the Indonesian National Standard (SNI), but F3 was the most optimal formulation, with a pH of 5.5 matching the natural pH of the scalp, the highest viscosity of 589 cPs, stable foam formation, and the largest antibacterial inhibition zone of 18 mm (strong category). Based on these results, it can be concluded that banana peel has high potential as an active ingredient in natural anti-dandruff shampoo production, which is not only effective in reducing dandruff but also contributes to reducing organic waste in a sustainable and eco-friendly way.

ABSTRAK
Kulit pisang merupakan limbah organik yang sering diabaikan, padahal mengandung senyawa bermanfaat seperti kalium dan flavonoid yang berpotensi sebagai bahan aktif anti ketombe. Limbah ini jika tidak dimanfaatkan dengan baik dapat mencemari lingkungan. Penelitian ini bertujuan untuk memanfaatkan kulit pisang (Musa paradisiaca L.) sebagai bahan dasar dalam formulasi sampo anti ketombe berbahan alami dan ramah lingkungan. Metode penelitian yang digunakan adalah eksperimen laboratorium dengan tiga variasi konsentrasi ekstrak kulit pisang, yaitu F1 (10%), F2 (20%), dan F3 (30%). Evaluasi terhadap masing-masing formulasi dilakukan melalui uji pH, homogenitas, tinggi busa, viskositas, dan uji aktivitas anti bakteri terhadap jamur penyebab ketombe. Hasil penelitian menunjukkan bahwa ketiga formulasi memenuhi standar yang ditetapkan oleh SNI, namun formulasi F3 menunjukkan hasil paling optimal, yaitu pH 5,5 yang sesuai dengan pH kulit kepala normal, viskositas tertinggi sebesar 589 cPs, busa stabil, serta zona hambat antibakteri sebesar 18 mm yang masuk kategori kuat. Berdasarkan hasil tersebut, dapat disimpulkan bahwa kulit pisang memiliki potensi tinggi sebagai bahan aktif dalam pembuatan sampo anti ketombe alami yang tidak hanya efektif dalam mengatasi ketombe, tetapi juga berkontribusi dalam mengurangi limbah organik.

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KEYWORDS
Banana Peel, Anti-Dandruff Shampoo, Organic Waste

INTRODUCTION

Dandruff is a common hair health problem experienced by Indonesians due to the tropical climate with high temperatures and humidity (Sambodo & Salimah, 2021). This condition is characterized by excessive flaking of dead skin cells, causing itching and discomfort (Widowati et al., 2020). The global prevalence of dandruff reaches 50% of the population and tends to increase with urbanization (Yusuf et al., 2020), while in Indonesia, the number of sufferers reaches more than 43 million people, ranking fourth in the world (Putri et al., 2020; US Census Bureau, 2004).

In an effort to address this issue, the anti-dandruff shampoo market continues to grow, estimated to reach USD 25.7 billion in 2019, with great opportunities for Indonesia to develop natural-based products (Trade Research and Development Agency, 2017). One potential ingredient is banana peel (Musa paradisiaca L.), which is abundantly produced in Indonesia and often ends up as waste (BPS, 2023). In fact, banana peel contains 14.28% potassium and flavonoid compounds that function as antioxidants and antibacterials, making it useful as an active ingredient in anti-

dandruff shampoo (Aryani et al., 2018). Bananas (Musa paradisiaca L.) are a high-yield commodity in Indonesia. Banana peels contain flavonoids, potassium, vitamins, and antioxidant comp ounds that have the potential to be used as active ingredients in anti dandruff products (Sari et al., 2022). The use of banana peels not only adds value to agricultural waste but also supports innovation in herbal cosmetic products. This study aims to formulate an anti-dandruff shampoo with varying concentrations of banana peel extract and evaluate its quality based on SNI parameters.

METHODS

The research method used was a true experiment, which is a type of quantitative research aimed at testing and developing the use of banana peel in anti-dandruff shampoo formulations.

Tools dan Materials

The tools used are bottles, blenders, glass stirrers, digital scales, spoons, Erlenmeyer flasks, watch glasses, containers, universal pH paper, beakers, Ostwald viscometers, and portable stoves. The main materials include banana peel extract (from maceration), sodium lauryl sulfate, sodium CMC, cocamide DEA, citric acid, propyl paraben, perfume, and distilled water.

Research Process

1. Banana Peel Extraction

   Banana peel extraction is carried out by selecting good quality banana peels, which are then separated from the fruit. The banana peels are washed thoroughly, mixed with distilled water, and blended until smooth. The mixture is then filtered to separate the pulp from the filtrate, and the filtrate is left to settle for 3–4 days to produce a precipitate. This study used the maceration method, which is a simple extraction method by soaking the powdered simplicia in a suitable solvent without heating.

2. Antidandruff Shampoo Production

   Three different shampoo formulations were used in the shampoo production, namely F1: 10%, F2: 20%, and F3: 30% extract. The formulations were made with the following compositions:

Table 1. Ingredient Composition

No	Ingredient	F1 (10%)	F2 (20%)	F3 (30%)
1	Banana Peel Extract	10 ml	20 ml	30 ml
2	Sodium Lauryl Sulfate	10 ml	10 ml	10 ml
3	Sodium CMC	3 ml	3 ml	3 ml
4	Cocomide DEA	4 ml	4 ml	4 ml
5	Perfume	1 ml	1 ml	1 ml
6	Citric Acid	1 ml	1 ml	1 ml
7	Propyl Paraben	0.3 ml	0.3 ml	0.3 ml
8	Distilled Water	100ml	90 ml	80 ml

The process of making anti-dandruff shampoo begins with preparing all the tools and ingredients, then weighing the sodium CMC and dissolving it in hot water until it expands to form the first mixture (Suryati & M, 2016). Next, 20 ml of distilled water is heated to a temperature of 60–70 °C and placed in a beaker, then sodium lauryl sulfate is added and homogenized to form the second mixture. Propyl paraben is also added to this mixture before homogenizing again. The two mixtures are combined by slowly pouring the second mixture into the first mixture while stirring until evenly mixed. After that, citric acid is added as a pH balancer, then banana peel extract is added according to the formulation (10%, 20%, and 30%) and 2 ml of banana fragrance. All ingredients are stirred until homogeneous, resulting in an anti-dandruff shampoo preparation based on banana peel extract.

3. Anti-Dandruff Shampoo Quality Test

   a. Homogeneity Test

      The level of homogeneity of the shampoo formulation can be seen by letting it sit for 14 days until coarse particles appear in it. If no coarse particles appear, then the homogeneity test of this banana peel extract shampoo shows that the anti-dandruff shampoo formulation is good or has passed the homogeneity test.

b. pH Test

The pH result is close to the skin pH value, which ranges from 4.5 to 6.5. The pH value of shampoo must meet the requirements set out in SNI No. 06-2692-1992, which ranges from 5.0 to 9.0. The higher the concentration, the lower the measured pH value. Therefore, if the pH value of the anti-dandruff shampoo formulation meets the requirements, the formulation is considered to be within the appropriate pH range (Hidayah et al., 2021).

c. Foam Stability Test

Foam stability is defined as the resistance of soap bubbles to maintain their size or the resistance of the film layer of the bubbles to break. After 5 minutes, the foam must be able to retain between 60-70% of its initial volume. It is placed in a graduated cylinder containing 10 ml of distilled water and then covered. The tube is shaken for 20 seconds and the height of the foam formed is measured. The tube is left to stand for 5 minutes, then the height of the foam produced after 5 minutes is measured again. This is then recorded and calculated.

d. Viscosity Test

Viscosity is the resistance of a liquid to flow. Viscosity affects the effectiveness and efficiency of shampoo. The standard viscosity value in SNI is 400-4000 cps so that the shampoo preparation meets the requirements. In this study, the Ostwald viscometer test was used. This test was conducted by placing the preparation in an Ostwald viscometer, then sucking it up with a pipette until it reached the Ostwald viscometer limit mark, then releasing the pipette and immediately calculating the flow time (Benediktus, 2017).

e. **Antibacterial Test**

According to Retnaningsih et al. (2019), the advantage of the well diffusion method is that it is easier to measure the area of the inhibition zone formed because the isolate is active not only on the surface of the agar nutrient but also below. The principle of this method is to make holes in the agar that has been inoculated with bacteria, then drip the solution into the holes that have been made.

Data Analysis

The data analysis technique used in this study was quantitative descriptive analysis by analyzing the data collected from banana peel extraction, shampoo manufacturing, and parameter measurement processes. The data obtained was then compared with the SNI standard for shampoo.

RESULTS AND DISCUSSIONS

Data Description

The overall average test results for anti-dandruff shampoo preparations made from banana peel extract, made with three formulations, are shown in the following table:

Table 3. Overall Test Results

Formulasi	pH test	Homogeneity Test	Foam Height Test	Viscosity Test
F1	5.0	No coarse grains	Foam Height A: 20 mm Foam Height B: 11 mm	540 cPS
F2	5.0	No coarse grains	Foam Height A: 23 mm Foam Height B: 13 mm	573 cPS
F3	5.0	No coarse grains	Foam Height A: 30 mm Foam Height B: 17 mm	589 cPS

Information:
F1: Shampoo preparation with a concentration of 10% F2: Shampoo preparation with a concentration of 20% F3: Shampoo preparation with a concentration of 30%

Hypothesis Testing

Testing of analysis requirements was carried out by testing homogeneous variance to determine whether the data distribution was homogeneous. The homogeneity test was carried out using SPSS version 24 software.

1. Homogeneity Test

Table 4. Homogeneity Test

No	Inhibition Zone Diameter	Level Statistic	df1	df2	Sig.
1	Based on Mean	1.130	2	6	.383
2	Based on Media	1.167	2	6	.373
3	Based on Median and with adjusted df	1.167	2	4.000	.399
4	Based on trimmed mean	1.137	2	6	.381

The hypothesis and basis for the decision-making process for this homogeneity test are as follows:

a. Ho: $\sigma_1^2 = 0.22 = 0.32 = 0.42$ = etc… (The population is identical/homogeneous)

b. H_1: One sign = not applicable (the population is not identical/homogeneous)

The decision-making criterion for rejecting Ho is if the calculated F value is greater than the table F value or the significance value is <0.05. The table above shows that the homogeneity test results for the data have a Sig. value of >0.05, which means H0 is accepted. Therefore, H0, which states that when the formulas are of the same formula, is accepted, then the formulas are homogeneous.

2. Anova test

Table 5. ANOVA test

No	Inhibition Zone Diameter	Sum of Squares	df	Mean Square	F	Sig.
1	Between Groups	76.222	2	38.111	21.438	.002
2	Within Groups	10.667	6	1.778		
3	Total	86.889	8			

The hypothesis and basis for the decision-making process in this ANOVA test are as follows:

a. H0: μα = μ... μn (No Difference in Mean)

b. H_1: μα ≠ μ... μn (There Is a Difference in Mean)

The decision-making criteria to reject Ho are if the calculated F > F table or significance < 0.05.

The table above shows that the ANOVA test results on the data have a Sig. < 0.05, which means H0 is rejected. Therefore, H0 is rejected and H1 is accepted, which states that there is a difference between the three formulas. Based on the ANOVA test, banana peel shampoo has an effect on the inhibition zone. This indicates that all three shampoo formulas have an effect on the antibacterial inhibition zone.

3. Post Hoc Test

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Diamter_Zona_Hambat

	(I) Formula	(J) Formula	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Tukey HSD	F1	F2	-4.667*	1.089	.012	-8.01	-1.33
		F3	-7.000*	1.089	.002	-10.34	-3.66
	F2	F1	4.667*	1.089	.012	1.33	8.01
		F3	-2.333	1.089	.161	-5.67	1.01
	F3	F1	7.000*	1.089	.002	3.66	10.34
		F2	2.333	1.089	.161	-1.01	5.67
Scheffe	F1	F2	-4.667*	1.089	.015	-8.16	-1.18
		F3	-7.000*	1.089	.002	-10.49	-3.51
	F2	F1	4.667*	1.089	.015	1.18	8.16
		F3	-2.333	1.089	.182	-5.82	1.16
	F3	F1	7.000*	1.089	.002	3.51	10.49
		F2	2.333	1.089	.182	-1.16	5.82
Dunnett T3	F1	F2	-4.667	1.202	.101	-11.18	1.85
		F3	-7.000*	1.291	.030	-12.80	-1.20
	F2	F1	4.667	1.202	.101	-1.85	11.18
		F3	-2.333	.667	.084	-5.16	.50
	F3	F1	7.000*	1.291	.030	1.20	12.80
		F2	2.333	.667	.084	-.50	5.16

*. The mean difference is significant at the 0.05 level.

Figure 1. Post Hoc Test

The figure above shows that the results of the post hoc test indicate that F1 and F3 are significant, but F1 and F2 and F2 and F3 are not significant, so the table of homogeneous subsets shows that formulas F2 and F3 are superior to F1.

Homogeneous Subsets

Diamter_Zona_Hambat

	Formula	N	Subset for alpha = 0.05	
			1	2
Tukey HSD[a]	F1	3	11.00	
	F2	3		15.67
	F3	3		18.00
	Sig.		1.000	.161
Duncan[a]	F1	3	11.00	
	F2	3		15.67
	F3	3		18.00
	Sig.		1.000	.076
Scheffe[a]	F1	3	11.00	
	F2	3		15.67
	F3	3		18.00
	Sig.		1.000	.182

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Figure 2. Inhibition Zone Diameter

4. Means Plots

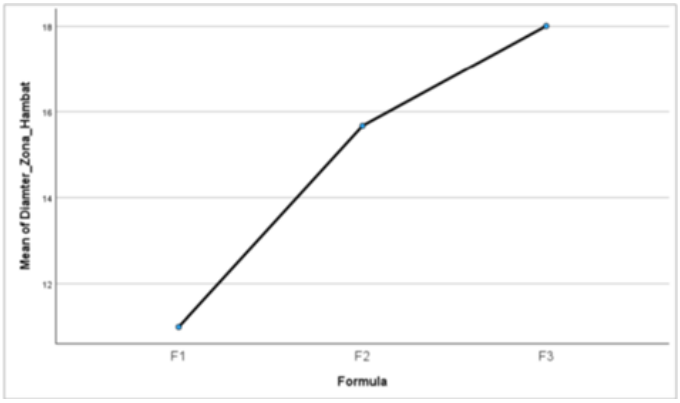

Figure 3. Means Plots Graph

Based on the Means Plot Table, the following is a graphic image of the three formulas.

Discussion of Research Results

1. Making Banana Peel Extract

   This process uses a maceration method to extract the resulting sediment. Maceration is the simplest extraction method, which involves soaking the powdered medicinal plant in a suitable solvent without heating

2. Shampoo Making.

   The shampoo making process begins with the preparation of all the tools and ingredients used, then weighing and dissolving sodium CMC in hot water and letting the solution sit for a few minutes until it expands and the mixture can become the first mixture (Suryati & M, 2016). Then continue by heating 20 ml of water to a temperature of 60-70°C before finally being placed in a beaker glass. After that, add sodium lauryl sulfate and propyl paraben and then homogenize. The mixture will become the second mixture. Mix the two solutions by adding the second solution mixture to the first solution mixture slowly. After the solution has been mixed, add cocamide DEA slowly and continue by adding 1 gram of citric acid and 1 ml of perfume to the beaker

glass and stir well. In this study using banana extract, add banana peel extract according to the desired formulation, namely 10%, 20% and 30%.

Discussion of Research Test Results

The tests conducted included pH, homogeneity, foam height, and viscosity. These tests were conducted to determine whether the shampoo formulation met SNI standards and to determine the best formulation for anti-dandruff shampoo.

1. pH Test Results

Table 6. pH Test Results

No	Formula	pH Test
1	F1	5.0
2	F2	5.0
3	F3	5.5

Description:
F1: Shampoo preparation with a concentration of 10% F2: Shampoo preparation with a concentration of 20% F3: Shampoo preparation with a concentration of 30%

Table 3 shows that the pH of the shampoo formulation yielded good results, at pH 5. The standard pH value for shampoo, as stipulated by SNI 06-2642-1992, is between 5 and 9, while the pH value for the scalp is between 4 and 6. Shampoo products should have a natural pH level similar to the skin's, to avoid allergies and skin irritation (Sulhatun, S. Et al., 2022).

The pH test aims to analyze the safety of the shampoo formulation for human use. The pH of the shampoo formulation must match the general skin pH of 4.5-5.5. A pH that is too high can be harmful to the skin, causing side effects such as burning, irritation, and even scaly skin. The pH value also correlates with the stability of the antioxidants in banana peel extract, thus affecting the preservative properties of the shampoo and the condition of the skin of the users. Therefore, shampoos with a high pH value should not be used because they can risk skin irritation.

Based on the results of the pH test that has been carried out, the results that can be seen on the pH paper, namely: the pH of formulation 1 is 5, the pH of formulation 2 is 5, and the pH of formulation 3 is 5.5. Based on the pH test results obtained, the best formulation is f3 with a pH of 5.5. This is because pH 5.5 is a weak acid. Shampoo is generally alkaline, but shampoo that is weakly acidic is able to eradicate dandruff on the head.

2. Homogeneity Test Results

The results of the homogeneity test on shampoo preparations made with three concentration variations can be seen in the following table:

Table 7. Homogeneity Test Results

No	Formula	Day th-	Presence/absence of coarse grains
		D-0	
1	F1	D-7	There isn't any
		D-14	
		D-0	
2	F2	D-7	There isn't any
		D-14	
		-0	
3	F3	D-7	There isn't any

Information:
F1: Shampoo preparation with a concentration of 10%
F2: Shampoo preparation with a concentration of 20%
F3: Shampoo preparation with a concentration of 30%

The results of the shampoo homogeneity test indicated that all shampoo preparations were homogeneous. The homogeneity of the shampoo preparations was determined by allowing the preparations to stand for a specified period of time until coarse grains appeared. The results of this study indicate that the shampoo produced no negative results in the homogeneity test after 14 days. The shampoo preparation made from banana peel extract also demonstrated that the shampoo formulation met the homogeneity test requirements.

Figure 5. Homogeneous Shampoo Results

3. Foam Height Test

Table 8. Foam Height Test Results

Formulasi	Foam Height A (shaken for 20 seconds)	Foam Height B (shake for 20 seconds and	% let stand for 5 minutes)
F1	20 mm	11 mm	45
F2	23 mm	13 mm	43.47
F3	30 mm	17 mm	43.3

Based on the results of foam height A, shaken for 20 seconds on the shampoo base and anti-dandruff shampoo preparations with concentrations F1, F2, and F3, the results were 20 mm, 23 mm, and 30 mm. Foam height B, shaken for 20 seconds and left for 5 minutes, yielded 11 ml, 13 ml, and 17 ml. Based on the research conducted, the shampoo formulation with the best potential for using banana peels as an anti-dandruff agent is Formulation 3 or F3. This is due to its highest foam height:F3 has a foam height of 30 mm, indicating better cleansing ability.

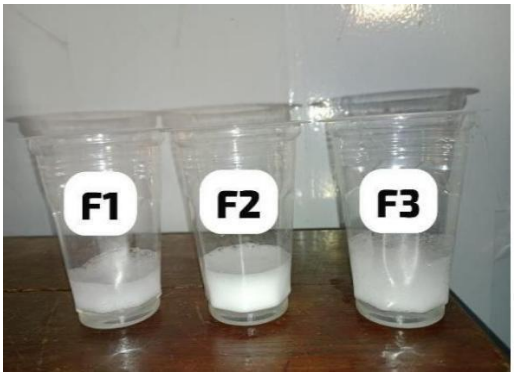

Figure 6.a Foam Height A

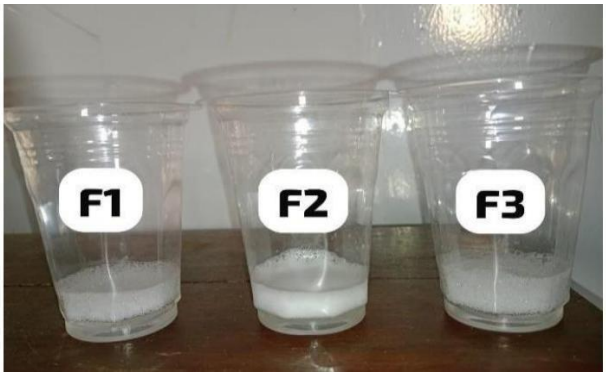

Figure 6.b Foam Height B

4. Viscosity Test

Viscosity test results of banana peel extract anti-dandruff shampoo:

Table 9. Viscosity Test

No	Formula	Viscosity Test (cPS)
1	F1	540
2	F2	573
3	F3	589

This viscosity test shows that the banana peel extract shampoo preparation meets the viscosity requirements for shampoo. The standard value for viscosity testing according to SNI is around 400-4000 cps (Indria, 2019). The viscosity test results for F1, F2, and F3 were 540 cPS, 573 cPS, and 589 cPS. If it spills easily and the rate is fast, the viscosity test results will affect shampoo application (Gina et al., 2020). Based on the research results, the viscosity of F3 has good potential because it has the highest value, namely 589 cPS, which is still within the SNI standard value

Figure 7. Antibacterial Test Results

CONCLUSIONS

Banana peel has potential as a natural ingredient for anti-dandruff shampoo formulations. The antioxidant content in the form of flavonoids in banana peel can help overcome dandruff problems and provide additional benefits for hair health. Flavonoid compounds found in banana peels include catechin, gallocatechin and epicatechin, giving banana peel potential as a source of antioxidants. Shampoo formulations made using banana peel extract showed fairly good results in testing. Testing for pH, homogeneity, foam height, and viscosity met SNI standards. Based on the research conducted, the shampoo formulation with the best potential for utilizing banana peel as an anti-dandruff agent is Formulation 3 or F3. This is because it has the highest foam height: F3 has a foam height of 30 mm. Good viscosity: F3 has a viscosity of 589 cPS, which complies with SNI standards for shampoo. Good homogeneity: F3 does not show any coarse particles for 14 days.

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