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Formulation and Physical Evaluation of Hand Wash Gel Containing Roselle Flower (*Hibiscus sabdariffa* L.) Ethanolic Extract

Formulasi dan Evaluasi Karakteristik Fisik Sabun Cuci Tangan Gel Mengandung Ekstrak Etanol Bunga Rosella (Hibiscus sabdariffa L.)

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ABSTRACT

Background: Hand hygiene is essential for preventing the spread of pathogenic microorganisms. The extensive use of synthetic antibacterial agents, such as triclocarban, in antiseptic soaps may contribute to bacterial resistance, creating a need for safer natural alternatives. Roselle flower (Hibiscus sabdariffa L.) contains flavonoids, phenols, saponins, and tannins with potential antibacterial and antioxidant activities. **Objective:** To formulate and evaluate gel hand soap containing roselle flower ethanol extract that complies with SNI physical quality standards. **Methods:** A laboratory experimental study was conducted using roselle flower ethanol extract at concentrations of FI (8%), FII (10%), and FIII (12%). The formulations were evaluated for organoleptic properties, homogeneity, spreadability, pH, foam height and stability, moisturizing effect, irritation potential, hedonic acceptance, and physical stability using a cycling test. **Results:** All formulations met SNI requirements and there were no significant changes during stability testing. No changes in color, odor, texture, or homogeneity were observed. Spreadability ranged from 6.9 - 7 cm and increased slightly with higher extract concentrations ($p>0.05$). The pH formulas remained stable at 4. Extract concentration significantly affected foam height and foam stability ($p<0.05$).Foam height ranging from 3 - 5 cm. Foam stability decreases with increasing concentration (from 90% to 75%). All formulations increased skin moisture and produced no signs of irritation. The FI (8%) was most preferred by respondens based on its color and texture **Conclusions:** Although all formulas met SNI standards, FI (8%) showed the best performance in terms of foam stability and respondent preference.

INTRODUCTION

Cancer is a disease characterized by Hand hygiene is essential to prevent the transmission of diseases caused by pathogenic microorganisms, as hands frequently act as vectors for bacteria, viruses, and fungi Therefore, antibacterial hand cleansing products are needed to reduce microbial contamination. Hand wash gel is widely used due to its higher viscosity, ease of use, and ability to help maintain skin moisture (Amalia *et al.*, 2024). The increasing demand for effective hand hygiene products has driven the development of antibacterial formulations. Although triclocarban is widely used due to its antibacterial activity, the FDA has raised concerns that its long-term use may contribute to bacterial resistance (Leny *et al.*, 2023). This highlighting the need for safer natural alternatives.

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Roselle flower (*Hibiscus sabdariffa* L.) is a potential substitute due to its phytochemical content, including flavonoids, saponins, tannins, polyphenols, alkaloids, and glycosides, which exhibit antibacterial and antioxidant properties (Karmana, 2023; Namira and Hendradi, 2023). It also contains vitamin C and anthocyanins that help protect the skin from oxidative damage and related skin problems (Siregar *et al.*, 2025). Phytochemical content making it a promising ingredient for natural hand wash formulations.

Previous studies have confirmed the antibacterial and antioxidant activities of roselle flower. Isnaeni, Hendradi and Zettira, (2021) reported that roselle gel in HPMC 6000 base had a MIC of 3% against *Staphylococcus aureus* ATCC 25923. In addition, Agustiarini & Wijaya, (2022) reported a very strong antioxidant activity with an IC_{50} value of 43 µg/mL. These findings support the potential use of roselle flower in gel soap formulation

Although roselle flower extract has antibacterial and antioxidant properties, most studies focus on gels or hand sanitizers. Research on its use in hand wash gel and the effect of concentration on physical quality remains limited. Key parameters such as organoleptic properties, homogeneity, pH, viscosity, spreadability, and foam stability are important for stability and acceptance. Therefore, further studies are needed to evaluate its suitability in hand wash gel formulations at different concentrations

Based on this research gap, the present study aimed to formulate and evaluate the physical quality of gel hand soap containing ethanol extract of roselle flower (*Hibiscus sabdariffa* L.) at various extract concentrations.

MATERIALS

This study employed a laboratory-based experimental design to evaluate the characteristics of hand-wash gel formulations containing roselle flower (*Hibiscus sabdariffa* L.) ethanol extract at concentrations of 8%, 10%, and 12%.

A. Preparation of Roselle Flower Simplicia (*H. sabdariffa* L.)

Roselle flower (*H. sabdariffa* L.) samples were collected from Bengkulu City. Fresh calyces of good quality, characterized by a dark red color, were selected, washed, separated from the seeds, and used for the extraction process.

B. Preparation and Phytochemical Screening of of Ethanol Extract of Roselle Flower (*H.sabdariffa* L.)

Extraction was performed by maceration using 96% ethanol. Fresh 11 kg simplicia was macerated for 5 days, followed by filtration and three times remaceration. The combined filtrate was concentrated using a rotary evaporator, and the extract yield was calculated. Then, the phytochemical content of the extract was examined. The secondary metabolites examined were flavonoids, phenols, tannins, and saponins.

C. Formulation of Roselle Flower Ethanol Extract Gel Hand Soap(*H.sabdariffa* L.)

The Gel Hand Soap was formulated using four variations of roselle flower ethanol extract (*H.sabdariffa* L.) concentrations (Table 1.)

Table 1. Formulation of Gel Hand Soap of Roselle Flower Ethanol Extract

Ingredient	Concentrations % $^{w}/_{w}$				Function	Standart (%)
	F0	FI	FII	FIII		
Roselle flower ethanol extract	0	8	10	12	Active ingredient	-
Hydroxypropyl Methylcellulose (HPMC)	1	1	1	1	Gelling agent	0,25-5,0
Carbopol 940	1,75	1,75	1,75	1,75	Gelling agent	0,5-2,0
Trietanolamin (TEA)	1	1	1	1	Emulsifier	2-4
Sodium lauryl sulfate (SLS)	1	1	1	1	Foaming agent	1
Glycerin	15	15	15	15	Humectant	≤30
Sodium Benzoate	0,1	0,1	0,1	0,1	Preservative	0,1-0,5
Fragrance Oil	Qs	Qs	Qs	Qs	*Coringen Odoris*	-
Aquadest	Ad 100	Ad 100	Ad 100	Ad 100	Solvent	-

D. Preparation Method of Gel Soap Formulation

HPMC and Carbopol 940 were dispersed in hot distilled water to form gel bases. Sodium benzoate and SLS were dissolved in water, while roselle extract was dissolved in glycerin. The gel bases were combined and neutralized with TEA, then mixed with the preservative, SLS solution, and extract solution. Corrigen odoris was added as needed, and distilled water was added to 100 g. The final preparation was evaluated for gel soap quality.

E. Evaluation of Roselle Flower (*H.sabdariffa*

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L.) Ethanol Extract Gel Hand Soap

The physical stability of the gel soap formulations was evaluated using a cycling test. The preparations were alternately stored at 4°C and 40°C for 24 hours each, constituting one cycle, for a total of six cycles. Physical parameters observed included organoleptic properties, homogeneity, pH, foam height and stability, spreadability, irritation potential, and hedonic acceptance (Irawan, Putra and Amirah, 2023).

1. Organoleptic Test

The organoleptic test was carried out through visual observation of the gel soap, including color, form, and aroma of the roselle flower ethanol extract gel soap preparation (*H. sabdariffa* L.).

2. Homogeneity Test

A sample weighing 0.5 g was spread onto an object glass and covered with a cover glass. The preparation was observed for the presence of coarse particles. The preparation was considered homogeneous if the color was evenly distributed and no lumps or coarse particles were present.

3. Spreadability Test

A sample weighing 0.5 g was placed on a glass plate lined with millimeter block paper and covered with another pre-weighed glass plate, then left for 1 minute. The diameter of spread was measured, and additional loads of 50 g were gradually applied to each sample until the total weight reached 150 g. The preparation met the spreadability requirement if the spread diameter ranged from 5 - 7 cm.

4. Foam Height Test

A sample weighing 1 g was mixed with 9 mL of distilled water in a covered measuring cylinder. The mixture was shaken by inverting the test tube for 20 seconds. The height of the formed foam was then measured in centimeters (V0).

5. Foam Stability Test

Foam stability was evaluated by measuring the height of foam formed immediately after shaking (V0). The preparation was allowed to stand for 5 minutes, and the foam height was remeasured (V1). Foam stability was calculated using the following formula:

$$Foam\ Stability\ (\%) = \frac{\text{Foam height after 5 minutes (V1)}}{\text{Initial foam height (V0)}}\ x\ 100\%$$

6. pH Test

pH test done by using Universal pH indicator. The preparation met the pH requirement if the pH ranged from 4 - 8.

7. Irritation Test

The irritation test used an open patch method, applying the preparation to a 2.5 × 2.5 cm area of the inner forearm. Irritation was indicated by the presence of redness, itching, or swelling at the application site (Irawan, Putra and Amirah, 2023).

8. Hedonic Test

The hedonic or preference test was conducted on 20 respondents. Each respondent was asked to assess their preference for the roselle flower ethanol extract hand wash gel preparation using two categories: like (1) and dislike (0), based on aroma, color, and skin feel (Irawan, Putra and Amirah, 2023).

9. Moisture Test

Skin moisture was measured using a Skin Analyzer FCM-1 with categories of dehydration (0 - 29%), normal (30 - 50%), and hydration (51 - 100%). Panelists were instructed to avoid using other topical products on the test area during the study (Firdausi, 2021; Istiharoh, 2022; Irawan, Putra and Amirah, 2023).

A. Preparation and Phytochemical Screening of Roselle Flower (*H. sabdariffa* L.) Ethanol Extract

Extraction was performed by maceration using 96% ethanol, yielding 2.392%. The yield was used to determine the required amount of simplicia for concentrated extract production. Maceration was chosen for its suitability for thermolabile compounds, while ethanol 96% was selected due to its ability to dissolve polar, semipolar, and nonpolar secondary metabolites (Alviola *et al.*, 2023).

The phytochemical screening showed that roselle flower (*H. sabdariffa* L.) contained flavonoids, phenols, tannins, and saponins. Flavonoids possess antioxidant activity by inhibiting ROS formation, neutralizing ROS, and protecting the antioxidant system (Ayu *et al.*,

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2024). Tannins possess antioxidant activity because the hydroxyl (OH) groups in these compounds are able to donate hydrogen atoms to free radicals, thereby stabilizing the radicals (Hasan *et al.*, 2022). Saponins has antioxidant activity because these compounds can scavenge superoxide radicals through the formation of hydroperoxide intermediates, thereby preventing biomolecular damage caused by free radicals (Anggraeni Putri, Chatri and Advinda, 2023).

B. Evaluation of Preparations

After formulation, all gel soap preparations were subjected to a stability test using a cycling method. The results of the observations are described as follows.

1. Organoleptic Test

All formulations were in gel form with a purplish-red color that intensified with increasing extract concentration and had a characteristic aroma (Figure 1)

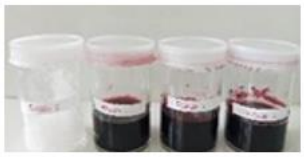

Figure 1. Gel Hand Soap of Roselle Flower (*Hibiscus sabdariffa* L.) Ethanolic Extract.

All formulation showed good stability with no changes in form, color, or odor, meeting organoleptic requirements. Increasing roselle extract concentration increased anthocyanin content, resulting in a darker red color, as anthocyanins are the main pigments in roselle flowers (Nurhayati *et al.*, 2025).

2. Homogeneity Test Results

The homogeneity test showed that all formulations met the homogeneity requirements, where the extract was evenly distributed throughout the gel soap preparation. no coarse particles and phase separation were found in all formulas (Amalia *et al.*, 2024).

3. Spreadability Test Results

The formulation fulfilled the spreadability requirement if the gel spread diameter ranged from 5 - 7 cm (Istiharoh, 2022). The results showed that all formulation (100%) met the requirements for good gel soap spreadability (Table 2).

Table 2. Spreadability Test Results of Roselle Flower Ethanol Extract Gel Soap

Formula	Spreadability (cm)				
	Day 0	Day 1	Day 7	Day 14	Description
F0 (Gel Soap Base)	5.5	5.5	5.8	5.9	Qualified
FI (8% roselle extract)	5.5	5.7	6.3	6.9	Qualified
FII (10% roselle extract)	6.3	6.5	6.7	6.9	Qualified
FIII (12% roselle extract)	6.5	6.8	6.9	7.0	Qualified

No significant differences were observed among FI, FII, and FIII ($p > 0.05$). Increasing extract concentration tended to reduce viscosity and improve spreadability likely due to active compounds that due to active compounds that disrupt the gel structure. (Yardani, Ulimaz and Awalina, 2023). Saponins in roselle extract also act as surfactants, reducing surface tension and gel viscosity, thereby enhancing spreadability on the skin (Suleman *et al.*, 2022)

4. pH Test Results

The results of the study showed that all formulation had the same pH, namely pH 4. There was a decrease in pH in the preparation due to the addition of the extract, where the pH of the gel base (F0) which was originally 5 became 4.. These results indicate that 100% of the gel soap preparations met the SNI standards for gel soap's pH. The pH test ensures compatibility with skin, as overly acidic or alkaline preparations may cause irritation, disrupt the skin barrier and microbiota, and lead to dryness or increased sensitivity (Harsep Rosi *et al.*, 2024).

5. Foam Height Test Results

The results showed that all formulation (100%) met the requirements for good foam height (ranges from 1.3 - 22 cm) (Jumardin, Firdaus and Utari, 2023) (Table 3).

Table 3. Foam Height Test Results of Roselle Flower Ethanol Extract Gel Soap

Formula	Foam Height (cm)				Description
	Day 0	Day 1	Day 7	Day 14	
F0 (Gel Soap Base)	2.5	2.4	2.9	2.9	Qualified
FI (8% roselle extract)	3	3	3	3	Qualified
FII (10% roselle extract)	4	4	4	4	Qualified
FIII (12% roselle extract)	5	5	5	5	Qualified

Sodium Lauryl Sulfate (SLS) acts as a surfactant and foaming agent, reducing surface tension to facilitate the removal of dirt and oil, while enhancing foam formation, cleansing effectiveness, and formulas homogeneity. The formulations produced moderate foam due to

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the low SLS concentration (1%). Foam height increased significantly with increasing roselle extract concentration ($p < 0.05$). Although SLS is commonly used at 1 - 10%, higher concentrations may increase the risk of skin irritation and dryness (Marlina, Kiromah and Rahayu, 2022).

Saponins have natural surfactant properties that reduce water surface tension, promoting foam formation and stability Higher saponin content enhances foam-forming ability; thus, increasing roselle extract concentration resulted in higher foam height (Suleman *et al.*, 2022).

6. Foam Stability Test Results

The results showed that all formulations (100%) met the requirements for good foam stability (≥ 70%) (Jumardin, Firdaus and Utari, 2023) (Table 4).

Table 4. Foam Stability Test Results of Roselle Flower Ethanol Extract Gel Soap

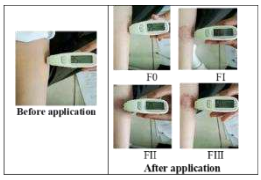
Formula	Foam Stability (%)				Description
	Day 0	Day 1	Day 7	Day 14	
F0 (Gel Soap Base)	96	95	95	95	Qualified
FI (8% roselle extract)	91	90	90	90	Qualified
FII (10% roselle extract)	87	85	85	85	Qualified
FIII (12% roselle extract)	78	75	75	75	Qualified

Foam stability in gel soap is influenced by surfactant concentration, pH, viscosity, and active compounds (Sheng *et al.*, 2021). Roselle contains tannins that can disrupt foam formation by interacting with proteins and surfactants through hydrogen bonding and hydrophobic interactions, weakening the foam film and accelerating bubble collapse. These interactions may also increase viscosity and reduce surfactant efficiency, leading to decreased foam stability with higher extract concentrations (Sepperer *et al.*, 2021).

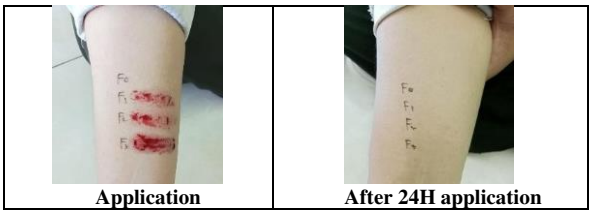
7. Moisture and Iritation Test Results

The Moisturizing ability and irritation tests were conducted on 20 respondens (Ethical Exemption No. KEPK.BKL/178/04/2025). It showed that all formulations improved skin hydration from normal - dry to highly moisturized, with no significant differences among F0, FI, FII, and FIII ($p > 0.05$). Irritation testing showed that all formulations caused no skin irritation and were safe for topical use.

Skin moisture after use may be attributed to humectants and gelling agents in the formulation. Glycerin acts as a humectant that retains water in the skin, improves texture, enhances softness, and reduces SLS-induced irritation (Wulandari, Yamlean and Abdullah, 2023). HPMC and Carbopol also help maintain skin hydration (Pan *et al.*, 2023), while flavonoids and anthocyanins in roselle extract may support skin moisture and provide antioxidant protection (Adinda, Limanan and Ferdinal, 2023; Amalia *et al.*, 2024).



(i)



(i) (ii)

Figure 2. Moisture Test Results (i); Iritation Test Result (ii)

9. Hedonic Test Results

The hedonic test showed that FI (8%) was the most preferred formulation in terms of odor, color, and texture (Figure 3).

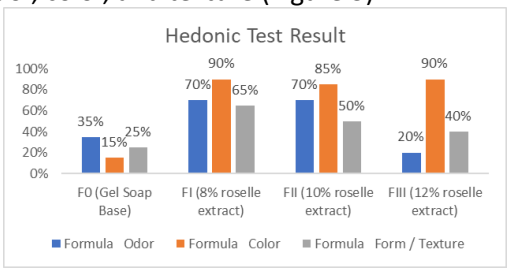


Figure 3. Hedonic Test Results of Roselle Flower Ethanolic Extract Gel Soap

CONCLUSIONS

All formulations met SNI 06-4085-1996 physical quality standards. Increasing extract concentration significantly increased foam height ($p < 0.05$) but reduced foam stability, while spreadability changes were not significant ($p > 0.05$). All formulations maintained a stable pH of 4,

increased skin moisture, and caused no irritation. Among them, the 8% extract formulation (FI) showed the best overall performance in terms of its foam stability and hedonic preference.

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