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Formulation And Evaluation Of Lip Scrub Using Beetroot Extract (*Beta Vulgaris L.)* As A Natural Colorant

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Abstract

Lips are prone to dryness due to the thin stratum corneum layer and environmental exposure, driving the need for natural dyes to replace synthetic carcinogenic risks such as Rhodamine B. This study aims to formulate a lip scrub extract of beetroot (Beta vulgaris L.) at a concentration of 5%, 10%, 15%, measure betacyanin levels, and evaluate physical quality. Quantitative experimental types were conducted at the Duta Bangsa University Laboratory in Surakarta (April-June 2025); beetroot population in Boyolali, tuber samples aged 3-6 months; UV-Vis spectrophotometer instrument, rotary evaporator; SPSS analysis (ANOVA). The results showed a yield of 17.5% of the crude drug, 16.81% of the extract, 1.145 mg/L of betacyanin, good homogeneity, pH 5.33-6.03, no irritation (9 panelists), although the width of 3.75-4.58 cm was suboptimal. Conclusion: the formulation is safe and stable as a natural dye, although pigment stability needs optimization.

Keywords: Betalain, Beet Extract, Lip Scrub, Physical Quality, Natural Color.

INTRODUCTION

Lips are a vital part of the face that plays a crucial role in shaping the overall aesthetic perception. Compared to facial skin, the stratum corneum of the lips is much thinner, consisting of only about 3 to 4 layers, making them vulnerable to external environmental influences such as sun exposure, dehydration, and cosmetic products. Globally, the problem of dry and chapped lips has become increasingly prominent in the past two years, primarily due to climate change and the increased use of decorative cosmetics, with prevalence reaching up to 37.5% in vulnerable groups such as adolescents due to low salivary flow (Farsi, 2020). In Indonesia, this trend is exacerbated by the intense tropical climate, where preliminary studies indicate that 70% of student respondents experience similar conditions, confirming the scientific and practical relevance of natural lip care research for mucosal skin health.

Furthermore, the national context highlights the increasing incidence of dry lips in women, with a study in Sweden reflecting a similar pattern, with 61.2% of cases affecting women, while in Indonesia, dehydration and UV exposure are the main triggers for keratin cell damage. This field phenomenon affects not only aesthetics but also the physiological function of the lips, such as the barrier against infection, with a prevalence of 44.4% in adolescents due to salivary disorders (Farsi, 2020; Nurmala, 2020). Recent empirical data suggests that the lack of natural lip protection contributes to chronic conditions such as cheilitis, which require safe cosmetic interventions to prevent long-term complications.

Previous research has explored lip cosmetic products such as lip balm, lip serum, lip scrub, and lip care to address dryness. Lip scrubs act as exfoliators with fine grains that help exfoliate dead skin and brighten the natural color (Kusniah et al., 2022; Alvi, 2016). By definition, cosmetics are applied to the epidermis, lips, and mucous membranes to cleanse, perfume, or protect the body, with a focus on natural ingredients to reduce irritation (Saputri et al., 2023). The main findings of this study emphasize the effectiveness of lip scrubs in improving lip moisture and color, particularly through their antimicrobial and anticancer natural colorants.

However, there are inconsistencies in previous studies regarding cosmetic dyes; synthetic dyes such as Rhodamine B and Orange K.1 are often detected in lipsticks, are carcinogenic, toxic, and cause irritation and liver damage at high concentrations (Qosim, 2023; Astuty et al., 2025). Meanwhile, lip balm formulations with red beet extract show a proportional red color at concentrations of 5-15%, both homogeneity and pH stability, but lack specific exploration of lip scrubs (Farika et al., 2024). Methodological limitations in these studies include the lack of analysis of betacyanin levels—the main pigments of red beet consisting of betacyanin (purplish red) and betaxanthin (yellow)—and comprehensive physical quality evaluations such as dilatation power and irritation at varying concentrations.

The research gap lies in the lack of lip scrub formulations based on beetroot extract as a safe natural dye, with betacyanin levels and physical quality (organoleptic, pH, homogeneity, broadening power, irritation) tested at concentrations of 5%, 10%, and 15%, which have not been analytically integrated to replace high-risk synthetic dyes (Astuty et al., 2025; Altalia, 2024). This problem statement arises because dependence on potentially carcinogenic synthetic dyes is still high, while natural alternatives such as red beet—rich in betalains with antiviral and anticancer properties—have not been comprehensively evaluated in the context of Indonesian lip scrubs (Victoria et al., 2020).

This study aims to formulate a beetroot extract-based lip scrub, analyze the effect of varying concentrations on color and betacyanin levels, and evaluate overall physical quality. The urgency of this study is driven by the post-pandemic trend of halal and natural cosmetics, where demand for safe products has increased by 30% globally. The novelty lies in the integration of betacyanin testing with irritation testing, which was absent in previous studies. The theoretical contribution enriches the literature on betalain-based cosmetic pharmaceuticals, while the practical contribution provides a safe alternative for industry and consumers, supporting environmentally friendly herbal innovation (Deiwi, 2022).

RESEARCH METHODS

This experimental study aimed to test the effect of varying concentrations of beetroot (*Beta vulgaris L.*) extract on the physical quality of lip scrub, through manipulation of independent variables under controlled conditions (Sugiyono, 2021). A quantitative approach was applied to generate numerical data that could be analyzed statistically, following a pre-post test experimental design with a control group (Creswell & Creswell, 2023). The study was conducted at the Duta Bangsa University Laboratory in Surakarta from April to June 2025, focusing on the formulation and evaluation of the preparation.

The population included fresh beetroots (*Beta vulgaris L.*) from Boyolali Regency, while the samples were 3-6 months old, ready to harvest, selected purposively for homogeneity (Sugiyono, 2021). The independent variable was the concentration of beetroot extract (5%, 10%, 15%), while the dependent variables included betacyanin levels (mg/L), physical qualities (organoleptic, pH, homogeneity, dispersibility, irritation) (Sudaryono et al., 2023). The non-probability sampling technique ensured relevance to the objectives of natural cosmetic formulation.

The main instruments include a UV-Vis spectrophotometer for betacyanin levels, an analytical balance, a rotary evaporator, a hot plate, a mortar, and a universal pH stick, supported by materials such as beetroot extract, BHT, methylparaben, vaseline alba, oleum rosae, cera alba, palm sugar, 96% ethanol, and distilled water (Sari et al., 2023). Instrument validity was verified through laboratory standard calibration, while reliability was retested for measurement accuracy (Emzir, 2022). All instruments meet cosmetic pharmaceutical standards to prevent contamination.

The procedure begins with sample determination at the Hortus Medicus Unit of Dr. Sardjito General Hospital and ethical clearance at Dr. Moewardi General Hospital, followed by preparation of beetroot from Samiran Hamlet, Boyolali (Deiwi et al., 2023). The preparation of the simplicia involves selecting 8 kg of tubers, washing, chopping, sun-drying, grinding (yield calculated:), standardization of water content (<10%) and drying loss () using gravimetry at 105°C (Wijaya, 2022). The extract was prepared via maceration of 300 g of powder with 3 L of 96% ethanol (3×24 hours), evaporation for yield (), similar standardization, ethanol-free test, phytochemical screening (alkaloids, flavonoids, tannins, saponins, terpenoids, steroids), and betacyanin levels by differential pH spectrophotometry (, DF=1, MW=550, =60,000) (Neilvita et al., 2020; Sudirman et al., 2024).$\frac{Berat\ serbuk}{Berat\ simplisia} \times 100\% \frac{Berat\ awal - Berat\ akhir}{Berat\ awal} \times 100\% \frac{Berat\ ekstrak}{Berat\ simplisia\ awal} \times 100\% \Delta A \times DF \times MW/(\varepsilon \times L \times 1000)\varepsilon$

Awalia's modified lip scrub formulation (2021): F1 (5%), F2 (10%), F3 (15%) extract with 40% vaseline, 5% cera alba, 12% oleum ricini, etc.; base melting (60-80°C), homogenization, cooling to 32°C, adding palm sugar and extract. Quality evaluation: organoleptic (five senses), homogeneity (smear on a glass slide), pH (1:100 aquadest solution, range 4.5-6.5), spreadability (1 g between watch glasses, average), irritation (patch test 9 female panelists 20-30 years old, 8 hours of erythema/edema observation) (Ardini, 2021; Imani, 2022). Data were analyzed descriptively (table/narrative) and inferentially via SPSS: ANOVA/Kruskal-Wallis for significant differences between formulations (Sugiyono, 2021).

RESULTS AND DISCUSSION

Sample Collection and Plant Determination

Beetroot (*Beta vulgaris* L.) samples were obtained from Samiran Hamlet, Seilo Village, Boyolali District, Boyolali Regency, Central Java, and used as research test materials. Initial identification was conducted at the Tawangmangu Traditional Health Service Unit to confirm the species identity, with results verifying the sample as *Beta vulgaris* L.

Sample Preparation

A total of 5000 g of *beetroot* (*Beta vulgaris* L.) was wet sorted, peeled, washed, cut, sun-dried for 5 days, mashed with a blender, and sieved using mesh No. 40 to reduce particle size (increase extraction effectiveness). The resulting powdered *simplicia* was 875 g with a yield of 17.5%, meeting the requirements of ≥10% (Ministry of Health of the Republic of Indonesia, 2017).

Standardization of Beetroot Powder (*Beta vulgaris L.*)

Drying Loss of BeetRoot Powder

Table 1. Results of Drying Shrinkage Test of Beetroot Powder (*Beta vulgaris L.)*

Replication	Initial weight (grams)	Final weight (grams)	Drying loss %	Requirements according to(Ministry of Health of the Republic of Indonesia, 2017)	Information
1	2	1.85	7.5	<10%	Memenuhi kondisi
2	2	1.87	6.5	<10%	Memenuhi kondisi
3	2	1.89	5.5	<10%	Memenuhi kondisi
Average			6.5%	<10%	Memenuhi kondisi

The shrinkage test was conducted to determine the maximum limit of moisture loss during the drying process. The shrinkage test requirements for simplicia are less than 10% (Ministry of Health of the Republic of Indonesia, 2017). The result of the shrinkage test on *beetroot* powder was 6.5%, which meets the requirements since it is less than 10%.

Water Content of Beetroot Powder

Beetroot simplicia (2 g each) was weighed, placed into a special plate on the moisture balance, and the tool was prepared and closed. The temperature was set to 105°C, and the process was run for 15 minutes until the tool signaled completion.

The water content test on *beetroot* powder aimed to determine the maximum limit of water content in powdered simplicia. Powder with high water content is prone to fungal and microbial contamination, which can reduce quality. The maximum allowable water content for *simplicia* powder is not more than 10% (Ministry of Health of the Republic of Indonesia, 2022).

The water content of *beetroot* powder was 7.88%, which meets the requirements since it is less than 10% (Ministry of Health of the Republic of Indonesia, 2017). Based on these standards, the powder produced in this research is suitable for the extraction process.

Making Beetroot Extract (*Beta vulgaris L.*)

The *beetroot* extract was prepared using the maceration method. A total of 500 g of *beetroot* (*Beta vulgaris* L.) powder was weighed, placed in a container, and macerated with 5000 mL of 96% ethanol at a 1:10 ratio. The container was closed and left for 3 days, protected from light, with occasional stirring. The mixture was then filtered using flannel cloth until dregs and filtrate were obtained. Re-maceration was performed on the remaining dregs by adding 2500 mL of 96% ethanol and soaking for 2 days with periodic stirring. The *beetroot* maceration was concentrated using a rotary evaporator at 50°C and thickened with a water bath to produce a total extract (Utami et al., 2021).

The obtained *beetroot* extract was dark red to purple with a distinctive *beetroot* aroma. The total extract yield was 77 g, resulting in a yield of 16.81%. Yield is calculated as the ratio of metabolites obtained from the extraction process to the initial weight used. A yield is considered good if it is not less than 10%; thus, the *beetroot* yield meets the requirements (Ministry of Health of the Republic of Indonesia, 2017).

Standardization Test of Beetroot Extract (*Beta vulgaris L.*)

Water content

Beetroot extract (2 g each) was weighed, placed into a special plate on the moisture balance, and the tool was prepared and closed. The temperature was set to 105°C, and the process was run for 15 minutes until the tool signaled completion. Water content meets the requirements for simplicia extract if it is not more than 10% (Ministry of Health of the Republic of Indonesia, 2017).

The water content test result for *beetroot* (*Beta vulgaris* L.) extract was 7.81%, which meets the requirements since it is less than 10% (Ministry of Health of the Republic of Indonesia, 2017). Based on these standards, the extract produced in this research is good and suitable for subsequent research processes.

Drying shrinkage

Table 2. Results of Drying Loss Test of Beetroot Extract (*Beta vulgaris L.)*

Initial weight (grams)	Final weight (grams)	Drying loss (%)	Conditions according to(Ministry of Health of the Republic of Indonesia, 2017)	Information
2	1.88	7%	<10%	Memenuhi kondisi
2	1.88	6%	<10%	Memenuhi kondisi
2	1.87	6.5%	<10%	Memenuhi kondisi
Average		6.5%	<10%	Memenuhi kondisi

The shrinkage test result for *beetroot* (*Beta vulgaris* L.) extract was 6.5%. According to the maximum limit set for traditional medicines, shrinkage should not exceed 10% (Ministry of Health of the Republic of Indonesia, 2017). Thus, the *beetroot* extract meets the standardization standards based on the shrinkage criteria.

Ethanol free

The ethanol residue test aimed to ensure the extract was free from ethanol contamination, yielding a pure extract. This test was conducted using the esterification method by adding acetic acid (CH_3COOH) and sulfuric acid (H_2SO_4) to the *beetroot* extract, followed by heating.

The ethanol residue test on *beetroot* (*Beta vulgaris* L.) extract showed negative results, indicating the extract was free from ethanol. This was confirmed by the absence of the distinctive ester aroma of ethanol.

Phytochemical Screening

Table 3. Phytochemical Screening Results of Beetroot Extract (*Beta vulgaris L.*)

Compound	Reagent	Positive Signs(Utami et al., 2021)	Observation result	Information
Alkaloid	Mayer	There is white sediment	There is white sediment	(+) positive
	Dragendroof	There is a reddish-brown sediment	There is an orange precipitate	(+) positive
Flavonoid	Mg powder + concentrated HCl	Red color formed	Red color formed	(+) positive
Tannin	$FeCl_3$	A brown color appearsgreen/blue toblackish	Turned brownish green	(+) positive
Saponin	Aquadest	Terbefor stable foam	Terbefor stable foam	(+) positive
Steroid	H_2SO_4+ acetic anhydride	Blue/green color change	Teget green colorblue	(+) positive

Alkaloid is a natural compound with basic properties, containing heterocyclic rings and nitrogen atoms. For the test, 2 mL HCl and 9 mL *aquadest* were added, then heated for 2 minutes. Acid addition was performed because *alkaloids* have basic properties, making them more soluble in acidic conditions. In the Mayer's reagent test, a yellow to white precipitate formed. This indicates *alkaloid* reaction with potassium ions (K^+) from potassium tetraiodomercurate (II), forming a potassium *alkaloid* complex precipitate (Putra et al., 2023).

Flavonoid testing was conducted with concentrated hydrochloric acid (HCl) reaction. Concentrated HCl addition functions to form flavilium salts, marked by red color change. The test result shows that the *beetroot* ethanol extract gives a positive reaction to *flavonoid* content (Hanani et al., 2018).

Tannin is a polar compound containing the –OH group. The *tannin* test uses $FeCl_3$ reaction to detect Fe^{3+} presence, marked by blackish-blue or green color change upon reagent addition. This shows complex formation between *tannins* and Fe^{3+} ions (Farida & Suyanto, 2021).

Saponin test is for active compounds characterized by foaming ability. The *saponin* test result was positive due to stable foam ≥1 cm height after shaking with distilled water. Stable foam formation is caused by glycosides capable of producing foam in water through hydrolysis into glucose and other compounds (Farida & Suyanto, 2021).

Steroid and *terpenoid* test results on *beetroot* extract show solution color change to blue-green. This change indicates steroid compounds undergoing oxidation to form conjugated double bonds (Farida & Suyanto, 2021).

Betacyanin Level Test

Preparation of buffer solutions pH 1.0 and pH 4.5

Betacyanins are pigments belonging to the *betalain* group. *Betacyanins* is soluble in water and function of it like natural color with high antioxidant activity. In this research, measuring the level of *betacyanins* in *beetroot* extract is done by using spectrophotometry UV-Vis method with pH difference using a buffer pH 1.0 and pH 4.5. This was chosen because *betacyanins* is stable in acidic conditions (pH low), so depending on the pH higher pigmentation in color experiencing degradation.

Measurement of betacyanin levels

Based on the results of the calculation using pH difference method, obtained value of absorbance difference as big as 0.025 between pH 1 and pH 4.5 solutions. With the PE factor 5 times, molecular *betacyanins* as big as 550 g/mol, coefficient molar absorptivity 60,000 L/mol.cm, and the length of the cuvette 1 cm, level *betacyanins* in sample is calculated as big as 1.15 mg/L. This value shows that content *betacyanins* in extract amount low, which can be seen influence on level to pure extract, process processing, as well as to pigment stabilizer to pH and light conditions.

Table 4. Results of Betacyanin Content Test of Beetroot Extract (*Beta vulgaris L.)*

pH Absorbance Difference	Results
0.025	1.145 mg/L
0.025	1.145 mg/L
0.025	1.145 mg/L

Results of the measuring shows the existence of absorbance difference as big as 0.025 which is used in calculation produce high levels of *betacyanins* as big as 1.145 mg/L. this value is categorized low when compared to with in another literature, where the content *betacyanins* in *beetroot* can reach 25-79 mg/100 g, even up to more than 200mg/100g depending on the variety bag, plant age, and environmental conditions. Low level of *betacyanins* in this research to possible influenced by process extraction and handling. *Betacyanins* is very sensitive to temperature, light, oxygen, pH value neutral to alkaline (Neiva et al., 2020).

Preparation Evaluation Test

Organoleptic test

Organoleptic observation is done in visual way observe visual way include color, odor, and taste texture seen on *lip scrub*. Good seen must shows aroma, color and color texture that flat. Regarding each formula different influenced by concentration *beetroot* extract used. The higher the concentration *beetroot* extract is used then increasingly the resulting color. *Organoleptic test* is used by using the five elements cover color, form, and smell so as not to get too leak on one observation. Data from the results of *organoleptic testing* on *lip scrub* can be seen in the table 5.

Table 5. Organoleptic test results of lip scrub preparations

Formula	Smell	Color	Texture
F0	Typical	Light brown	Not too rough
F1	Typical	Brown	Not too rough
F2	Typical	Reddish brown	Not too rough
F3	Typical	Reddish brown	Not too rough

Based on the results of the literature, organoleptic observation toward *Lip Scrub beetroot* extract (*Beta vulgaris* L.) shows that each formula have a color that is good, even though the aroma produced is the same. Different color on the each *lip scrub* formulation is caused by variation of the number of *beetroot* extract used. Even though like that, the aroma of each formulation the same too, namely the typical aroma pineapple essence. More and more added *beetroot* extract, semakin gelap warna yang dihasilkan . This test aim for color value, texture and aroma of *lip scrub*, up to three formulations different can be considered stable in organoleptic testing.

However, the color that is good for not reach category pure extract. Color change become darker this condition is caused by pigment instability properties *betacyanins* who contained in beet tubers. Pigment this is known sensitive to environmental factors and temperature long process made by seen, where heat exposure during mix can trigger pigment degradation that result in *peonidin* derivatives color less natural (Farika et al., 2024).

Even though become internal change color, aroma of each formulation but the same, namely the distinctive aroma of pineapple juice. This test aim for color value, texture and aroma of *lip scrub*, until show to formulation decay to three different can be considered have characteristic organoleptic stable physically.

Homogeneity Test

Results of the homogeneity test toward *Lip Scrub beetroot* extract with microscope can seen on the object glass can be seen in attachment 9. Homogeneous examination unity from to four *lip scrub* formulas shows that all formula have homogeneous properties marked with particle distribution that average in each observation. *Homogeneity test results lip scrub* can be seen in the table 6.

Table 6. Results of the homogeneity test of the Lip Scrub preparation

Formula	Result description
F0	Homogeneous
F1	Homogeneous
F2	Homogeneous
F3	Homogeneous

Homogeneous examination unity from to four *lip scrub* formulas shows that all formula have homogeneous properties marked with particle distribution that average in each observation. This is show the resulting homogeneous seen on to four seen. There is different on the literature because homogeneity test *Lip Scrub* show less homogeneous results on F1 and F3 (Awalia Sarningsih, 2021).

pH test

The *pH* test is carried out to determine adjustments and ensure the safety of the *lip scrub* preparation against the skin of the lips, preventing dryness or irritation. The standard *pH* of the skin of the lips is 4.5 – 6.5, measured using a *pH meter* that has been calibrated. The test is conducted by taking 1 gram of the sample and dissolving it in 100 ml of distilled water, after which the *pH* testing is performed using a *pH meter*. Results of the *pH test* for the *lip scrub* can be seen in Table 7.

Table 7. Results of pH Test of Lip Scrub Preparations

Formulation	I	II	III	Average	Information
F0	5.38	5.47	5.35	5.4	Meet
F1	5.42	5.55	5.68	4.55	Meet
F2	6.23	5.93	5.95	6.03	Meet
F3	5.29	5.37	5.38	5.34	Meet
Average				5.33	Meet

The *pH* testing is carried out with the aim of knowing what the *pH* value is and whether it is already in accordance with the standard, so that the resulting *lip scrub* does not cause skin irritation. The *pH* level that is good for *lip scrub* preparations is generally around 4.5–6.5. The product formulated with *color beetroot* extract on four formulas showed an average *pH* of 5.4–6.03. The results show that three formulas meet the criteria that were shown, with the same *pH* range suitable, namely 4.5–6.5 (Ardini, 2021).

Data of the *pH test* of *lip scrub* preparations using *beetroot* extract (*Beta vulgaris* L.) as natural color, analyzed using SPSS covering *normality*, *homogeneity*, and continued with *One-Way ANOVA*. Results of data analysis using *Shapiro–Wilk* (since the data are less than 50) show that the *pH* data have a significance value, namely F0 = (0.463), F1 = (1.000), F2 = (0.114), and F3 = (0.194), where the significance value ≥0.05 means that the variation of data in this research follows a *normal distribution*. *Homogeneity* test shows the significance value of 0.173, where the results >0.05, which means the variation of data in this literature is *homogeneous*. *One-Way ANOVA* result shows a significance value of 0.000, where the results <0.05, which means the variance of the data in this research has a significant difference.

Spread Power Test

The spreadability test is carried out to measure how much force is needed for the lip scrub to spread when applied to the lip surface. It is expected that the lip scrub can spread properly without difficulty in use, so that the lip area exposed to the lip scrub becomes wider. The following are the results of the spreadability test of the lip scrub bar made from beetroot extract (*Beta vulgaris* L.) which can be seen in Table 8.

Table 8. Results of the Spreadability Test of the Lip Scrub Preparation

Formulation	I (cm)	II (cm)	III (cm)	Average
F0	3.72	3.76	3.79	3.75
F1	3.99	4.02	4.03	4.01
F2	3.88	3.91	3.93	3.90
F3	4.56	4.58	4.61	4.58

The spreadability test on the lip scrub obtained an average result of 3.75–4.58 cm. The lip scrub is said to be easy to use if its spreadability is about 5–7 cm. Based on the results of the spreadability test, it is concluded that each formula has poor spreadability. This result is the same as the results of previous research that tested lip scrub preparations with spreadability results of 4 cm in all formulations (Awalia Sarningsih, 2021).

The spreadability test data of the lip scrub bar containing beetroot extract (*Beta vulgaris* L.) were analyzed using the SPSS application, including normality and homogeneity tests, and continued with One Way ANNOVA. The results of the data analysis using Shapiro-Wilk, because the data were less than 50, showed that the spreadability data had significance values of F0 = (0.843), F1 = (0.463), F2 = (0.780), and F3 = (0.780), where the significance values were >0.05, meaning that the data variation in this research was normally distributed. The homogeneity test showed a significance value of 0.863, where the result was >0.05, which means that the data variation in this research was homogeneous. The results of the One Way ANNOVA showed a significance value of 0.000, where the result was <0.05, which means that there was a significant difference in the data variation in this research.

Irritation Test of Lip Scrub Preparation

The irritation test is said to be good if the preparation applied to the skin does not cause signs of irritation such as redness, itching, or swelling. The irritation test was carried out to determine the presence of irritation effects on the skin and to evaluate and characterize the characteristics of a substance when exposed to the skin. The signs that generally appear on the skin are redness, itching, and swelling. The results of the irritation test on the lip scrub can be seen in Table 9.

Table 9. Results of Irritation Test of Lip Scrub Preparations

Formula	Reaction	Number of Panelists	Information
F0	Redness, Itching, and Swelling	- - -	No irritation observed
F1	Redness, Itching, and Swelling	- - -	No irritation observed
F2	Redness, Itching, and Swelling	- - -	No irritation observed
F3	Redness, Itching, and Swelling	- - -	No irritation observed

The results of the irritation test conducted on 9 panelists by applying the lip scrub preparation to the lower skin area for 8 hours showed that no panelist experienced signs of irritation such as redness, itching, or swelling. The selection of the lower skin area was carried out because the skin in that area is thinner and more sensitive, so it is considered the most representative for showing the characteristics of the lip mucosa and making irritation observation easier.

Based on these results, it can be concluded that the lip scrub formulations (F0, F1, F2, and F3) are safe to use on the skin and do not cause irritation. These results meet the irritation test requirements in the literature (Awalia Sarningsih, 2021). The absence of this irritation effect is caused by the lip scrub preparation having a pH in the range of 4.5–6.5, which is within the physiological pH range of the lip skin, so it does not disturb the acid mantle balance of the skin. In addition, the beetroot extract used is made from natural ingredients (food grade), which have a good toxicity profile and are safe to apply topically, compared with synthetic colorants which are more at risk of triggering sensitivity.

CONCLUSION

This study successfully formulated a lip scrub based on beetroot (*Beta vulgaris L.)* extract with concentrations of 5%, 10%, and 15%, which met overall physical quality standards. Key findings included a yield of 17.5% of the crude drug and 16.81% of the extract, a betacyanin content of 1.145 mg/L, perfect homogeneity, pH 5.33-6.03 (lip range 4.5-6.5), and no irritation in 9 panelists; although the average width of 3.75-4.58 cm was less than optimal (<5 cm), the natural dye produced a proportional reddish-brown color without significant degradation. ANOVA analysis confirmed significant differences between formulations in pH and width ($p<0.05$), confirming the effectiveness of betalain as a substitute for synthetic dyes with carcinogenic risks such as Rhodamine B.

Limitations of this study include the relatively low betacyanin content due to the pigment's sensitivity to heat and light during maceration, as well as suboptimal broadening power, which may require additional stabilizers. Further long-term stability and panelist hedonic testing have also not been conducted. Suggestions for further research include optimizing cryogenic extraction for higher betalains, microbiological testing, and 3-month stability. The practical implication is that this formula is ready to be developed by the Indonesian halal cosmetics industry as a safe alternative, supporting the post-pandemic herbal trend with export potential.

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