

Formulation of Lip Balm Extract from Red Spinach Leaves (*Amaranthus tricolor* L.)

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A B S T R A C T

Background: Red spinach leaves (*Amaranthus tricolor* L.) are known to contain natural pigments as well as antioxidant compounds such as betacyanin, carotenoids, vitamin C, flavonoids, and polyphenols that have the potential to be utilized in topical cosmetic products, one of which is lip balm that has a wide usage, particularly among women due to its important function in caring for and maintaining lip health. **Objective:** This study aims to formulate and evaluate a lip balm formulation with the addition of red spinach leaf extract. **Sample:** The research sample consists of ethanol extract of red spinach leaves (*Amaranthus tricolor* L.). **Method:** The extraction process was carried out using a soaking method with 70% ethanol, then formulated into three concentration levels, namely 3% (F1), 5% (F2), and 7% (F3). The evaluation of the formulation includes several parameters, such as sensory evaluation, uniformity, application ability, spreadability, pH, skin irritation test, and preference test. **Results:** All formulas show a typical olive green color, but F2 and F3 exhibit non-homogeneity due to the precipitation of active ingredients. The spreading power of all formulas is within the ideal range of 3–5 cm, with pH values between 6.49 and 6.64, which are still suitable for topical use. All preparations do not cause irritation to the skin. Based on the preference test results, F1 is the most preferred formula in terms of color, aroma, and moisture produced. **Conclusion:** It can be concluded that F1 (3%) is declared the best formula based on physical and sensory parameters.

INTRODUCTION

Cosmetics are products specifically designed for use on the external areas of the human body. Their application includes the outer layers of skin tissue, hair strands, nail layers, and external genital mucosa. Additionally, cosmetics can also be applied to teeth and oral mucous membranes. Their purposes include cleansing, imparting a pleasant fragrance, enhancing appearance, eliminating unpleasant odors, and protecting and maintaining the body to keep it in a healthy and good condition (BPOM RI, 2019). As part of the face, lips play an important role in supporting aesthetic aspects. The structure of the lips, which is thinner than other parts of the skin, makes them more susceptible to environmental factors and the use of certain care products. This can cause the lips to lose moisture, become chapped, dull, and even cause pain and discomfort. To address these issues, a product that can protect and care for the condition of the lips is needed, one of which is lip balm (Yuliasri et al., 2023). Moisture is an important aspect in maintaining lip health, as dryness and chapping can cause irritation and increase the risk of infection. Therefore, the use of lip balm is necessary to keep lips smooth, supple, and well hydrated (Muthi'ah et al., 2024).

Lip balm is a cosmetic product with widespread use, particularly among women. Unlike other makeup products, lip balm is primarily used to maintain lip health, specifically by retaining moisture and protecting against dryness (Yuliatika et al., 2023). In addition to its role in maintaining moisture and lip health, some lip balm products are also developed with added colorants. The long-term use of synthetic colorants has the potential to cause side effects on the skin, thereby increasing interest in safer and more body-friendly natural colorants (Rahmatunnisa et al., 2022).

Red spinach (*Amaranthus tricolor* L.) is among the plants rich in nutrients and bioactive compounds, such as iron, calcium, vitamins A and C, as well as protein and anthocyanins that serve as antioxidants (Daud et al., 2021). The betacyanin content in red spinach leaves also has potential as a natural dye in cosmetic products (Cahya et al., 2021). This plant is widely cultivated due to its nutritional benefits and antioxidant content (Isrul et al., 2020), including compounds such as betalains, carotenoids, vitamin C, flavonoids, and polyphenols (Wiyasihati & Wigati, 2016).

Based on several studies, red spinach leaf extract has been proven effective as an active ingredient in lip cosmetics, such as lip cream (Abadi et al., 2023) and lipstick (Cahyani, 2018). The uniqueness of this study lies in the use of red spinach leaves originating from the Batauga District, South Buton Regency, which have different phytochemical content due to geographical influences (Afida et al., 2020).

This research was conducted with the aim of designing a lip balm formulation with the addition of red spinach leaf extract as the active ingredient while also evaluating its quality.

METHODOLOGY

Time and Place of Research

This research was conducted from April to June 2025 at the Pharmacy Laboratory of Baubau Polytechnic.

Tools and Materials

The tools used include a Bunsen burner, stirring rods, blender, porcelain dish, funnel, gegep, beakers, graduated cylinder, watch glass, tripod stand, wire gauze, parchment paper, filter paper, labels, ruler, pH meter, dropper pipette, lip balm container, rotary evaporator, horn spoon, analytical balance, glass jar, extract container.

The materials used include aquadest, BHT, cera alba, extract of red spinach leaves (*Amaranthus tricolor* L.), strawberry essence, ethanol, glycerin, nipagin, nipasol, vaseline album.

Research Procedure

Preparation of Simplisia

This research uses a sample of red spinach leaves (*Amaranthus tricolor* L.) taken from a region in the Batauga District, with the collection time between 08:00 and 10:00 WITA. The preparation of the simplicia powder is done by preparing 2 kg of fresh leaves, followed by a wet sorting process, washing, and cutting. The leaves are then dried under sunlight covered with black cloth, followed by a dry sorting process. Once dry, the leaves are ground using a blender, sifted until fine powder is obtained, and then stored in a tightly closed container (Kiko et al., 2023).

Production of Red Spinach Leaf Extract

A total of 200 grams of powder from red spinach leaves was extracted using the soaking method with 70% ethanol at a ratio of 1:10 for three times 24 hours in a glass jar at room temperature, being stirred occasionally to ensure optimal extraction. After the extraction period was completed, the mixture was filtered to separate the filtrate from the residue. The remaining residue was then re-extracted using the same method as the initial step to maximize the extraction yield. The filtrate obtained from the filtering was then evaporated using a rotary evaporator until a thick extract was produced (Cahyani et al., 2024).

Lip Balm Formulation

The formulation process of lip balm was carried out in three formulation variations, namely F1, F2, and F3 (Table 1.), with each formula containing red spinach leaf extract at concentrations of 3%, 5%, and 7%. The making of the lip balm began by melting white soft paraffin and beeswax in a porcelain cup until they melted and became homogeneous, forming mixture A. Separately, mixture B was prepared consisting of nipagin (methyl paraben), nipasol (propyl paraben), BHT, and glycerin. Mixture B was stirred until homogenized, then added to mixture A while still in a liquid state, continuously stirred until thoroughly mixed. After the mixture cooled down, red spinach leaf extract and strawberry essence were added as needed and stirred until evenly distributed. The final mixture was poured into the lip balm container and allowed to set until solidified at room temperature (Ambarsari et al., 2024).

Table 1. Formulation of Lip Balm from Red Amaranth Leaf Extract (*Amaranthus tricolor* L.) (Ambarsari et al., 2024)

No.	Ingredients	Formulation Concentration (%)			Usefulness
		F1	F2	F3	
1.	Red spinach leaf extract	3%	5%	7%	Active ingredient
2.	Glycerin	8%	8%	8%	Humectant
3.	Cera Alba (<i>Beeswax</i>)	15%	15%	15%	Emollient
4.	Nipagin (<i>Methyl Paraben</i>)	0,15%	0,15%	0,15%	Preservative
5.	Nipasol (<i>Propyl Paraben</i>)	0,05%	0,05%	0,05%	Preservative
6.	BHT	0,02%	0,02%	0,02%	Antioxidant
7.	Vaseline Album	Ad 5 g	Ad 5 g	Ad 5 g	Base
8.	<i>Essence Strawberry</i>	q.s	q.s	q.s	Perfume

Physical Evaluation Test of Lip Balm Preparations

Organoleptic Test

The organoleptic test begins with preparing each formula of the lip balm produced. Next, the physical characteristics of the product are observed, including aspects of color, aroma, and shape, and the results of the observations obtained are recorded (Arisanty et al., 2021).

Homogeneity Test

The uniformity test begins with preparing each formulated lip balm preparation. Next, samples are applied in a specified amount on the clear glass surface, and the observations are recorded (Supartiningsih et al., 2021).

Test of Spread Ability

To evaluate the spreading ability, the lip balm is tested by applying it to the surface of the back of the hand. Then the results of the application on the back of the hand are observed. The spreading test is intended to assess the ability of the formulation to spread on the skin surface. A formulation is considered good if it remains adhered and appears shiny on the skin after 15 minutes (Endriyatno et al., 2024).

Spread Test

The procedure for testing the spreadability begins with weighing 0.5 grams of lip balm, then placing it in the center of a watch glass. The surface is covered with another watch glass and weighted down with 200 grams. After being left for 1 minute, the diameter of the lip balm spread is measured. This test is used to determine how far the preparation can spread on the skin during use (Putri et al., 2025).

pH Test

pH measurement is performed to ensure that the formulation is suitable and safe for use, especially when applied to the lip area, which is a relatively thin mucous membrane of the body. The pH test is conducted by calibrating the pH meter before use. A 1% sample solution is created by dissolving 1 gram of the formulation in hot aquadest until the volume reaches 100 ml, then allowed to cool to room temperature. The pH meter electrode is then fully immersed in the test liquid and allowed to sit for a while until the device displays the pH value, then record the pH result (Arisanty et al., 2021).

Irritation Test

Irritation testing of the formulation was conducted on 5 respondents to determine the presence or absence of skin irritation reactions after using the formulation (Diba et al., 2023). The irritation test was carried out to evaluate whether the obtained product is safe or potentially causes negative effects on the skin, by applying lip balm to the skin surface, then letting it sit for half an hour, and observing the possibility of irritation reactions such as a burning sensation, itching, or pain (Fauziah, 2021). If the results do not indicate any skin irritation reactions, then it is continued by applying the lip balm to the lips and letting it sit for 15-30 minutes, then observing the reactions that occur.

The irritation test results are evaluated descriptively based on skin reaction scoring criteria in accordance with OECD Test Guideline No. 404, using a scoring scale from 0 to 4 (0 = no irritation, 1 = mild irritation, 2 = moderate irritation, 3 = severe irritation, and 4 = very severe irritation). These criteria are used to classify the severity of irritation based on the symptoms that appear (Organisation for Economic Co-operation and Development, 2015).

Preference Test

A preference test was conducted on 5 panelists to determine the most favored formulation among several formulations that had been created, by providing three formulations with different concentrations to each panelist, who were then asked to evaluate each lip balm formulation and determine and judge which formulation they considered most preferred or superior according to them (Fauziah, 2021). The panelists rated each formulation using a scale of 1 to 5, where 1 indicates dislike, 2 somewhat like, 3 neutral, 4 like, and 5 very much like. The assessment was conducted through filling out a questionnaire that included several sensory aspects, namely application practicality (texture), novelty (aroma), visual color, and moist feeling after use (Tampubolon, 2023).

RESULTS & DISCUSSION

The production of lip balm begins with the collection of red spinach leaf samples in the morning, around 08:00-10:00, when the water content in the plant tissue is not too high and the active compounds are still stable. A total of 2 kg of fresh leaves are collected, then rinsed with flowing water to remove dirt and dust. After that, the samples are cut into smaller pieces to accelerate the drying process. The drying process is carried out by sun-drying the simplicia in a place exposed to sunlight, covered with

black cloth to prevent damage to the bioactive compounds due to excessive light and heat exposure. This is then followed by grinding the dried simplicia using a blender until a fine powder of dried simplicia is obtained, ready for the extraction stage.

The extraction of red spinach leaves in this study was carried out using the soaking method with 70% ethanol. The reason for using this method is based on its simplicity and its ability to help the solvent penetrate the cell walls of the plant and dissolve bioactive compounds without causing damage to their chemical structure (Siska et al., 2024). 70% ethanol was chosen because it is effective in dissolving compounds with low to moderate polarity, so various secondary metabolites can be well extracted (Sarni et al., 2020). The maceration process was performed at room temperature for 3 days, after which the results were filtered and then evaporated using a rotary evaporator until a thick extract was obtained that is ready to be formulated.

The yield of the extract is one of the important indicators in assessing the efficiency of the extraction process. Based on the results obtained, the maceration extraction process using 70% ethanol produced a concentrated extract of red spinach leaves with a yield value of 13% (Table 2.). This figure indicates that from 200.7 grams of dried simplicia used, 26.1 grams of concentrated extract was obtained. A yield value of 13% is considered quite good and indicates that the solvent used is effective in dissolving bioactive compounds such as betacyanin, flavonoids, and vitamin C found in red spinach leaves.

Table 2. Results of the presentation of the yield of red spinach leaf extract (*Amaranthus tricolor* L.)

Sample Weight	Weight of Red Spinach Leaf Extract	Yield
200,7 g	26,1 g	13%

Source: Primary data, 2025

The development of lip balm products with the addition of red spinach leaf extract (*Amaranthus tricolor* L.) was carried out in three formulas, namely F1, F2, and F3, with different extract concentrations of 3%, 5%, and 7% respectively. The manufacturing process began with the collection of plant samples, followed by the stages of making dried simplicia and concentrated extract. After the extract was obtained, the formulation process of the lip balm preparation was carried out. The visualization of the final results of the lip balm preparation formulation with red spinach leaf extract can be seen in Figure 1.



Figure 1. Red Spinach Leaf Extract Lip Balm Preparation

Table 3. Results of Organoleptic Testing of Lip Balm Preparations

Formulation	Organoleptic test		
	Color	Aroma	Shape
F1	Pale olive green with a yellowish tint	The distinctive aroma of strawberries	Semi solid
F2	Natural olive green	The distinctive aroma of strawberries	Semi solid
F3	Dark olive brown	The distinctive aroma of strawberries	Semi solid

Source: Primary data, 2025

The organoleptic examination of the lip balm formulation was conducted to assess the physical characteristics of the lip balm such as color, aroma, and shape (Arisanty et al., 2021). According to Table 3. the findings from the organoleptic test, all three formulations (F1, F2, and F3) showed differences in color ranging from pale yellowish olive green to dark brownish olive green due to differences in the concentration of red spinach leaf extract. However, the color produced does not yet meet the initial expectation, which is a purplish red color, characteristic of the betacyanin pigment found in red spinach leaves. On the contrary, the extract actually showed a color change to green, indicating degradation or damage to the betacyanin pigment structure during the extraction process. This change

is likely caused by the oxidation of active compounds due to exposure to light and air, as well as the solvent's pH not being within the stable range for betacyanin. A study by Putri et al., (2025) explains that the stability of betacyanin pigments is greatly influenced by environmental factors such as light exposure, unsuitable pH (optimal pH 3-7), and open extraction conditions. These factors can accelerate the degradation of betacyanin pigments and significantly reduce the antioxidant activity of plant extracts (Putri et al., 2025). Research by Kuncoro et al., (2022) also shows that betacyanin pigments are most stable at a pH of around 5 and at room temperature (29-31°C). Storing in closed containers can reduce damage caused by oxygen compared to open containers. The decrease in betacyanin content occurs more rapidly at high temperatures and in storage conditions exposed to oxygen, leading to color changes in the extract (Kuncoro et al., 2022). This becomes a drawback in formulations, as visual color is one of the important indicators in the appeal of cosmetic products, especially for lip preparations.

Table 4. Results of Lip Balm Preparation Homogeneity Test

Formulation	Homogeneity	Results	Standard
F1	Homogeneous	Eligible	Homogeneous
F2	Not homogeneous	Not eligible	
F3	Not homogeneous	Not eligible	

Source: Primary data, 2025

The lip balm preparation is declared homogeneous if all components contained in the lip balm formulation are evenly mixed and show results without any coarse particles when applied on a transparent glass (Supartiningsih et al., 2021). The presence of coarse texture grains indicates that the lip balm is not homogeneous. In this study, the results of the homogeneity test (Table 4.) on the lip balm preparation of red spinach leaf extract with concentrations of 3%, 5%, and 7% showed that formulation F1 was homogeneous because there were no coarse particles, while formulations F2 and F3 were not homogeneous as their active ingredients precipitated and did not mix evenly. The heterogeneity observed in the preparations is likely due to the lack of initial treatment of the extract, such as the addition of additional solvents or cosolvents that function to enhance the solubility and dispersion of the extract in the lip balm base. Plant extracts, especially those that are polar or semi-polar, generally have low solubility in fatty bases or oils, so that without solvent modification, the extract will not mix properly in the system. As a result, there is precipitation of active ingredients which causes the preparation to become non-homogeneous. This is in line with research conducted by Prisukarno et al., (2018) which shows that the use of co-solvents such as propylene glycol effectively increases the solubility of extracts, so that extracts are evenly dispersed in the formulation and reduce phase separation, resulting in a more homogeneous and stable preparation (Prisukarno et al., 2018).

Table 5. Results of Lip Balm Spreadability Test

Formulation	Spreadability	Results	Standard
F1	Easy to apply and spreads evenly	Eligible	Easy to apply and spreads evenly
F2	Easy to apply and spreads evenly	Eligible	
F3	Easy to apply and spreads evenly	Eligible	

Source: Primary data, 2025

Spreadability testing was conducted to assess the spreadability of lip balm preparations when applied to the skin surface (Endriyatno et al., 2024). The results of the spreadability test, as shown in Table 5. indicate that all three formulas (F1, F2, and F3) exhibit good spreadability, characterized by ease of application and minimal residual stickiness.

Table 6. Results of Lip Balm Preparation Spreadability Test

Formulation	Spread (cm)	Results	Standard
F1	3,8 cm	Eligible	3-5 cm
F2	3,3 cm	Eligible	
F3	3,5 cm	Eligible	

Source: Primary data, 2025

Based on Table 6. the results of the spreadability test measurements indicate that all formulations exhibit spreadability within an acceptable range, specifically between 3.3 cm and 3.8 cm, under a standard load of 200 grams. In general, all three formulations still meet the ideal spreadability standard for lip balm formulations, which ranges from 3 cm to 5 cm (Risnayanti et al., 2022). Optimal spreadability is important to ensure the formulation can be evenly distributed on the lip surface without requiring strong pressure, thereby enhancing user comfort.

Table 7. pH Test Results for Lip Balm Preparations

Formulation	pH	Results	Standard
F1	6,64	Eligible	4,5-7
F2	6,49	Eligible	
F3	6,59	Eligible	

Source: Primary data, 2025

pH testing aims to determine the acidity or alkalinity (Sarni et al., 2023) of lip balm preparations to ensure their safety when applied to the lips (Arisanty et al., 2021). A pH level that is too acidic or too alkaline may cause irritation or discomfort, so it is important for the formulation to be within the physiological pH range of the skin, which is approximately 4.5 to 7.0. According to the measurement data in Table 7, formulation F1 has a pH of 6.64, F2 has a pH of 6.49, and F3 has a pH of 6.59. All these pH values are still within the safe range and meet the standards for topical use on the lips. This aligns with Leana and Savitri (2022), who state that safe and suitable lip balm formulations should have a pH ranging from 4.5 to 7.0 to avoid causing irritation or discomfort on the lip skin (Leana & Savitri, 2022). This pH value, which is slightly closer to neutral, offers the advantage of comfort in use, as it does not cause a stinging sensation or irritative reactions on sensitive lips. Thus, it was found that all the lip balm formulations tested meet the suitability criteria in terms of pH.

Table 8. Lip Balm Preparation Irritation Test Results

Respondents	Scores			Observation Period	Remarks
	F1	F2	F3		
R1	0	0	0	30 minutes	No irritation
R2	0	0	0	30 minutes	No irritation
R3	0	0	0	30 minutes	No irritation
R4	0	0	0	30 minutes	No irritation
R5	0	0	0	30 minutes	No irritation

Source: Primary data, 2025

Irritation tests were conducted to assess the safety of using lip balm formulations on the skin. In this study, 3 lip balm formulations were tested on 5 panelists through topical application for 15-30 minutes using a rating scale from 0 to 4 (0 = no irritation, 1 = mild irritation, 2 = moderate irritation, 3 = severe irritation, and 4 = very severe irritation). The observation results in Table 8. prove that there were no indications of irritation, such as rash (erythema) or swelling (edema), on all panelists for the three formulations tested. This indicates that the formulations did not produce irritation reactions based on OECD criteria (2015), which state that the absence of redness or swelling symptoms is classified as a score of 0 or no irritation (Organisation for Economic Co-operation and Development, 2015).

Table 9. Lip Balm Preparation Preference Test Results

Formulation	Texture	Aroma	Color	Moisture
F1	4,4	4,6	4	4,6
F2	4,4	4	3,6	4,4
F3	4,4	3,8	2,4	4,6

Source: Processed data, 2025

Based on Table 9. the results of the preference test conducted by five panelists using a rating scale of 1 to 5 (1 = dislike, 2 = dislike, 3 = neutral, 4 = like, and 5 = very like) show that formulation F1 obtained the highest average score for the aroma parameter at 4.6, color at 4.0, and moisture at 4.6. Meanwhile, for the texture parameter, all formulations received similar average scores of 4.4, indicating consistent comfort of use across all formulations. This statement aligns with Tampubolon's (2023) opinion that preference tests are important to assess consumer acceptance of a product, especially regarding sensory characteristics such as texture, aroma, color, and moisture (Tampubolon, 2023). Thus, it can be concluded that formulation F1, a lip balm with red spinach leaf extract (3%), is the formulation that received the highest level of preference from the panelists. This finding indicates that the

combination of active ingredients used in F1 is able to provide a pleasant aroma and color, as well as optimal moisture for users.

CONCLUSION

Based on the research results, the extract of red spinach leaves (*Amaranthus tricolor* L.) has been proven to be formulated into lip balm preparations. The evaluation results show that all lip balm formulas with the addition of red spinach leaf extract (*Amaranthus tricolor* L.) meet good criteria in terms of spreadability, pH, and do not cause skin irritation. Among the three formulas, F1 (3%) is the best formula because it shows good homogeneity and received the highest preference rating from the panelists. However, this formula still has limitations in terms of color, which does not match the expected characteristics of the formulation, as well as the lack of homogeneity in formulas F2 and F3 due to the sedimentation of active ingredients.

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