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Formulation of Lip Balm Extract of Temu Mangga Rhizome (*Curcuma mangga* Val) as Moisturizer

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Abstract

Background*: Lip balm moisturizes the lips and can be made from natural ingredients such as mango rhizome extract (Curcuma mangga Val), which is rich in antioxidants.* ***Objective:*** *This study aims to evaluate the formulation of lip balm with varying concentrations of mango rhizome extract and determine its optimal concentration.* ***Methods:*** *The research employs a qualitative and quantitative approach using 1 Kg of mango rhizome simplisia from Southeast Sulawesi. The lip balm formulations include extract concentrations of 0%, 5%, 10%, and 15%, involving ingredients such as mango rhizome extract, cera alba, olive oil, glycerin, BHT, nipasol, strawberry essence, D & C Red 6, and vaseline album. Evaluation was conducted through organoleptic tests, pH, homogeneity, adhesion, spreadability, melting point, cycling test, moisture, irritation, and panelist preference. All formulations demonstrated stability in color, texture, and aroma at room temperature and during the cycling test. Consistency, homogeneity, and pH of all formulas remained stable.* ***Results:*** *Spreadability and adhesion improved with the concentration of the extract, with Formula F3 (15% extract) showing the best results, including an increased melting point indicating thermal stability. All formulas were safe and did not cause irritation. Preference tests indicated that F3 was preferred for moisture, while F1 and F2 were favored for aroma and color.* ***Conclusion:*** *The mango rhizome extract lip balm is stable, safe, and effective as a lip moisturizer, with Formula F3 being the most effective. Future research is expected to develop other formulations from mango rhizome to enhance moisturizing effects while maintaining the stability of the preparation.*

Keywords*: lip balm, mango rhizome extract (curcuma mangga val), lip moisturizer, stability*

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INTRODUCTION

The development of cosmetics in the modern era has become a daily necessity for people to enhance their appearance. The use of cosmetics serves not only beauty but also health (Tranggono, 2007). Cosmetics are substances applied to the outer parts of the human body, such as the skin, hair, nails, lips, and external genital organs, as well as the teeth and mucous membranes of the mouth. They are primarily intended to cleanse, improve body odor, protect, or care for the body. Skin care cosmetic products, or skincare, are utilized to cleanse the skin (cleanser), moisturize the skin (moisturizer), and protect the skin (sunscreen) (Pusmarani, 2023).

Lips are a part of the body that need protection to maintain moisture. Lips do not have sweat glands or hair follicles, and they possess a thinner stratum corneum (Rasyadi et al., 2022). Damage to the lips can also be caused by exposure to UV rays from the sun, which harm the keratin cells in the lips that serve to protect them. When keratin cells are damaged, the lips may peel, appearing chapped, dry, and dull in color. Additionally, chapped lips can cause pain, appear less attractive, and make the skin of the lips even more unhealthy (Ambari et al., 2020).

Lip balm is a product that is applied to the lips that serves as a moisturizer by forming a protective layer of unmixed oil on the surface. The primary purpose of using lip balm is to enhance lip moisture (Kase et al., 2023). While the use of lip balm has become a lifestyle choice for many, it has also evolved into a necessity. However, numerous manufacturers incorporate hazardous chemicals as fundamental components of lip balm, which can irritate the lips and undermine the very purpose of the product. These synthetic ingredients may lead to side effects and even compromise the natural shape of the lips (Tampubolon, 2023).

Natural ingredients offer a safe alternative for formulating lip balm. One such ingredient is the rhizome of temu mangga (Curcuma mangga Val). This rhizome is rich in compounds such as curcumin, flavonoids, polyphenols, and p-hydroxycinnamic acid. The presence of flavonoids and curcumin in temu mangga is believed to be closely associated with its antioxdant activity (Zulkarnain et al., 2023). These antioxidants can help address lip issues by delaying or inhibiting the oxidation reactions of free radicals, which can lead to cellular damage (Erwan et al., 2022).

Research conducted by Susiloningrum and Mugita Sari (2021) evaluated the antioxdant activity and total flavonoid content in *temu mangga* rhizomes, with optimal results achieved using a 96% ethanol solvent. Under these conditions, the flavonoid content was measured at 10.22 ± 0.11%, and the IC50 value was determined to be 75.06 ppm, indicating strong antioxidant activity. According to Zulkarnain (2023), temu mangga rhizomes are rich in flavonoids and curcumin, both of which exhibit antioxidant properties.

Pujimulyani (2020) stated that *temu mangga* rhizome can reduce oxidative stress caused by excessive exposure to free radicals and disruptions in the antioxdant system, which can accelerate the aging process. Additionally, *temu mangga* rhizome extract can also protect collagen from degradation and inhibit the activity of pro-inflammatory enzymes such as MMP1, MMP3, and MMP13. Furthermore, it helps maintain the health of human skin fibroblast cells that have been induced by free radicals, serving as a model for cellular aging.

In this study, the concentrations of *temu mangga* rhizome extract to be used in the lip balm preparation were 5%, 10%, and 15%. Based on research by Susiloningrum and Mugita Sari (2021), the cream preparation with a combination of temu mangga rhizome and zinc oxide showed the best results at a concentration of 5%. Additionally, Zulkarnain et al. (2023) found that a concentration of 10% also produced favorable outcomes, while Widyastuti (2017) reported that a concentration of 15% achieved optimal results in the formulation. Based on the background provided, the researcher is interested in conducting a study entitled "Lip Balm Formulation of Mango Ginger Rhizome Extract (*Curcuma mangga Val*) as a Lip Moisturizer. a lip balm using mango ginger rhizome extract and to compare different concentrations to determine which formulation exhibits the best characteristics.

MATERIALS AND METHODS

Materials

The materials used in this study included turmeric extract, 96% alcohol (Brataco), ammonia (Mitra Muda Berkah), BHT (Advent), magnesium metal powder (Mitra Muda Berkah), cera alba (Making Cosmetic), Cl 15850, strawberry essence (Spectra), $FeCl_3$, glycerin (Palapa Muda Perkasa), HCl (Supelco), H_2SO_4 (Supelco), chloroform (Mitra Muda Berkah), nipasol (Mitra Muda Berkah), Mayer's reagent, Wagner's reagent, Dragendorf, and Vaseline album (Brataco), olive oil (NHR), and aquadest.

Tools

The tools utilized in this study included a stirring rod (Pyrex), glass beaker (Pyrex), porcelain cup (Pyrex), measuring cup (Pyrex), hand scoop (latex examination), hot plate (IKA C-MAG HS 7), watch glass (Pyrex),

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object glass (Pyrex), filter cloth, oven (Memmert), universal pH meter (Nesco), dropper pipette (Pyrex), rotary evaporator (Stuart), skin moisture analyzer, test tube (Pyrex), and digital scales (Ohaus).

Method

Sampling

The samples used in this study were mango ginger rhizomes (Curcuma mangga Val) that were ready for harvest. These samples were obtained from Penanggo Jaya Village in the Lambandia District of East Kolaka Regency, Southeast Sulawesi.

Sample determination

The plant specimens were identified at Mandala Waluya University in Kendari. The purpose of this identification is to verify the authenticity of the samples used in the study. Plant identification is conducted by comparing the morphological characteristics of the specimens with descriptions found in existing literature (Ekayani et al., 2021).

Sample processing

The temu mangga rhizome samples were sorted to remove impurities, washed, and cut into pieces. They were then dried in the sun until completely dry, crushed using a blender, and sieved with a 60 mesh sieve to produce temu mangga powder (Bintoro et al., 2017).

Sample extraction

Extraction of temu mangga rhizome employing the maceration method involves soaking. Temu mangga powder is placed in a dark container, and 96% ethanol is added until the simplicia is fully submerged. The simplicia is stirred evenly, and then the vessel is tightly sealed. The maceration process is conducted for 3 x 24 hours, replacing the solvent daily and stirring several times, keeping it in a location protected from sunlight. The resulting macerate is filtered using filter paper with the assistance of a vacuum pump to separate it from the filtrate. The resulting filtrate is evaporated with a rotary evaporator at a temperature of 40°C to produce a thick extract (Ambari et al., 2020).

Phytochemical screening of mango rhizome extract (*Curcuma mangga* Val)

Alkaloid testing

A weighing 4 g was combined with an adequate amount of chloroform. Subsequently, 10 mL of ammonia was added, and the solution was filtered. The filtrate was then transferred to an Erlenmeyer flask, followed by the addition of 10 drops of 2 N H2SO4. The mixture was shaken gently and allowed to sit until two distinct layers formed. The upper layer was carefully transferred to a test tube. The solution was then tested with Mayer, Wagner, and Dragendorff reagents. The formation of a precipitate indicates the presence of alkaloids: Meyer's reagent produces a white precipitate, Wagner's reagent yields a brown precipitate, and Dragendorff's reagent results in an orange precipitate (Rahmi et al., 2021).

Flavonoid test

The flavonoid test was conducted using 0.5 g of extract, to which 5 mL of ethanol was added. The mixture was then heated for approximately 5 minutes, after which 10 drops of concentrated hydrochloric acid (HCl) and 0.2 grams of magnesium powder were introduced. The formation of a reddish-black, yellow, or orange color indicates a positive result for flavonoids (Septia Ningsih et al., 2020).

Phenol test

The phenol test was conducted by adding 0.5 g of the extract to 3-4 drops of FeCl3. A color change from bluish black to dark black indicates the presence of phenolic compounds (Septia Ningsih et al., 2020).

Saponin test

A total of 0.5 grams of extract was placed into a test tube, followed by the addition of 10 mL of previously heated distilled water. The mixture was shaken vigorously for approximately one minute. It was then allowed to sit for 10 minutes, during which the formation of foam was observed, indicating a positive result for saponins (Septia Ningsih et al., 2020).

Tannin test

The tannin test was conducted by adding 0.5 grams of extract to 10 mL of hot water, followed by with the addition of 1% FeCl3. The formation of a blackish-green color indicates the presence of tannins (Septia Ningsih et al., 2020).

Steroid and terpenoid testing

A total of 0.5 g of extract was placed into a test tube, followed by the addition of 2 mL of concentrated H2SO4. The solution was gently shaken and allowed to sit for a few minutes. A blue to green color indicates a positive result for steroids, while a brownish red to purple color indicates a positive result for terpenoids (Septia Ningsih et al., 2020).

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Table 1. Formula design of lip balm extract from mango ginger rhizome (*Curcuma mangga* Val)

Material	Function	F0	F1	F2	F3
Mango ginger rhizome extract	Active Substance	0%	5%	10%	15%
Glycerin	Humectant	8%	8%	8%	8%
Cera alba	Stiffening agent	15%	15%	15%	15%
Olive Oil	Oil	5%	5%	5%	5%
Nipasol	Preservative	0.2%	0.2%	0.2%	0.2%
BHT	Antioxidant	0.05%	0.05%	0.05%	0.05%
Strawberry Essence	Fragrance	1%	1%	1%	1%
Cl 15850	Coloring	0.5%	0.5%	0.5%	0.5%
Vaseline album	Mass gainer/Base	ad 100%	ad 100%	ad 100%	ad 100%

Making lip balm preparations from mango ginger rhizome extract (*Curcuma mangga* Val.)

Melt the base of Vaseline, cera alba, and olive oil at a temperature of 60-65˚C (Mixture A). In a separate container, mix Nipasol, BHT, and glycerin to create Mixture B. Gradually incorporate Mixture A into Mixture B while continuously stirring at a temperature of 50-55°C. Once the mixture is not too hot, add strawberry essence and CI 15850. While stirring, incorporate the extract of mango ginger (Curcuma mangga Val). Pour the mixture into a mold that has been coated with glycerin. Allow it to set at room temperature (Sholehah et al., 2022).

Physical evaluation of mango turmeric extract lip balm

Organoleptic test

Organoleptic testing utilizes human senses as the primary means of assessing the acceptability of a preparation. The types of tests conducted include evaluations of color, taste, smell, and shape (Ambari et al., 2020).

pH Test

The pH measurement was conducted using a Universal pH Indicator tool, with each formula replicated three times. The Universal pH Indicator was immersed in the lip balm preparation and allowed to sit for a few seconds. Subsequently, the color on the paper was compared to the comparator provided on the packaging. The pH of the lip balm preparation ranged from 4.5 to 6.5 (Ambari et al., 2020).

Homogeneity test

Each lip balm preparation containing the active ingredient, temu mangga rhizome extract, was evaluated for homogeneity by applying 1 gram of the formulation to a glass surface. The coarse particles were then assessed by touch, ensuring that the preparation exhibited a homogeneous composition with no visible coarse grains are visible (Ministry of Health of the Republic of Indonesia, 2020).

Spreadability test

A sample of lip balm weighing 0.5 grams was placed on a spreadability tester, which consisted of a glass plate with a scale paper base. The sample was covered with a previously weighed glass plate and allowed to rest for 1 minute. The diameter of the lip balm spread was measured from various angles, and the average was calculated. This process was repeated three times, with incremental loads added periodically (50 g, 100 g, 150 g, 200 g) (Ambari et al., 2020). Good spreadability for lip balm preparations is between 3 and5 cm (Pawestri et al., 2024).

Adhesive power test

The lip balm preparation sample was weighed to a mass of 0.25 grams and then placed on a glass object. Two glass objects were joined together until they were united. A load of 1 kg was applied for 5 minutes, after which it was removed. Subsequently, a load of 80 grams was applied, and the time was recorded until the two glass objects were separated. This procedure was replicated three times (Ambari et al., 2020). A good adhesive power is defined as lasting more than 4 seconds (Pawestri, et al 2024).

Melting point test

The method for determining the melting point of lip balm involves placing the lip balm in an oven set to an initial temperature of 50°C for 15 minutes to observe whether it melts. After this initial period, the temperature is increased by 1°C every 15 minutes, and observations are made to identify the temperature at which the lip balm begins to melt. The melting point specifications for lip balm are based on SNI 5769-1998, which stipulates a range of 50-70°C, with the experiment being replicated three times under the same conditions. According to Pertiwi (2020), a quality lip balm should haves a melting point above 50°C (Tampubolon, 2023).

Stability test (cycling test)

The cycling stability test evaluates the stability of the preparation by storing it at specific temperatures and

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humidity levels over designated intervals. The temperature storage is conducted at 4°C and 40°C for 24 hours (one cycle), with three replicates for each condition. The test is performed for a total of six cycles, and each cycle is monitored for physical changes (Abdul et al., 2022)

Moisture test

This test involved 20 panelists, divided into four groups. Five researchers utilized formula 0, while five panelists each used formulas F1, F2, and F3. The moisture test for the lip balm preparation was conducted by applying the product to the panelists' lower arms every morning and evening. This test was carried out for 12 days, with measurements taken daily. Observations of the results were made by directly assessing physical changes and measuring skin moisture with a skin moisture analyzer. The skin moisture analyzer (U-trac Model: CR-302) employs sensor technology to gauge the skin's moisture levels. It analyzes the skin's ability to conduct electrical signals, which are then processed to determine whether the skin is dry, normal, or hydrated. The measurement results are presented in numerical form or as graphs, indicating the percentage of skin moisture (Imani, 2022).

Irritation test of preparations

The technique employed in this irritation test is an open patch test conducted on the inner lower arm of 20 panelists who have provided written consent. The open patch test involves applying the preparation to a designated area (2.5 x 2.5 cm) and leaving it uncovered to observe any reactions (ethical clearance 004/KEP/UMW/II/2024). This test is performed three times a day over two consecutive days (Ambari et al., 2020). The inclusion criteria for the irritation test are as follows: female participants aged 20 to 30 years, who are physically and mentally healthy, have no history of allergic diseases, and have expressed their willingness to participate. The preparation is deemed acceptable if the researcher does not observe any irritation reactions, such as erythema, papules, vesicles, or edema (Sariwating and Wass, 2020).

Preference test (hedonic test)

The preference test was conducted visually with 20 panelists. Each panelist was instructed to apply the prepared formula to the skin on their wrist. Subsequently, the panelists selected the formula variation they preferred the most. They rated their preferences using a scale: 1 for strong dislike, 2 for dislike, 3 for like, and 4 for strong like. Panelists completed the provided questionnaire, which assessed observation parameters in the preference test, including ease of application (texture), aroma, color, and the level of moisture felt on the skin (Tampubolon, 2023).

RESULTS AND DISCUSSION

This study commenced with the collection and processing of 1,000 grams of temu mangga (Curcuma mangga Val) rhizome samples from Penanggo Jaya Village, Lambandia District, East Kolaka Regency, Southeast Sulawesi. The initial procedure involved wet cleaning to eliminate dirt from the rhizomes, followed by cutting to reduce the sample size for easier drying. The samples were then sun-dried using a black cloth until completely dry, after which they were crushed using a blender. The identity of this plant was verified at the Pharmacognosy-Phytochemistry Laboratory of Mandala Waluya University in Kendari, confirming it as the Curcuma mangga Val species.

Rhizome extraction is performed using the maceration method, which involves soaking powdered simplicia in a solvent. This method was selected for its simplicity and its ability to preserve thermolabile compounds. Ethanol is utilized as the solvent due to its universal, polar nature and its availability (Asworo and Widwiastuti, 2023). A 96% ethanol solution was chosen for its selective properties, non-toxicity, effective absorption, and high extraction capacity, enabling it to extract non-polar, semi-polar, and polar compounds (Wendersteyt et al., 2021).

The ginger mango rhizome powder is placed in a dark container, and 96% ethanol is added until the herbal material is fully submerged. The mixture is stirred thoroughly, and the vessel is sealed tightly. The maceration process is conducted for three days, with periodic stirring, and is kept in a location protected from sunlight. Stirring is intended to facilitate a more rapid equilibrium of the extracted material's concentration in the solvent. Subsequently, the initial brown macerate is filtered. The residue is then soaked again in the solvent during the remaceration process, which involves adding fresh solvent to the remaining herbal material to optimize the extraction of active compounds. Remaceration continues until a clear-colored macerate is obtained, indicating that no more soluble compounds remain (Alviola Bani et al., 2023).

After the maceration process, the filtrate was separated using a vacuum pump to eliminate any remaining liquid. Subsequently, the filtrate was evaporated with a rotary evaporator at a temperature of 40°C to prevent damage to the compounds from

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excessive heat, while also concentrating the extract and removing 96% ethanol solvent from the rhizome of temu mangga (Curcuma mangga Val) through the principle of solvent evaporation. The concentration process continued until a constant weight was achieved over three days (Ambari et al., 2020).

The yield of *temu mangga* rhizome extract was measured at 11.21%, as presented in Table 2. This extract is characterized by its brown color, thick consistency, distinctive odor, and bitter taste. The yield exceeds the minimum requirement of 10.7% set by the Indonesian Ministry of Health (2017). Table 3 displays the results of the phytochemical screening, indicating that the temu mangga rhizome extract contains various compounds. The extract also yielded positive results for several phytochemical constituents: flavonoids (indicated by a reddish-black color when treated with HCl and Mg), phenols (dark red color with FeCl3), saponins (stable foam formation with hot distilled water), tannins (blackish-green color with 1% FeCl3), and terpenoids (brownish-red color with concentrated H2SO4) (Septia Ningsih et al., 2020).

Based on the standard formula proposed by Sholehah et al. (2022), the lip balm formulation incorporating ethanol extract of temu mangga rhizome was modified to enhance physical stability and moisturizing properties, attributed to its antioxidant content. This formulation includes ethanol extract of temu mangga rhizome at concentrations of 5%, 10%, and 15%, along with additional ingredients such as cera alba (15%), glycerin (8%), olive oil (5%), nipasol (0.2%), BHT (0.05%), strawberry essence (1%), Cl 15850 dye (0.5%), and vaseline album, totaling 100%. Cera alba is utilized to improve consistency at a concentration of 15%, glycerin serves as a humectant at 8%, olive oil acts as an oil base at 5%, nipasol functions as a preservative at 0.2%, BHT is included as an antioxidant at 0.05%, strawberry essence provides fragrance at 1%, and Cl 15850 dye (D&C Red 6) is used at 0.5%. Vaseline album is incorporated as a fat base, with a total weight of up to 5 grams.

A physical stability evaluation was conducted on days 0, 7, 14, 21, and 28 at room temperature. The evaluation included a Cycling Test consisting of 6 cycles to assess the stability of the lip balm. Various parameters were examined, including organoleptic properties, homogeneity, pH, spreadability, adhesion, melting temperature, humidity, irritation, and preference tests (hedonic).

The room temperature stability test and temperature cycle test are crucial for ensuring the stability and effectiveness of mango ginger rhizome extract lip balm. The room temperature stability test evaluates the performance of the lip balm at ambient conditions, confirming that there are no changes in color, texture, or efficacy. In contrast, the temperature cycle test simulates extreme temperature fluctuations to verify that the quality of the lip balm is preserved during storage. Both tests are essential for ensuring that the lip balm retains its optimal moisturizing benefits as a lip moisturizer under various conditions (Pertiwi and Unggul, 2023).

Table 2. Results of extraction of mango ginger rhizome (*Curcuma mangga* val)

Solvent	Powder Weight(gram)	Extract Color	Extract Weight (gram)	% Yield
Etanol 96 %	1000	Brown	112.1	11.21

Table 3. Phytochemical screening results

No	Type of testing	Reagen	Result	Information
1	Alkaloid Test	Mayer	No sediment	(-)
		Dragendoff	There is orange sediment	(+)
		Wagner	There is brown sediment	(+)
2	Flavonoid Test	Concentrated HCl and Powder Mg	Blackish red color	(+)
3	Fenol Test	$FeCl_3$	Dark black color	(+)
4	Tanin Test	$FeCl_3$ 1%	Greenish black color	(+)
5	Saponin Test	Aquadest Hot	Forms a stable foam	(+)
6	Triterpenoid Test	H_2SO_4 Pekat	Brownish red color	(+)

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The organoleptic test revealed that F0 (without extract) was pink, F1 was pink, F2 was red, and F3 was brick red. After 4 weeks, there was no change in shape, color, or aroma, indicating the stability of the preparation. Organoleptic testing during the Cycling Test showed that the F0, F1, F2, and F3 preparations maintained their original color, with no change before and after the Cycling Test. The correlation between the results of room temperature storage and the Cycling Test indicated that the preparation exhibited high stability against various environmental conditions. Thus, the resulting lip balm demonstrates good quality and can be relied upon during storage and use.

The observation results regarding the consistency of all lip balm formulas indicate that all samples have a soft texture, making them easy to apply to the lips. This softness is attributed to the use of a cera alba base, which is one of the components in oil-in-water (o/w) preparations, ensuring ease of application, good spreadability on the skin, and a soft texture. Additionally, the inclusion of Vaseline album as a mass enhancer and softener further contributes to the softness and ease of application of the product (Sholehah et al., 2022).

The homogeneity test was conducted by applying 1 gram of the preparation to a glass object, demonstrating that all formulas (F0, F1, F2, F3) did not contain coarse grains for 28 days, both before and after storage, indicating good homogeneity (Ambari et al., 2020). Homogeneity testing during the Cycling Test also revealed no changes in all preparations. This is attributed to the method of making lip balm, which employs a melting technique where the ingredients are heated until completely melted to ensure a homogeneous mixture (Desnita et al., 2022). Research by Nurul Afriyanti Yusuf (2019) also indicated that the use of cera alba base in lip balm formulations produced good homogeneity, confirming that the cera alba base influences the homogeneity of the preparation (Sholehah et al., 2022).

The pH test was conducted using universal pH paper. The results of the test, shown in Table 4, indicate that preparations F0, F1, F2, and F3 maintained a pH of 5 for 28 days, both before and after storage. The pH cycling test of lip balm preparations F0, F1, F2, and F3 also showed a pH of 5 before and after the cycling test. This indicates a stable pH, meeting the requirements for a good lip balm pH, which is 4.5-6.5 according to Tranggono (2007).

Based on the results of the spreadability test of the lip balm preparation using the ethanol extract of temu mangga rhizome (*Curcuma mangga* Val), there was an increase in spreadability over 28 days. The F0 preparation increased from 3.39 cm to 3.72 cm; F1 went from 3.35 cm to 3.75 cm; F2 rose from 3.31 cm to 3.48 cm; and F3 improved from 3.38 cm to 3.50 cm. In the cycling test for spreadability, results were gathered for all formulations (F0-F3). Formulation F0 (without temu mangga rhizome) exhibited the smallest increase, from 3.51 ± 0.21 cm to 3.59 ± 0.09 cm. Meanwhile, formulation F1, which contains 5% temu mangga rhizome, showed a more significant increase, rising from 3.53 ± 0.20 cm to 3.79 ± 0.19 cm. Formulations F2 (10%) and F3 (15%) also demonstrated an increase in spreadability. This increase suggests that higher extract concentrations enhance the stability of spreadability (Pawestri et al., 2024).

Table 4. Organoleptic examination

Preparation	Inspection	Day-to-Day Observations				
		0	**7**	**14**	**21**	**28**
F0 (0%)	Color	Pink	Pink	Pink	Pink	Pink
F1 (5%)		Pink	Pink	Pink	Pink	Pink
F2 (10%)		Red	Red	Red	Red	Red
F3 (15%)		Brick red	Brick red	Brick red	Brick red	Brick red
F0 (0%)	Aroma	Strawberry	Strawberry	Strawberry	Strawberry	Strawberry
F1 (5%)		Strawberry	Strawberry	Strawberry	Strawberry	Strawberry
F2 (10%)		Strawberry	Strawberry	Strawberry	Strawberry	Strawberry
F3 (15%)		Strawberry	Strawberry	Strawberry	Strawberry	Strawberry
F0 (0%)	Consistency	Semi Solid	Semi Solid	Semi Solid	Semi Solid	Semi Solid
F1 (5%)		Semi Solid	Semi Solid	Semi Solid	Semi Solid	Semi Solid
F2 (10%)		Semi Solid	Semi Solid	Semi Solid	Semi Solid	Semi Solid
F3 (15%)		Semi Solid	Semi Solid	Semi Solid	Semi Solid	Semi Solid

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The adhesion test indicated that all formulas (F0, F1, F2, and F3) satisfied the adhesion requirements of over 4 seconds after being stored for 28 days. Increased adhesion was also observed in all formulas following the Cycling Test. Formula F0 (without extract) improved from 12.47 seconds to 13.47 seconds, F1 (with 5% extract) from 12.50 seconds to 13.98 seconds, F2 (10% extract) from 13.92 seconds to 14.40 seconds, and F3 (15% extract) from 14.03 seconds to 14.68 seconds. The most significant increase was noted in F3. All formulations met the criteria for good adhesion testing, defined as exceeding 4 seconds. During six cycles of stability testing, the adhesion test values showed a trend of increasing, suggesting that the active substance was strongly retained within the formulation base, thereby enhancing the adhesion duration. Augmenting the concentration of temu mangga rhizome extract in lip balm led to an improved adhesion capacity.

The test results show that all lip balm formulas meet the criteria for a good adhesion test, which is more than 4 seconds. During the six cycles of stability testing, the adhesion value tends to increase. After the cycling test, the adhesion duration becomes longer because the active substance is strongly bound in the formulation base, affecting the increase in adhesion time. Higher concentrations of temu mangga rhizome extract in the formulation produce greater adhesion, increasing the duration of contact between the preparation and the skin, as well as the effectiveness of the delivery of active substances (Ridhani et al., 2022). Adhesion is greatly influenced by the viscosity of the preparation base (Priawanto, 2017). Vaseline album, which is used in the formulation, can reduce the consistency of the preparation, making it thinner (Alfilaili et al., 2021). In the formulation, the concentration of vaseline album in F0 yields the thinnest preparation consistency or the lowest viscosity. A decrease in the viscosity of the preparation can lead to a decrease in adhesive power (Lumentut et al., 2020).

At room temperature, the melting point of lip balm gradually increased for all formulas, indicating enhanced thermal stability over time. An increase in melting point was also observed after the cycling test, but this change was not as pronounced as that seen during room temperature storage. There was a positive relationship between extract concentration and the increase in melting point, both at room temperature and during the cycling test. The effect of room temperature storage appeared to be more significant than the cycling test regarding the increase in melting point.

The addition of ethanol extract from temu mangga rhizome increases the melting point of lip balm, with a more significant increase occurring during room temperature storage compared to the cycling test. This indicates that the formulation containing the extract is more thermally stable, particularly at room temperature. The higher the concentration of the extract, the higher the melting point of the lip balm preparation (Hayati et al., 2024). The obtained melting point meets the SNI 16-5769-1998 standard (50-70°C), although the ideal melting temperature for lip balm should be close to body temperature (36-38°C). A higher temperature (55-75°C) was chosen to enhance resistance to tropical conditions and maintain shape during distribution, storage, and use (Tampubolon, 2023).

The results of the humidity test demonstrated the impact of the concentration of the preparation on the changes in the parameters measured over several days of observation, both in the morning and evening. Group F0 (0%) exhibited minimal changes in parameters, with differences ranging from 1.2 to 3.6. Group F1 (5%) experienced a greater increase in the difference compared to F0, ranging from 4.2 to 6.2. Group F2 (10%) showed a more substantial increase, with a difference reaching up to 9.0. Meanwhile, group F3 (15%) displayed the most dramatic increase, with a difference reaching 20.4 in the morning and 19.2 at night.

Lip balm moisture testing was conducted in the morning and evening to obtain a comprehensive understanding of the product's effectiveness in various situations. In the morning, lips are typically drier after waking up, while at night, they have been exposed to various environmental factors throughout the day. By testing at these two times, researchers can assess the lip balm's ability to retain moisture and provide maximum protection, both during activities and while resting. This test also reflects daily usage patterns, where lip balm is usually applied in the morning and evening, making the test results more relevant and applicable (Bielfeldt et al., 2019).

These findings can be explained by the skin hydration theory, which highlights the importance of balancing water content in the stratum corneum with the rate of water evaporation from the skin surface (Mojumdar et al., 2017). Mango turmeric extract in lip balm works to enhance hydration through two mechanisms: creating a barrier to reduce water evaporation (occlusive effect) and attracting moisture from the environment into the skin (Azmin et al., 2020).

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The effectiveness of this lip balm can be understood through the theory of active ingredient penetration. Increasing the concentration of temu mangga extract creates a greater concentration gradient, facilitating the penetration of active ingredients into the skin layers of the lips. This explains why Formula 3, with the highest concentration, showed the most significant moisturizing effect. Although the increased concentration of the extract resulted in enhanced moisturizing properties, the right formulation must consider the overall balance and stability of the preparation (Dal'Belo et al., 2006).

A study by Yuandanandi et al. (2021) on Curcuma mango extract showed high antioxidant activity, which may contribute to skin protection from oxidative damage. This aligns with the findings of this study, where increasing the concentration of the extract resulted in a better moisturizing effect, which may also provide additional skin protection benefits.

A study by Zang et al (2024) investigated the dose-response relationship between the concentration of natural active ingredients in skincare products and their effectiveness. The researchers discovered that higher concentrations did not always correlate linearly with increased effectiveness, highlighting the significance of formula optimization. This finding is pertinent to the results of the current study, as Formula 3 demonstrated the best outcomes; however, further optimization may still be necessary.

A lip balm irritation test was conducted to ensure that the lip balm does not irritate the lips. Irritation is categorized into primary irritation, which occurs immediately after contact with the skin, and secondary irritation, which occurs several hours later. The irritation test employed an open patch test on the forearms of 20 panelists who consented to participate. The preparation was applied to an area measuring 2.5 x 2.5 cm, left uncovered, and observed three times a day for two days. Inclusion criteria required participants to be women aged 20-30 years, physically and mentally healthy, with no history of allergies, and willing to serve as panelists. The reactions monitored included erythema, papules, vesicles, and edema. The test results indicated that all formulations (F0, F1, F2, and F3) did not elicit irritation reactions in the panelists, as they had a pH of 5, which is within the skin's normal pH range of 4.5-6.5. A preparation is considered safe if it does not cause irritant reactions on the skin.

Table 5. Homogeneity test results

Preparation	Day to Day Observations				
	0	**7**	**14**	**21**	**28**
F0 (0%)	Homogen	Homogen	Homogen	Homogen	Homogen
F1 (5%)	Homogen	Homogen	Homogen	Homogen	Homogen
F2 (10%)	Homogen	Homogen	Homogen	Homogen	Homogen
F3 (15%)	Homogen	Homogen	Homogen	Homogen	Homogen

Table 6. Results of pH test

Preparation	Day-to-Day Observations					Acceptance Parameter
	0	**7**	**14**	**21**	**28**	
F0 (0%)	5.00±0,00	5.00±0,00	5.00±0,00	5.00±0,00	5.00±0,00	4.5-6.5
F1 (5%)	5.00±0,00	5.00±0,00	5.00±0,00	5.00±0,00	5.00±0,00	
F2 (10%)	5.00±0,00	5.00±0,00	5.00±0,00	5.00±0,00	5.00±0,00	
F3 (15%)	5.00±0,00	5.00±0,00	5.00±0,00	5.00±0,00	5.00±0,00	

Table 7. Spreading power test results

Preparation	Day-to-Day Observations				
	0 (cm)	7 (cm)	14 (cm)	21 (cm)	28 (cm)
F0 (0%)	3.31±0.15	3.31±0.16	3.34±0.14	3.47±0.20	3.72±0.17
F1 (5%)	3.35±0.19	3.32±0.17	3.41±0.15	3.45±0.13	3.75±0.17
F2 (10%)	3.38±0.13	3.41±0.18	3.43±0.16	3.47±0.19	3.48±0.13
F3 (15%)	3.39±0.17	3.44±0.20	3.46±0.19	3.46±0.16	3.50±0.17

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Table 8. Results of adhesion power test

Preparation	Day-to-Day Observations				
	0 (det)	**7 (det)**	**14 (det)**	**21 (det)**	**28 (det)**
F0 (0%)	12.45±1.64	12.50±0.61	12.57±1.54	13.47±0.57	13.65±0.59
F1 (5%)	12.47±1.05	12.55±0.84	12.74±0.39	10.84±0.33	13.82±0.44
F2 (10%)	12.50±0.70	12.70±1.93	12.77±0.92	10.83±0.37	14.51±1.02
F3 (15%)	12.59±0.87	13.01±1.67	13.92±0.56	14.06±0.17	14.63±1.00

Table 9. Melting point test results

Preparation	Day-to-Day Observations				
	0 (℃)	**7 (℃)**	**14 (℃)**	**21 (℃)**	**28 (℃)**
F0 (0%)	54.0±0.00	55.1±0.00	56.5±0.00	57.0±0.00	58.5±0.00
F1 (5%)	59.0±0.00	60.0±0.00	61.1±0.00	63.0±0.00	64.0±0.00
F2 (10%)	60.0±0.00	61.0±0.00	61.5±0.00	62.0±0.00	63.0±0.00
F3 (10%)	61.0±0.00	62.0±0.00	63.0±0.00	63.5±0.00	64.0±0.00

Table 10. Organoleptic cycling test results

Formula	Inspection	Observation *Cycling Test*	
		Before	**After**
F0 (0%)	Color	Pink	Pink
F1 (5%)		Pink	Pink
F2 (10%)		Red	Red
F3 (15%)		Brick red	Brick red
F0 (0%)	Aroma	Strawberry	Strawberry
F1 (5%)		Strawberry	Strawberry
F2 (10%)		Strawberry	Strawberry
F3 (15%)		Strawberry	Strawberry
F0 (0%)	Dosage Form	Semi Solid	Semi Solid
F1 (5%)		Semi Solid	Semi Solid
F2 (10%)		Semi Solid	Semi Solid
F3 (15%)		Semi Solid	Semi Solid

Table 11. Cycling test homogeneity test results

Formula	Homogeneity Examination Result	
	Before	**After**
F0 (0%)	Homogen	Homogen
F1 (5%)	Homogen	Homogen
F2 (10%)	Homogen	Homogen
F3 (15%)	Homogen	Homogen

Table 12. pH cycling test results

Formula	Observation *Cycling Test*		Acceptance Parameter
	Before Accelerated	**After Accelerated**	
F0 (0%)	5.00±0.00	5.00±0.00	4.5-6.5
F1 (5%)	5.00±0.00	5.00±0.00	
F2 (10%)	5.00±0.00	5.00±0.00	
F3 (15%)	5.00±0.00	5.00±0.00	

Table 13. Spreadability test results cycling test storage

Formula	Spread Power Test Observation	
	Before (cm)	**After (cm)**
F0 (0%)	3.53±0.25	3.59±0.09
F1 (5%)	3.51±0.21	3.79±0.19
F2 (10%)	3.60±0.23	3.70±0.10
F3 (15%)	3.53±0.20	3.75±0.16

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Table 14. Cycling test storage adhesion test results

Formula	Observation of Adhesion Test	
	Before (det)	After (det)
F0 (0%)	12.47±1.05	13.47±0.57
F1 (5%)	12.50±0.61	13.98±0.37
F2 (10%)	13.92±0.56	14.40±0.15
F3 (15%)	14.03±0.84	14.68±0.40

Table 15. Melting point test results storage cycling test

Formula	Before (℃)	After (℃)
F0 (0%)	59.7±0.00	62.0±0.00
F1 (5%)	61.0±0.00	62.8±0.00
F2 (10%)	62.0±0.00	63.0±0.00
F3 (15%)	63.0±0.00	64.0±0.00

Table 16. Humidity Test Results

Formula	Day Ke-	Before (SD)	After (SD)	Difference (SD)
F0 (0%) Morning	1	36.8 ±2.59	38.6±2.07	1.8 ±3.32
	2	39.0±4.06	41.2±4.21	2.2 ±5.85
	3	37.4±2.51	39.2±2.39	1.8 ±3.47
	4	36.4±1.14	39.2±1.10	2.8 ±1.59
	5	39.8±2.39	42.2±3.27	2.4 ±4.05
	6	38.2±2.49	40.0±2.24	1.8 ±3.35
	7	37.0±1.00	39.4±0.55	2.4 ±1.14
	8	35.0±3.16	38.6±2.30	3.6 ±3.91
	9	40.8±1.30	43.6±2.61	2.8 ±2.92
	10	37.6±3.05	40.4±2.61	2.8 ±4.01
	11	38.6±2.88	41.8±2.59	3.2 ±3.87
	12	37.4±2.07	40.4±1.52	3.0 ±2.57
F1 (5%) Morning	1	35.4±2.61	41.6±2.88	6.2 ±3.88
	2	37.6±2.07	42.4±3.65	4.8 ±4.20
	3	37.0±1.41	42.2±1.79	5.2 ±2.28
	4	37.0±1.00	41.6±2.07	4.6 ±2.30
	5	37.8±2.59	42.2±3.77	4.4 ±4.58
	6	35.8±2.86	40.0±3.67	4.2 ±4.65
	7	34.4±2.30	40.4±3.13	6.0 ±3.88
	8	37.6±1.82	43.2±1.64	5.6 ±2.45
	9	37.2±1.10	43.0±1.22	5.8 ±1.64
	10	36.6±1.67	42.2±1.79	5.6 ±2.45
	11	38.0±2.74	43.8±2.05	5.8 ±3.42
	12	38.4±0.55	43.8±0.84	5.4 ±1.01
F2 (10%) Morning	1	38.0±2.24	47.0±5.15	9.0 ±5.61
	2	38.4±1.95	44.2±2.49	5.8 ±3.16
	3	37.2±1.79	44.0±1.58	6.8 ±2.39
	4	38.0±2.12	45.4±3.21	7.4 ±3.84
	5	35.0±1.87	41.6±1.95	6.6 ±2.70
	6	37.6±2.41	43.6±3.36	6.0 ±4.14
	7	37.0±1.22	44.4±2.61	7.4 ±2.88
	8	35.6±2.51	42.6±2.97	7.0 ±3.88
	9	38.6±3.91	44.8±3.35	6.2 ±4.83

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	10	39.2±2.49	47.6±1.14	8.4 ±2.74
	11	36.8±2.95	44.6±3.85	7.8 ±4.85
	12	37.0±1.58	44.4±1.95	7.4 ±2.51
F3 (15%) Morning	1	39.6±2.30	57.6±5.37	18.0 ±5.84
	2	39.8±2.39	59.0±2.24	19.2 ±3.28
	3	40.2±1.64	58.0±3.46	17.8 ±3.83
	4	40.8±1.92	60.0±0.00	19.2 ±1.92
	5	39.6±5.32	54.6±5.55	15.0 ±7.69
	6	38.4±1.34	55.8±4.55	17.4 ±4.74
	7	38.6±1.52	59.0±2.24	20.4 ±2.71
	8	39.6±1.67	58.2±3.49	18.6 ±3.87
	9	39.2±1.48	59.6±0.89	20.4 ±1.73
	10	40.0±1.58	55.8±4.38	15.8 ±4.66
	11	39.0±3.67	57.8±4.92	18.8 ±6.13
	12	39.8±3.03	56.0±4.18	16.2 ±5.16
	1	37.2±3.56	39.2±3.03	2.0 ±4.67
	2	37.4±2.30	38.6±2.41	1.2 ±3.33
	3	37.8±2.17	40.2±2.28	2.4 ±3.15
	4	38.4±1.82	39.8±1.64	1.4 ±2.45
	5	40.2±2.95	42.2±2.59	2.0 ±3.93
F0 (0%)	6	36.0±1.73	37.8±2.17	1.8 ±2.78
Evening	7	38.6±1.14	41.2±0.84	2.6 ±1.42
	8	37.2±1.48	40.6±1.14	3.4 ±1.87
	9	39.2±2.59	41.4±2.61	2.2 ±3.68
	10	39.6±2.07	42.2±2.05	2.6 ±2.91
	11	37.2±1.79	40.4±1.52	3.2 ±2.35
	12	39.6±0.89	42.4±1.14	2.8 ±1.45
	1	36.4±1.67	41.8±1.48	5.4 ±2.23
	2	36.8±1.64	41.6±1.14	4.8 ±2.00
	3	37.0±3.39	41.4±3.97	4.4 ±5.22
	4	39.0±0.71	43.8±1.10	4.8 ±1.31
	5	38.6±1.52	43.6±1.52	5.0 ±2.15
	6	38.0±2.35	43.4±2.30	5.4 ±3.29
F1 (5%)	7	37.8±1.79	42.4±2.30	4.6 ±2.91
Evening	8	38.0±3.16	42.8±3.03	4.8 ±4.38
	9	39.0±2.24	44.2±2.17	5.2 ±3.12
	10	38.6±1.67	42.8±3.56	4.2 ±3.93
	11	37.4±1.82	43.2±2.95	5.8 ±3.47
	12	40.0±1.22	45.6±1.14	5.6 ±1.67
	1	36.4±0.55	42.8±3.11	6.4 ±3.16
	2	38.0±2.35	46.8±2.17	8.8 ±3.20
	3	37.6±1.95	43.6±2.88	6.0 ±3.48
F2 (10%)	4	37.0±1.58	44.4±4.04	7.4 ±4.34
Evening	5	38.2±1.79	43.8±3.03	5.6 ±3.52
	6	36.8±1.48	42.6±1.95	5.8 ±2.45
	7	36.6±2.19	41.8±1.48	5.2 ±2.64
	8	37.4±1.14	44.2±1.30	6.8 ±1.73

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	9	36.6±2.30	45.6±2.61	9.0 ±3.48
	10	37.6±1.67	43.8±1.64	6.2 ±2.34
	11	37.8±2.17	46.0±1.87	8.2 ±2.87
	12	37.8±1.10	44.2±1.48	6.4 ±1.84
	1	42.2±3.49	59.0±2.24	16.8 ±4.15
	2	42.0±3.24	59.4±1.34	17.4 ±3.51
	3	40.6±2.70	57.0±4.80	16.4 ±5.51
	4	40.0±2.65	56.6±4.72	16.6 ±5.41
	5	40.0±1.22	58.8±1.79	18.8 ±2.17
F3 (15%)	6	41.8±2.59	59.4±1.34	17.6 ±2.92
Evening	7	40.6±0.89	57.4±3.71	16.8 ±3.81
	8	38.8±2.49	58.0±2.74	19.2 ±3.70
	9	40.4±2.51	59.0±2.24	18.6 ±3.37
	10	38.6±2.07	57.0±4.00	18.4 ±4.50
	11	41.2±0.84	57.6±2.19	16.4 ±2.35
	12	40.8±1.79	59.2±1.79	18.4 ±2.53

Table 17. Preparation Irritation Test Results

Formula	Eritema	Eritema and Papula	Eritema, Papula, and Vesikula	Edema and Vesikula
F0 (0%)	-	-	-	-
F1 (5%)	-	-	-	-
F2 (10%)	-	-	-	-
F3 (15%)	-	-	-	-

Table 18. Hedonic test results

Formula	Indicator			
	Texture	Aroma	Color	Hummadity
F0 (0%)	63	71	67	54
F1 (5%)	62	72	72	62
F2 (10%)	65	68	64	68
F3 (15%)	72	65	65	73

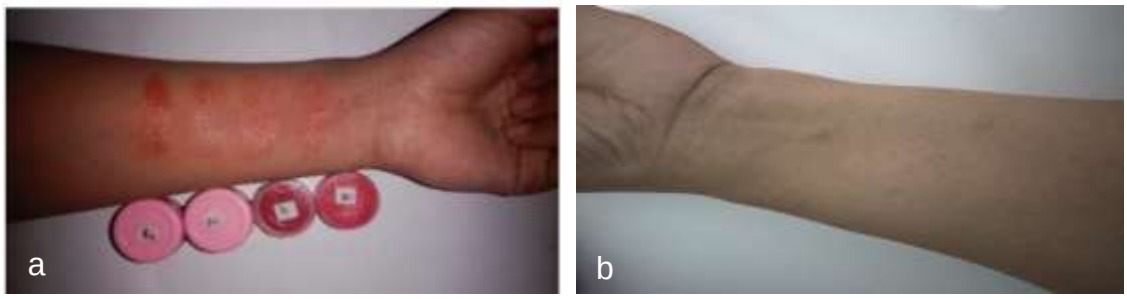

Figure 1. Irritation test on the formulation (a) application of the formulation (b) test results showing no irritation reaction

Description:
Erythema (Redness) : +
Erythema & Papules (Redness & Small solid bumps in red) : ++
Erythema, Papules & Vesicles (Redness, small solid bumps in red and small blisters containing fluid) : +++
Edema & Vesicles (Swelling and small blisters containing fluid) : ++++
No reaction : -

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CONCLUSION

The lip balm containing temu mangga rhizome extract from all formulations demonstrated good stability regarding color, aroma, consistency, homogeneity, and pH. Formula F3, which contains 15% extract, excelled in spreadability, adhesion, and thermal stability, making it the most preferred option for moisture retention. Formulas F1 and F2 were favored for their pleasant aroma and appealing color. All formulations were found to be safe and non-irritating.

The lip balm containing turmeric rhizome extract (Curcuma mangga Val) in formulations F1, F2, and F3 significantly enhanced moisture levels, with F3 (15%) demonstrating the highest effectiveness in moisture retention. The effectiveness of the extract in moisturizing the lips increases with higher concentrations. Future research should aim to develop additional formulations that incorporate turmeric rhizome (Curcuma mangga Val) for moisturizing benefits, thereby broadening its applications. Furthermore, increasing the concentration of the extract in the formulation may yield a more optimal moisturizing effect while maintaining product stability.

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