FORMULATION AND DEVELOPMENT OF LIP BALM FROM RED SEAWEED (GELIDIUM SP.) EXTRACT AS A NATURAL ANTIOXIDANT

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Abstract

This study aimed to formulate and evaluate lip balm preparations incorporating red seaweed (Gelidium sp.) extract as a natural active ingredient with antioxidant and moisturizing potential. Four formulations were prepared: F0 (without extract), FI (5% extract), FII (7.5% extract), and FIII (10% extract). The formulations were evaluated through organoleptic observation, homogeneity testing, pH measurement, melting point determination, spreadability testing, qualitative antioxidant testing using DPPH, and a consumer preference test.

The organoleptic evaluation showed a consistent strawberry aroma across all formulations, with color and texture differences becoming more pronounced as extract concentration increased. Homogeneity testing indicated that F0 and FI met quality standards, while FII and FIII did not, likely due to uneven pigment distribution caused by the extract. All formulations exhibited pH values within the physiological lip pH range (4.0–6.5) and melting points between 51–58 °C, aligning with the acceptable cosmetic range (50–70 °C). All samples also met the required spreadability standard (5–7 cm). Qualitative DPPH testing revealed positive antioxidant activity for FI, FII, and FIII, with stronger activity observed at higher extract concentrations.

A preference test with 30 panelists showed that F0 and FI were most preferred for color and texture, while FII and FIII were less favored despite similar aroma and moisturizing characteristics. These results indicate that red seaweed (Gelidium sp.) extract can be effectively utilized as an active ingredient in lip balm formulations, particularly at lower concentrations, to provide antioxidant benefits and maintain desirable physical and sensory characteristics.

Keywords: Gelidium sp., red seaweed, lip balm, antioxidant activity, formulation evaluation, cosmetic product development.

1. INTRODUCTION

Indonesia is a tropical country with year-round exposure to sunlight. Sunlight contains ultraviolet (UV) rays that play an important role in the production of vitamin D and in eliminating bacteria. However, excessive UV exposure can damage the skin, including the lips[7]. The lips are one of the most sensitive parts of the face and lack a protective layer, making them prone to dryness and cracking when exposed to excessive heat or cold[4]. In addition, prolonged exposure to UV rays can damage the keratin cells of the lips, which serve as a protective barrier. Damaged keratin cells peel off, causing chapped lips, dryness, and dull lip color. Apart from being aesthetically unappealing, cracked lips can also cause pain and discomfort. To address this condition, cosmetic preparations such as lip balm are needed to help protect and maintain lip moisture[1].

Lip balm is a topical preparation applied to the lips to prevent dryness and protect against environmental factors. It may contain active ingredients that function to shield the lips from sunlight and other external stressors. These active ingredients can be derived from natural sources or synthesized as pure chemical compounds. Natural ingredients are often preferred because they tend to produce fewer side effects, especially with long-term use[4]. One of the active ingredients that can be incorporated into lip balm formulations is antioxidants.

Natural antioxidant compounds can be incorporated into lip balm formulations. Antioxidants function to counteract or neutralize free radicals, and the use of products containing antioxidants is expected to help prevent and slow down skin damage[4]. One natural ingredient with strong antioxidant potential is red seaweed (Gelidium sp.).

Gelidium sp. is a type of red seaweed found in Indonesia that contains antioxidant compounds. This species belongs to the class Rhodophyta (red algae). It is rich in agarose, vitamin B12, amino acids, aspartic acid, and other bioactive compounds. The secondary metabolites of red seaweed are known to provide several skin benefits, including reducing signs of skin aging, improving skin firmness, preventing wrinkle formation, stimulating collagen production, and supporting tissue regeneration. A previous study by Sopianti (2021) demonstrated that red seaweed (Gelidium sp.) extract at concentrations of 5%, 7.5%, and 10% exhibited antioxidant activity. Therefore, this study utilizes red seaweed extract at the same concentrations (5%, 7.5%, and 10%) as an antioxidant in lip balm formulations.

Based on the aforementioned background, the researcher is interested in conducting a study entitled “Formulation of Lip Balm Preparation from Red Seaweed (Gelidium sp.) Extract as an Antioxidant.” This research aims to formulate red seaweed (Gelidium sp.) extract into a lip balm preparation that meets the physical and chemical quality requirements of cosmetic formulations.

2. METHODOLOGY

The research stages in this study included the preparation of red seaweed (Gelidium Sp.) extract, the preparation of a lip balm from the red seaweed (Gelidium Sp.) extract, and the physical and chemical evaluation, hedonic (preference) test and qualitative antioxidant testing of the red seaweed (Gelidium Sp.) extract lip balm preparation.

2.1. Plant Determination

Plant species determination was carried out at PT Palapa Muda Perkasa, located at Gg. Ceplik Kalimulya RT 03/04 No. 4, Cilodong District, Depok City, West Java 16413, Indonesia. Identification was carried out at the same location using morphological characteristics and taxonomic keys to accurately classify plant species.

2.2. Preparation Of Red Seaweed Extract (Gelidium Sp.)

The seaweed was thoroughly washed and chopped, then dried at 37-40°C for 3-4 days. Weigh 50 grams of red seaweed, place it in an Erlenmeyer flask, add pure water until submerged, add 0.1N sodium hydroxide (NaOH) solution to reach a pH of 7, then heat with an electric heater to 80°C, stirring occasionally, until a solution forms. Next, filter the mixture while still hot using Whatman filter paper number 41 under vacuum to obtain a filtrate. Add 300 ml of 95% ethanol to the filtrate, let it stand for 24 hours at room temperature (25-27°C), then filter it using plain filter paper. The precipitate was separated, added with 200 ml of 95% ethanol, let it stand for another 24 hours, and then filtered. The precipitate and filter paper were placed in a desiccator for several hours until they reached a constant weight. The sediment obtained is agar extract.

2.3. Preparation A lip Balm From Red Seaweed Extract (Gelidium Sp.)

The procedure for preparing lip balm from red seaweed (Gelidium sp.) extract was carried out as follows. All equipment and materials were prepared, and each ingredient was weighed according to the formulation. Solid paraffin, petrolatum, and cera alba were melted in an evaporating dish placed on a water bath at a temperature of 60–70 °C. Liquid paraffin was then added to the evaporating dish and stirred until a homogeneous mixture was obtained. The temperature was lowered to 45 °C, after which glyceryl monostearate, phenoxyethanol, and BHT were added and stirred until homogeneous (this was referred to as mixture 1).

Separately, the red seaweed extract and cetyl alcohol were placed into a mortar and triturated until homogeneous. Strawberry essence then added and further triturated to form mixture 2.

Mixture 1 and mixture 2 were combined in the mortar and triturated thoroughly until a uniform and homogeneous mass was obtained. The final preparation was then evaluated. After evaluation, the lip balm mixture was poured into pre-prepared molds and allowed to set at room temperature (25 °C) until solidified.

Table 1. *Antioxidant Lip Balm Formula with Red Seaweed Extract (Gelidium Sp)*

Ingredient	Function	F0 (g)	F I (g)	F II (g)	F III (g)
Red Seaweed (*Gelidium* sp.) Extract	Active ingredient	–	5%	7.5%	10%
Petrolatum	Emollient	30	30	30	30
Liquid Paraffin	Emollient	30	30	30	30
Cera alba (Beeswax)	Wax/Base	15	15	15	15
Glyceryl Monostearate	Humectant	0.95	0.95	0.95	0.95
Cetyl Alcohol	Emulsifier	0.05	0.05	0.05	0.05
BHT (Butylated Hydroxytoluene)	Antioxidant	0.05	0.05	0.05	0.05
Phenoxyethanol	Preservative	0.2	0.2	0.2	0.2
FD&C Red No. 4	Colorant	2 drops	2 drops	2 drops	2 drops
Strawberry Essence	Fragrance	3 drops	3 drops	3 drops	3 drops
Solid Paraffin (ad 100%)	Base	Ad 100%	Ad 100%	Ad 100%	Ad 100%

2.4. Evaluation Of Lip Balm Formulation

The evaluation of the lip balm formulation included several tests: organoleptic evaluation, homogeneity test, pH test, melting point test, spreadability test, antioxidant qualitative test, and preference test.

2.4.1. Organoleptic Evaluation

Organoleptic evaluation was performed by visually observing the lip balm formulation in terms of color, aroma, and texture during each sampling period[7]. The formulation was required to appear uniform light pink color, strawberry aroma with a slightly oily texture

2.4.2. Homogeneity Test

Homogeneity was evaluated by spreading 0.1 g of the lip balm formulation onto a transparent glass plate. The formulation was required to appear uniform without the presence of coarse particles[7].

2.4.3. pH Test

The pH value of the lip balm formulation was determined using a pH meter. The instrument was first calibrated with standard buffer solutions of pH 7.01 (neutral) and pH 4.01 (acidic) until the readings were stable. The electrode was then rinsed with distilled water and dried with tissue. A 1% sample solution was prepared by weighing 1 g of the formulation and dissolving it in 100 mL of distilled water, then heating it slightly. Once the temperature returned to room temperature, the electrode was immersed in the solution until the reading stabilized. The displayed value was recorded as the pH of the formulation[7]. The physiological pH of the lips ranges from 4.0 to 6.5[3].

2.4.4. Melting Point Test

The melting point was determined by placing the lip balm sample in an oven at an initial temperature of 50 °C for 15 minutes and observing whether melting occurred. The temperature was then increased by 1 °C every 15 minutes, and the melting temperature of the lip balm was recorded. An ideal lip balm formulation typically has a melting point in the range of 50–70 °C[7,8].

2.4.5. Spreadability Test

An amount of 0.5 g of lip balm formulation was placed on a glass plate with a marked scale. The sample was covered with another glass plate of known weight and allowed to stand for 1 minute. The diameter of spread was measured from several angles, and the average value was recorded. This procedure was repeated three times with increasing loads of 50 g, 100 g, 150 g, and 200 g. A formulation passes the spreadability test if the spread diameter is within 5–7 cm[1].

2.4.6. Antioxidant Qualitative Test (Color Test)

A total of 10 mg of lip balm formulation was mixed with five drops of 0.1 mM DPPH solution. A positive antioxidant activity was indicated by a color change from purple to yellow[6].

2.4.7. Preference Test (Hedonic Test)

The preference test involved 30 volunteer panelists. Each panelist was asked to evaluate the different lip balm formulations and select their preferred formula. A hedonic scale of 1 to 5 was used, where 1 = strongly dislike, 2 = dislike, 3 = neutral, 4 = like, and 5 = strongly like. The parameters evaluated were texture, aroma, and color. The percentage of preference for each formulation was then calculated[2].

3. RESULTS

3.1. Results of Red Seaweed (Gelidium sp.) Determination

The determination of the red seaweed specimen was carried out at PT Palapa Muda Perkasa, located at Gg. Ceplik Kalimulya RT 03/04 No. 4, Cilodong District, Depok City, West Java 16413, Indonesia. Based on morphological and taxonomic identification, the seaweed was confirmed to be Gelidium sp., a species of red seaweed commonly found in Indonesian coastal waters.

3.2. Results Of Red Seaweed (Gelidium Sp.) Extraction

The red seaweed (Gelidium sp.) extract was obtained through the maceration method using 95% ethanol and 0.1 N NaOH as solvents. The red seaweed material was sourced from PT Palapa Muda Perkasa, located at Gg. Ceplik Kalimulya RT 03/04 No. 4, Cilodong District, Depok City, West Java 16413, Indonesia. The resulting extract was in the form of a gel-like agar, brownish in color, and had a distinct characteristic odor. Phytochemical Identification of Red Seaweed (Gelidium sp.) Extract A qualitative phytochemical screening was conducted to identify the bioactive compounds present in the red seaweed (Gelidium sp.) extract. The results indicated the presence of saponins, alkaloids, flavonoids, tannins, and triterpenoids.

3.3. Evaluation of Lip Balm Containing Red Seaweed (Gelidium Sp.) Extract

3.3.1. Organoleptic Evaluation

The organoleptic characteristics of the lip balm formulations were assessed based on color, aroma, and texture (Table 2). All samples, including F0 (control), FI (5% *Gelidium* sp. extract), FII (7.5%), and FIII (10%), demonstrated a consistent strawberry aroma. However, noticeable differences in color and texture were observed among the formulations.

Organoleptic testing was performed to evaluate the sensory characteristics of the lip balm formulations, including color, aroma, and texture.

Table 2. *The Result of Organoleptic Evaluation*

Sample	Color	Aroma	Texture
FI	Light pink	Strawberry	Oily
FII	Darker pink with red granules	Strawberry	Very oily
FIII	Darker pink with red granules	Strawberry	Very oily

All formulations (F0, FI, FII, and FIII) showed the same strawberry aroma, indicating that the addition of Gelidium sp. extract did not affect the fragrance profile of the product.

However, differences were observed in color and texture with increasing extract concentration. F0 and FI exhibited a uniform light pink color with a slightly oily texture. In contrast, FII and FIII showed a darker pink shade with visible reddish granules and a much oilier texture. This is likely caused by higher concentrations of Gelidium sp. extract, which increased the viscosity of the base and resulted in incomplete dispersion of the extract. High levels of natural extract may also absorb colorants, creating an uneven distribution of color.

3.3.2. Homogeneity Test

Homogenity was evaluated visually to determine the uniform distribution of the active extract within the base. The results are summarized in Table 3.

Table 3. *The Result of Homogeneity Test*

Formula	Homogeneity
F0	Homogeneous
FI	Homogeneous
FII	Not homogeneous
FIII	Not homogeneous

The homogeneity test determines the even distribution of components in the formulation. F0 and FI demonstrated good homogeneity, whereas FII and FIII were not homogeneous. The presence of visible particles and uneven coloration in FII and FIII suggests poor mixing at higher extract concentrations.

This may be attributed to the interaction between the extract and base ingredients, as well as limited solubility of the extract. The findings indicate that 5% Gelidium sp. extract is the optimal concentration to maintain good homogeneity in the lip balm formulation.

3. pH Measurement

pH testing revealed values within the acceptable physiological range for lip products (4.0–6.5). Table 4. presents the pH values of each formulation.

Table 4. *The Result of pH Measurement*

Formula	pH	Standard Range
F0	5.48	4.0 – 6.5
FI	5.57	4.0 – 6.5
FII	5.86	4.0 – 6.5
FIII	5.96	4.0 – 6.5

The pH of the lip balm formulations ranged from 5.48 to 5.96, which falls within the physiological range for the lips (4.0–6.5). A slight increase in pH was observed as the concentration of the extract increased. This is likely due to residual alkaline compounds from the extraction process.

Since all formulations met the physiological pH range, the lip balm is considered safe and non-irritating for application on the lips.

4. Melting Point Test

Melting point evaluation ensures product stability under normal storage conditions. Table 5 shows the melting points of each formulation.

Table 5. *The Result of Melting Point Test*

Formula	Melting Point (°C)	Acceptable Range (°C)
F0	58	50 – 70
FI	56	50 – 70
FII	53	50 – 70
FIII	51	50 – 70

The melting point of all formulations ranged from 51 °C to 58 °C, which is within the recommended range of 50–70 °C for lip balm products. A decreasing trend in melting point was observed with increasing extract concentration.

This reduction may be caused by interactions between the extract and wax components, which alter the structural integrity of the base. However, the values remai

ned within the acceptable range, indicating that the formulations have good physical stability at room temperature.

5. Spreadability Test

Spreadability indicates the ease of application on the skin. The test was conducted under two weight conditions (50g and 100g), as shown in Table 6.

Table 6. *The Result of Spreadability Test*

Formula	Load (g)	Spread Diameter (cm)	Requirement (cm)
F0	50	5.0	5 – 7
F0	100	5.2	5 – 7
FI	50	5.1	5 – 7
FI	100	5.3	5 – 7
FII	50	5.2	5 – 7
FII	100	5.4	5 – 7
FIII	50	5.4	5 – 7
FIII	100	5.6	5 – 7

Spreadability determines how easily the lip balm can be applied and distributed on the lips. All formulations met the standard spreadability requirement (5–7 cm). The spreadability values slightly increased in FII and FIII, which may be due to the softer consistency caused by higher extract content. Good spreadability ensures better user comfort and product performance.

6. DPPH Qualitative Test (Antioxidant Activity)

Antioxidant potential was analyzed using the DPPH radical scavenging assay. Formulations FI, FII, and FIII showed a positive reaction, indicated by a color change from violet to yellow.

Antioxidant activity was evaluated using the DPPH qualitative test. FI, FII, and FIII showed a positive reaction with a color change from violet to yellow, indicating the presence of antioxidant compounds in the lip balm.

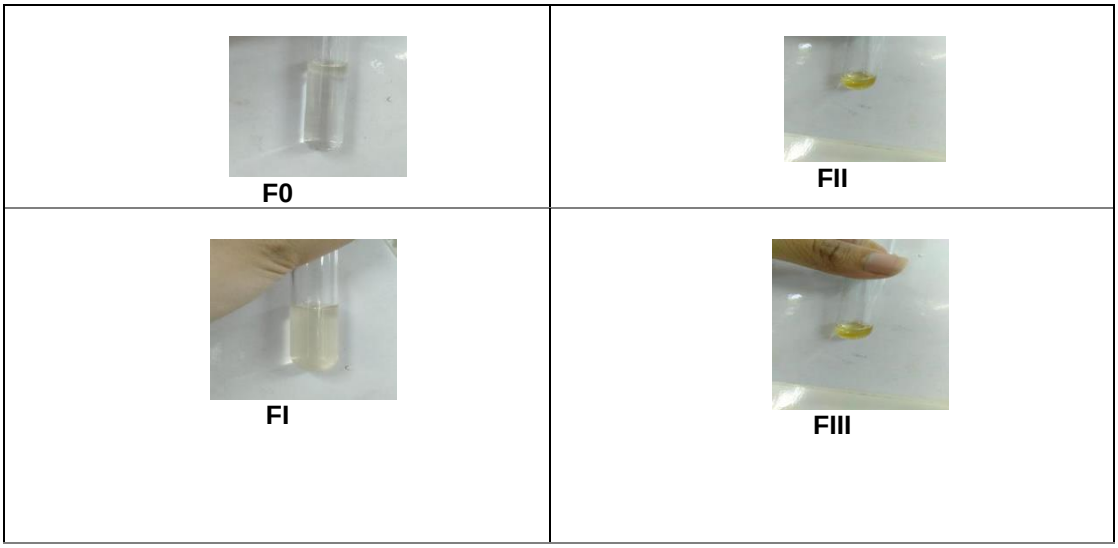

Figure 1. *Result of Qualitative DPPH test*

The strongest color change was observed in FII and FIII, demonstrating higher antioxidant activity at higher extract concentrations. This is consistent with the presence of bioactive compounds in Gelidium sp., such as flavonoids, saponins, and phenolics, known for their free radical scavenging activity.

7. Hedonic Test

A hedonic test was conducted with 30 untrained panelists to evaluate consumer preferences for color, aroma, moisture, and texture (Table 8).

Table 8. *The Result of Hedonic Test*

Parameter	F0 (0%)	FI (5%)	FII (7.5%)	FIII (10%)
Color	3 (like)	3 (like)	2 (dislike)	2 (dislike)
Aroma	3 (like)	3 (like)	3 (like)	3 (like)
Moisture	3 (like)	3 (like)	3 (like)	3 (like)
Texture	3 (like)	3 (like)	2 (dislike)	2 (dislike)

The results showed that F0 and FI received higher scores (3 = like) for most parameters, particularly color and texture. In contrast, FII and FIII received lower scores (2 = dislike) for color and texture due to their darker shade and greasier texture, even though aroma and moisture were well accepted across all formulations.

This indicates that increasing extract concentration enhances antioxidant activity but can decrease product appeal and comfort. Thus, a balanced formulation is essential to achieve both functional and sensory quality.

4. CONCLUSIONS

Based on the results of the formulation and evaluation of lip balm containing red seaweed (Gelidium sp.) extract, it can be concluded that the concentration of the extract plays a significant role in determining the physical characteristics, antioxidant activity, and consumer acceptability of the product. All formulations met the required pH and melting point standards, with pH values ranging from 5.48 to 5.96 and melting points between 51–58 °C, which are within the acceptable physiological range for lip products.

The antioxidant activity increased with higher concentrations of red seaweed extract, as indicated by the DPPH qualitative test showing a clear color change from violet to yellow. However, formulations with higher extract concentrations (7.5% and 10%) exhibited poor homogeneity, a darker color, and an oily texture, which affected the sensory acceptance by the panelists.

Among all formulations, the 5% extract concentration (Formula I) showed the most balanced results, with good physical stability, adequate antioxidant activity, and the highest level of consumer acceptance. This indicates that Gelidium sp. extract can be effectively utilized as a natural antioxidant ingredient in lip balm formulations.

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