

The Effect of Varying Concentrations of Mugwort Leaf Extract (*Artemisia vulgaris* L.) on SPF and Cream Physical Stability

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ABSTRACT

Mugwort (*Artemisia vulgaris* L.) has antioxidant activity that can neutralize free radicals on the skin and also has sunscreen activity to protect the skin from UV exposure. This study highlights the benefits of the mugwort plant, which are currently unknown to the general public, requiring investigation into the formulation of its topical cream. This research aims to determine the stability of mugwort leaf extract cream and its SPF value. The extraction process uses the maceration method with 96% ethanol as the solvent. This study employed variations in mugwort leaf extract concentrations across formulas, starting from the control at 0% extract and increasing to 0.5%, 1%, 1.5%, and 2%. The organoleptic test results of the cream in the control formula showed a white color and green color in F1 to F4, with a characteristic smell and a semi-solid texture. The physical quality test for homogeneity indicates that all formulas are homogeneous. The pH test results of the formulation obtained values of 4,74-5,49, which meet the skin pH standard. The spreadability results obtained values of 6,15-6,38 cm. The cream's viscosity was in the range of 4,870-4,950 cPs. The hedonic test results showed that panelists preferred F1 with an extract concentration of 0.5%. The SPF test yielded scores ranging from 6,45 to 14,71. All formulations were able to preserve the physical quality stability of the preparations, according to the findings of the stability test conducted using the cycling test.

Keywords: *Artemisia vulgaris*, cream, sunscreen, stability test.

Introduction

Cosmetics are substances or preparations applied to the outer surface of the human body as body care to improve appearance (Forestryana et al., 2021). Cosmetic products can include soap, lotion, lipstick, gel, cream, and so on. One way to reduce the negative impact of chemicals contained in cosmetics is by using active natural ingredients from plants (Iskandar et al., 2021).

Mugwort (*Artemisia vulgaris* L.) has long been used as a herbal medicine for nosebleeds, expectoration, pain relief, and to reduce nausea and vomiting (Sumbe et al., 2023). Secondary metabolites found in mugwort, including flavonoids, terpenoids, tannins, saponins, and phenols, may have antioxidant properties that counteract free radicals produced by exposure to UV-A and UV-B (Suhartinah et al., 2023). Mugwort shows antioxidant activity with an IC₅₀ value of 4.3 µg/mL (Thangjam et al., 2020). Mugwort can be developed into cosmetic compositions, such as creams, due to its activity.

Cream is a semi-solid formulation characterized by a thick emulsion containing a minimum of 60% water, designed for external application. Cream is well favored within the community due to its ease of application, non-sticky texture, effortless removal with water, and hydrating effect (Ain Thomas et al., 2022). Sunscreen is a cosmetic that functions to protect the skin from sun exposure. Stability and effectiveness in cream formulations can be influenced by the concentration of active ingredients in the form of extracts, so it is necessary to evaluate the impact of varying extract concentrations on the physical and chemical properties of the cream formulations. Variations in extract concentration can impact the spreadability, viscosity, pH, and SPF values in cream formulations (Budianor et al., 2022). Temperature, composition, and excessive additives to the cream formulation all have an impact on the cream's stability.

Methodology

Equipment

The tools used for this study include glassware, analytical balance (Fujitsu), pH meter (Ohaus), Brookfield viscometer (NDJ-8S), a waterbath, moisture analyzer (Ohaus), UV-Vis spectrophotometer (Shimadzu), and evaporator.

Material

The materials used in this research include dried simplicia of mugwort leaves (*Artemisia vulgaris* L.), liquid paraffin, tween 80, span 80, cetyl alcohol, stearic acid, glycerin, lanolin, Nipagin, Nipazol, ethanol p.a and 96% ethanol.

Sample Collection and Plant Determination

Samples of mugwort leaves were collected from Bromo, Tengger, Semeru, National Park area, Probolinggo, East Java. Plant determination is carried out to ascertain the authenticity of the plant species according to its correctness. The parts of the mugwort plant used for determination are all parts of the plant. The determination of the mugwort plant (*Artemisia vulgaris* L.) was conducted at the UPT Herbal Materia Medica Laboratory in Batu, Malang City.

Extraction Process

The dried mugwort leaves were weighed at 1,500 grams and then ground using a grinder. The maceration process is carried out for 3 × 24 hours and stirred every 24 hours. The results of the maceration are filtered and evaporated at a temperature of 40°C, then the liquid extract is concentrated using a water bath at 40°C until a thick extract is formed.

Phytochemical Screening Test of Extract

1.) Saponin test

A test tube containing up to 40 mg of mugwort leaf extract was filled with 10 mL of aquadest, dissolved, and agitated for one minute. Saponins are present when stable foam forms (Manongko et al., 2020).

2.) Tanin test

0.1 grams of mugwort leaf extract are dissolved in 10 milliliters of boiling water and heated for five minutes. A 2 ml sample is taken and placed into a test tube, then 2-3 drops of 1% FeCl₃ solution are added and shaken. A positive result containing tannins is indicated by the formation of a greenish-black color change (Manongko et al., 2020).

3.) Alkaloid test

0.5 grams of mugwort leaf extract is mixed with 1 mL of 2M HCl and 9 mL of distilled water, heated for 2 minutes, then cooled and filtered. The obtained filtrate is divided into three parts, each added with Mayer's, Dragendorff's, and Wagner's reagents. The results are considered positive for alkaloids if the extract reacts with Mayer's reagent, forming a white precipitate; if the extract reacts with Dragendorff's reagent, forming an orange-yellow color; and if the extract reacts with Wagner's reagent, forming a brown precipitate. (Harahap & Nurbaity Situmorang, 2021).

4.) Steroid/triterpenoid test

Ten drops of CH₃COOH and two drops of H₂SO₄ are added to forty milligrams of fresh mugwort leaf extract. The solution is shaken gently and left for a few minutes, then the result is observed. Steroids are indicated by the color blue or green, whereas triterpenoids are indicated by the color red or purple. (Manongko et al., 2020).

5.) Flavonoid test

0.5 grams of mugwort leaf extract is combined with 1 mL of 10% NaOH reagent, then the results are observed. A favorable flavonoid reaction is signified by a color transition to orange (Supriyanto et al., 2021).

Cream Formulation

Table 1. Formula Design

Material	Concentration (%)					Function
	F1	F2	F3	F4	F5	
Ethanol extract of mugwort leaves	0	0,5	1	1,5	2	Active substance
White oil	5	5	5	5	5	Emolien
Tween 80	10	10	10	10	10	Emulgator
Span 80	10	10	10	10	10	Emulgator
Cetyl Alcohol	5	5	5	5	5	Emolien
Stearic acid	5	5	5	5	5	Emulsifier
Adeps Lanae	5	5	5	5	5	Emolien
Gliserin	15	15	15	15	15	Humektan
Nipagin	0,18	0,18	0,18	0,18	0,18	Preservative
Nipasol	0,02	0,02	0,02	0,02	0,02	Preservative
Aquadest	Ad 100	Ad 100	Ad 100	Ad 100	Ad 100	Solvent

Procedure for Cream Formula Preparation

The oil phase (cetyl alcohol, lanolin, stearic acid, white oil, span 80) is placed in a porcelain dish. The water phase (Nipagin, Aquadest, glycerin, tween 80) is placed in a porcelain dish. The aqueous phase and the oil phase are heated at a temperature of 60°C-70°C and heated until the oil phase is homogeneously mixed, then propyl paraben and the aqueous phase are added until all components dissolve. The aqueous phase is

added to the oil phase and stirred until homogeneous, forming a cream mass. The extract is added and mixed until homogeneous.

Physical Evaluation Test of Cream Formulation

1.) Organoleptic test

Organoleptic testing involves direct observation of the cream preparation, including its texture, color, and smell (Suhaela et al., 2023).

2.) Homogeneity test

The homogeneity test is performed to determine if the cream preparation is homogeneous. A 0.5-gram sample of the cream is obtained and positioned on a glass slide, and thereafter distributed to examine for any coarse aggregates (Tungadi et al., 2023).

3.) Uji pH

The pH testing of the preparation is carried out using a pH meter (Thomas et al., 2023).

4.) Spreadability test

0.5 grams of mugwort leaf extract cream is placed on the surface of a petri dish. Another dish is placed on top of it and left for 1 minute. Then, weights ranging from 50 to 250 grams are added, and the diameter is measured every 1 minute, with the dispersion diameter meeting the requirement of 5-7 cm (Idawati et al., 2024).

5.) Viscosity test

The viscosity test of the cream preparation was conducted using a Brookfield Viscometer at a rotation speed of 60 rpm on spindle number 4 immersed in the preparation. The viscosity requirement for the cream preparation is 2,000 to 50,000 cPs (Ikhsan et al., 2023).

6.) Hedonic test

Hedonic tests were conducted on 20 volunteers to observe the preparations and fill out the questionnaire. This assessment includes the smell, color, and texture of the cream in each formula, with rating points (1) dislike (2) neutral (3) like (4) extremely like (Efendi et al., 2025).

Determination of Cream SPF Value

The SPF of the cream formulation was tested using a UV-Vis spectrometer by measuring the absorption of the solution from each formula at a wavelength of 290 – 320 nm with three replicates of the test. The samples were prepared with a concentration of 1% by dissolving in ethanol p.a. up to 5 mL. The absorbance values obtained were then processed using the Mansur method (Suhesti et al., 2021).

$$SPF = \frac{CF}{\sum_{290}^{320} EE(\lambda) \cdot I(\lambda) \cdot Abs(\lambda)}$$

Keterangan :

CF : Correlation factor (10)

EE : Erythema Efficiency (λ)

I : Spectrum of solar intensity (λ)

Abs : The absorbance value that is read (λ)

The SPF value can be calculated by multiplying the CF or correlation factor by the product of sigma in the range of 290-320 nm from the EE or erythema spectrum and the absorbance value of the sunscreen preparation, as well as I or the simulated

sunlight spectrum. The product of EE and I is a constant that has been applied for each 5 nm wavelength interval in the range of 290-320 nm.

Stability Test

Stability testing was conducted using the cycling test method before and after storage at low temperature (4 °C) for 24 hours and at high temperature (40 °C) for 24 hours (1 cycle) using a climatic chamber. The test was performed for 6 cycles. After 6 cycles, observations were made on organoleptic properties, homogeneity, pH, spreadability, and viscosity (Nurfita et al., 2021).

Data Analysis

Descriptive analysis was conducted on the results of organoleptic testing and the homogeneity of the cream preparation. *One-way ANOVA* was used for statistical analysis of the data from the preparation's pH test, spreadability, viscosity, and SPF value, provided that the data were normally and homogeneously distributed (as shown by a normality test significance value >0.05). Testing using the *Kruskal-Wallis* method was conducted on data that were not normally distributed. For further analysis of the hedonic test, the *Duncan Post Hoc* test was applied. The analysis of the stability test data using the cycling test method employed the *Paired Sample T-test*, which aims to compare data before and after the stability test. The Statistical Package for the Social Sciences (SPSS) program was used to analyze the quantitative data (Putri et al., 2025).

Results and Discussion

Sample Preparation

The simplicia of mugwort leaves used are those that meet the dry simplicia requirements, which are with a moisture content of <10%. The yield of the mugwort leaf extract is 5.33%, the moisture content of the mugwort leaf extract is 9.35%, and the drying loss is 8.64%. These results have satisfied the criteria (Handayani et al., 2024).

Phytochemical Screening of Extract

Table 2. Results of Phytochemical Screening of Extract

Compound	Reagen	Result	Explanation
Alkaloid	Mayer	White sediment	+
	Dragendrof	Orange sediment	+
	Wagner	Brown sediment	+
Saponin	Distilled water	Stable foam	+
Tanin	FeCl ₃ 1%	Blackish green color	+
Flavonoid	NaOH 10%	Orange color	+
Steroid	H ₂ SO ₄ and CH ₃ COOH	Green color	+

Preliminary phytochemical screening tests on the extract aim to identify the metabolite compounds contained in mugwort (*Artemisia vulgaris* L.). The testing was conducted using several color reagents according to the compounds being tested. The alkaloid test showed positive results with a white precipitate in Mayer's reagent, an orange or reddish precipitate in Dragendorff's reagent, and a brown precipitate in Wagner's reagent (Harahap & Nurbaiti Situmorang, 2021). The existence of stable foam bubbles

for one minute indicated a positive saponin test result (Manongko et al., 2020). The tannin compound test showed a positive result with a dark green colour when using FeCl₃ 1% (Manongko et al., 2020). The flavonoid test showed a positive result with an orange colour using 10% NaOH (Supriyanto *et al.*, 2021). The steroid compound test showed a positive result with a green colour using H₂SO₄ and CH₃COOH reagents (Manongko et al., 2020).

Results of the Physical Stability Test of the Preparation

1.) Organoleptic test

Organoleptic testing aims to describe, through the five senses, including color and texture, the cream preparation of mugwort leaf extract (*Artemisia vulgaris* L.).

Table 3. Results of Organoleptic Testing

Formula	Organoleptic (color, texture)	
	Before	After
F0	White color, semi-solid texture	White color, semi-solid texture
F1	Green color, semi-solid texture	Green color, semi-solid texture
F2	Green color, semi-solid texture	Green color, semi-solid texture
F3	Green color, semi-solid texture	Green color, semi-solid texture
F4	Green color, semi-solid texture	Green color, semi-solid texture

Explanation:

- F0 : Concentration of 0% ethanol extract of mugwort
 F1 : Concentration of 0,5% ethanol extract of mugwort
 F2 : Concentration of 1% ethanol extract of mugwort
 F3 : Concentration of 1,5% ethanol extract of mugwort
 F4 : Concentration of 2% ethanol extract of mugwort

The results of the organoleptic test in Table 3 show differences in color and texture among the various formulas. The organoleptic results for F0 have a bone-white color with a semi-solid texture because it does not contain mugwort leaf extract. From F1 to F4, with varying concentrations of mugwort leaf extract, there are differences in the color and texture of the cream preparation, but no difference in smell. The more extract content, the greener the cream preparation and the more liquid the texture. The organoleptic stability testing of the mugwort leaf cream preparation was conducted before the stability test and after the stability test. Based on sensory observation, the mugwort leaf extract cream preparation did not experience any color change in cycle 0 and cycle 6, but the texture became increasingly liquid in cycle 6. This is caused by the extreme storage temperature factor (Sari et al., 2017).

2.) Homogeneity test

The purpose of the homogeneity test is to ascertain the homogeneity of the cream preparation. In order to conduct this test, the cream mixture is applied to a watch glass, and its uniform hue and lack of coarse particle grains are visually observed.

Table 4. Results of the homogeneity test

Formula	Homogeneity	
	Before	After
F0	Homogeneous	Homogeneous
F1	Homogeneous	Homogeneous
F2	Homogeneous	Homogeneous
F3	Homogeneous	Homogeneous

F4	Homogeneous	Homogeneous
Explanation:		
F0	: Concentration of 0% ethanol extract of mugwort	
F1	: Concentration of 0,5% ethanol extract of mugwort	
F2	: Concentration of 1% ethanol extract of mugwort	
F3	: Concentration of 1,5% ethanol extract of mugwort	
F4	: Concentration of 2% ethanol extract of mugwort	

The results of the homogeneity test in Table 4 show that each formula exhibits a homogeneous cream preparation with no unblended granules or coarse particles and an even color. The higher the variation in the concentration of mugwort leaf extract can affect the viscosity and color of the preparation, but it does not affect the homogeneity of the preparation. The stability test of the homogeneity of the mugwort leaf cream preparation was conducted before the stability test (cycle 0) and after the stability test (cycle 6). Based on the homogeneity test results, the cream preparation was able to produce a homogeneously stable preparation after being stored for 6 cycles.

3.) pH test

The goal of the pH test on the mugwort leaf extract cream preparation is to determine its acidity or alkalinity and make sure that the final pH value falls within the pH range of human skin, which is between 4.5 and 6.5. This ensures that the cream preparation is safe to use on the skin and won't irritate it. A pH meter that had previously been calibrated with pH 4 buffer solution (acidic environment), pH 7 buffer (neutral), and pH 10 buffer (basic) was used to measure the cream's pH.

Table 5. pH test results

Formula	pH (mean±SD)	
	Before	After
F0	5,49±0,02	5,27±0,05
F1	5,10±0,04	5,09±0,05
F2	4,95±0,05	4,88±0,04
F3	4,80±0,02	4,74±0,04
F4	4,75±0,06	4,69±0,04

Explanation:

- F0 : Concentration of 0% ethanol extract of mugwort
- F1 : Concentration of 0,5% ethanol extract of mugwort
- F2 : Concentration of 1% ethanol extract of mugwort
- F3 : Concentration of 1,5% ethanol extract of mugwort
- F4 : Concentration of 2% ethanol extract of mugwort

The results of the pH test of the preparation in Table 5 show that the pH of the cream preparation of mugwort leaf extract before the stability test was 4.75 – 5.49 and after the stability test was 4.69 – 5.27, thus meeting the skin pH requirement, which ranges from 4.5 – 6.5 (Thomas et al., 2023). The pH of the preparation before and after the stability test showed a decrease caused by external factors such as extreme storage temperatures (Sari et al., 2017). Based on the results of the pH evaluation of the cream preparation, the higher the content of mugwort leaf extract, the lower the pH of the preparation will be, or the more acidic it will become (Ain Thomas et al., 2022). This result is due to the mugwort leaf extract, which has a weakly acidic nature with a value

of 4.54. The pH value of topical preparations is related to the sensation when applied. A pH that is too acidic will cause skin irritation, while a pH that is too alkaline will make the skin dry. Therefore, the cream formulation must match the skin's pH (Nafisah et al., 2023). The pH stability test of the mugwort leaf cream preparation was conducted before the stability test (cycle 0) and after the stability test (cycle 6). *One-Way ANOVA* analysis of the pH test findings revealed a significance value of < 0.05 , particularly 0.000, indicating a substantial impact of the fluctuation in the concentration of mugwort leaf extract on the preparation's pH value. Wilcoxon analysis of the stability test results before and after revealed a significance value of < 0.05 , specifically 0.000, indicating a difference between the data before and after storage for six cycles. This suggests that the temperature and duration of storage may have an impact on the pH value of the cream preparation.

4.) Spreadability test

The spreadability test of the cream formulation is conducted to observe the formulation's ability to spread on the skin surface.

Table 6. Result Spreadability test

Formula	Spreadability test (cm) (mean±SD)	
	Before	After
F0	6,15±0,02	6,25±0,04
F1	6,19±0,02	6,28±0,04
F2	6,22±0,01	6,30±0,03
F3	6,26±0,02	6,36±0,04
F4	6,29±0,02	6,38±0,03

Explanation:

- F0 : Concentration of 0% ethanol extract of mugwort
- F1 : Concentration of 0,5% ethanol extract of mugwort
- F2 : Concentration of 1% ethanol extract of mugwort
- F3 : Concentration of 1,5% ethanol extract of mugwort
- F4 : Concentration of 2% ethanol extract of mugwort

The results of the physical evaluation of the spreadability test in Table 6 show that the cream preparation of mugwort leaf extract has a spreadability ranging from 6.15 to 6.38 cm, which falls within the required spreadability range for creams, namely 5 – 7 cm (Idawati et al., 2024). The spreadability of the cream preparation after the stability test in cycle 6 increased, which was due to the cream preparation becoming more fluid, influenced by extreme storage temperatures. The test results from F0 to F4 showed an increase in spreadability, which was caused by the variation in the concentration of the extract used. The mixture will be more liquid and have a stronger spreading potential if more mugwort leaf extract is utilized. Viscosity and spreading ability are correlated; the preparation's spreading ability increases with decreasing viscosity. The active ingredient's capacity to disperse on the skin's surface may be improved by applying more spreading power (Rahmawati et al., 2025). The stability test of the spreadability of the mugwort leaf cream preparation was conducted before the stability test (cycle 0) and after the stability test (cycle 6). The results of the spreadability test, analyzed using *One-Way ANOVA*, yielded a significance value of < 0.05 , specifically 0.000, which can be concluded to have a significant effect on the

variation in the concentration of mugwort leaf extract on the spreadability of the cream preparation. The results of the stability test before and after, analyzed using the Paired Sample Test, yielded a significance value of < 0.05 , specifically 0.000, indicating a difference between the data before and after storage for 6 cycles, which suggests that the duration and temperature of storage can affect the spreadability of the cream preparation.

5.) Viscosity test

To determine a cream formulation's thickness, viscosity is measured. An increase in viscosity value indicates a thicker texture, which can be said to make the formulation denser.

Table 7. Viscosity Test Results

Formula	Viscosity (cPs) (mean±SD)	
	Before	After
F0	4905,47±8,86	4899,73±7,99
F1	4900,39±8,78	4897,80±9,34
F2	4882,78±9,09	4880,98±9,11
F3	4878,64±12,11	4870,17±12,81
F4	4875,76±10,56	4870,93±13,10

Explanation:

- F0 : Concentration of 0% ethanol extract of mugwort
- F1 : Concentration of 0,5% ethanol extract of mugwort
- F2 : Concentration of 1% ethanol extract of mugwort
- F3 : Concentration of 1,5% ethanol extract of mugwort
- F4 : Concentration of 2% ethanol extract of mugwort

Mugwort leaf extract cream preparation's viscosity value varies from 4.870 to 4.905 cPs, which is within the necessary viscosity range for cream preparations, which is 2,000 to 50,000 cPs, according to the viscosity test findings in Table 7 (Ikhsan et al., 2023). The viscosity of the cream preparation after the stability test at cycle 6 decreased, which was due to the cream preparation becoming more diluted, influenced by extreme storage temperatures. The viscosity value of the preparation decreased after the stability cycling test due to the influence of air entering the preparation, which increased the water content in the preparation (Budianor et al., 2022). The spreadability value is inversely correlated with the cream's viscosity or thickness; the higher the viscosity, the lower the spreadability rating. The viscosity stability test of the mugwort leaf cream preparation was conducted before the stability test (cycle 0) and after the stability test (cycle 6). *One-Way ANOVA* analysis of the viscosity test findings revealed a significance value of < 0.05 , precisely 0.000, showing a substantial impact of the variation in mugwort leaf extract content on the viscosity of the cream product. The Paired Sample Test was used to analyze the stability test results before and after. The results showed a significance value of < 0.05 , specifically 0.000, indicating that there was a difference between the data before and after storage for six cycles. This suggests that the temperature and duration of storage can have an impact on the viscosity of the cream preparation (Erwiyani et al., 2018).

Hedonic test

The purpose of hedonic testing on cream preparations is to ascertain panelists' degree of acceptance, preference, and liking for the cream formulation. In order to identify the optimal formula, this test assesses the organoleptic properties of the cream, including its color, texture, and scent, on 20 panelists. The hedonic test results show that the most preferred preparation by the panelists, based on the color indicator, is formula 1 with 0.5% mugwort leaf extract, based on the texture indicator is formula 3 with 1.5% mugwort leaf extract, and based on the smell or aroma indicator is formula 2 with 1% extract. The overall preference in the hedonic assessment of the mugwort leaf extract cream preparation is formula 1 with 0.5% mugwort leaf extract because it has a color that is not too intense compared to the other formulas.

SPF Effectiveness Test

The testing of Sun Protection Factor (SPF) effectiveness on cream formulations aims to measure the product's effectiveness in protecting the skin from UV-B radiation, which can cause sunburn and skin damage. The SPF effectiveness test is conducted using a UV-Vis spectrophotometer by measuring the absorption of the solution at wavelengths from 290 to 320 nm.

Table 8. SPF Test Results

Formula	Results SPF	Type of protection
F0	3,69±0,18	Minimal Protection
F1	6,45±0,34	Extra Protection
F2	8,86±0,52	Maximum Protection
F3	10,43±0,45	Maximum Protection
F4	14,71±0,51	Maximum Protection

Explanation:

- F0 : Concentration of 0% ethanol extract of mugwort
- F1 : Concentration of 0,5% ethanol extract of mugwort
- F2 : Concentration of 1% ethanol extract of mugwort
- F3 : Concentration of 1,5% ethanol extract of mugwort
- F4 : Concentration of 2% ethanol extract of mugwort

The mugwort leaf extract's SPF value ranges from 1.44 to 27.44, while the cream preparation's SPF value ranges from 3.69 to 14.71, according to Table 8's results of the SPF (Sun Protection Factor) effectiveness test. There is a drop in SPF once the mugwort leaf extract is added to the cream mixture. This is due to the fact that the components of the cream may alter how the sunscreen absorbs UV rays, which could alter the SPF rating that is measured (Firdaus *et al.*, 2024). The value is in line with the increasing concentration of mugwort leaf extract as an active ingredient, which will also result in higher SPF effectiveness.

Conclusion

According to the study's findings, a sunscreen cream that satisfies all physical requirements—including organoleptic, homogeneity, pH, spreadability, viscosity, and SPF effectiveness—can be made using a 96% ethanol extract of mugwort leaves (*Artemisia vulgaris* L.). The panelists' favorite formula was F1, which contained 0.5% mugwort leaf extract. With a 2% mugwort leaf extract content, F4 produced the formula with the greatest SPF value.

Conflict of Interest Statement

The authors of this study have stated that the absence of commercial relationships is not considered a conflict of interest.

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