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Formulation And Evaluation Of Anti-Aging Face Spray Preparation From Ethanol Extract Of Rosemary Leaf (Salvia Rosmarinus Spenn.) And Antioxidant Activity Test Using The DPPH Method

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ABSTRACT
The skin's need to prevent premature aging requires skincare products with antioxidant content. A popular skincare product used today is face spray. Face sprays containing active ingredients as antioxidants are beneficial in preventing premature aging. One of the plants known for its antioxidant properties is rosemary leaf (Salvia rosmarinus Spenn.). The development of face spray with the addition of rosemary leaf extract is a form of utilizing plants in cosmetic products. This study is an experimental research. In this study, rosemary leaf ethanol extract face spray was formulated with concentrations of 0%, 0.5%, 1%, 3%, and 5%. Evaluation included physical quality, hedonic test, irritation test, antioxidant activity test, and anti-aging effectiveness test. Anti-aging data were analyzed using SPSS. Based on physical quality evaluation, the face spray formula with the best physical quality was found at extract concentrations of 1%, 3%, and 5%, with observations indicating stable organoleptic properties, pH within the skin range of 4.5-6.5, good spreading ability, no coarse particles or clumping, and stable formulations after 28 days of room temperature stability testing (25°C) and 6 cycle cycling tests. The formulations also showed no irritation to the skin. In the antioxidant activity test, the 0.5% extract concentration exhibited moderate antioxidant activity, while concentrations of 1%, 3%, and 5% showed strong antioxidant activity. In the anti-aging effectiveness test using a skin analyzer, each formula demonstrated significant differences in skin changes with a p-value of <0.05.

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INTRODUCTION

Maintaining and protecting the skin is essential for everyone, particularly against external issues. Skin health plays a crucial role in the body's defense system. Damage to the skin can impact both health and appearance. Indonesia, being a tropical country with year-round exposure to ultraviolet sunlight, makes its population highly susceptible to skin aging,

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particularly extrinsic aging caused by prolonged UV exposure (Zahruddin & Damayanti, 2018).

Aging is caused by two main factors: intrinsic and extrinsic. Intrinsic factors stem from physiological factors within the body, such as genetics, hormones, or race. Extrinsic factors, on the other hand, result from external influences like UV radiation from excessive sun exposure (photoaging), pollution, smoking, and others. Anti-aging is a branch of cosmetics that contains ingredients that can reduce wrinkles and improve skin moisture (Hakim et al., 2018). The primary function of anti-aging products is to reduce wrinkles, maintain skin elasticity, and prevent dark spots on the face.

Efforts to prevent or address the effects of premature aging can be made in various ways. One of the skin's needs to prevent damage from free radicals is antioxidants. Antioxidants are substances that provide protection against free radicals, making them essential for maintaining the skin's cells. The role of antioxidants is vital in protecting cells and DNA from potential damage caused by free radicals (Alim & Hasan, 2022). A common skincare product today is face spray. Face sprays containing active antioxidant ingredients have several benefits, such as neutralizing free radicals, preventing premature aging, and addressing dry skin. Products like face sprays with antioxidant content have become popular in the skincare routines of the Indonesian population (Nusaibah et al., 2022).

Free radicals are identified as the primary cause of premature aging in skin tissues. Premature aging occurs due to excessive exposure to free radicals, which leads to the degradation of skin collagen. Antioxidants are compounds that can slow down or inhibit oxidation reactions and have the ability to prevent or even reduce skin damage. Natural antioxidants can be found in plant parts and play an essential role in protecting the skin from the harmful effects of free radicals (Hutahaen & Saputri, 2022). One of the herbal plants with antioxidant properties is rosemary leaf (Salvia rosmarinus Spenn.). Rosemary is an herb widely distributed throughout the world. In a study by Esati et al. (2022), the ethanol extract of rosemary leaves showed an IC50 value of 10.68 ppm using the DPPH method and 51.84 ppm using the FRAP method, indicating that rosemary leaves have strong antioxidant activity in both antioxidant testing methods. The antioxidant test results of the ethanol extract of rosemary leaves were then applied as an active ingredient in a lotion product. A study by Kusumo et al. (2024) found that the IC50 value of 50% ethanol extract of rosemary leaves using the DPPH method was 35.388 ppm, indicating that this extract possesses very strong antioxidant activity.

Methods for measuring antioxidant activity can help determine the characteristics of antioxidants in a sample. Various methods can be used to assess the total antioxidant characteristics. One method for measuring antioxidant activity is DPPH (2,2-diphenyl-1-picrylhydrazyl) (Theafelicia & Narsito Wulan, 2023).

The creation of face spray with the addition of rosemary leaf extract (Salvia rosmarinus Spenn.) is one way to utilize plants as antioxidants in cosmetic products. Therefore, research into the use of rosemary leaf extract (Salvia rosmarinus Spenn.) in the production of face

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sprays, as a free radical neutralizer, premature aging prevention, and solution for dry skin, is essential for meeting the skin's needs.

METHODS

The research conducted is experimental. The study begins with sample collection, preparation of simplicia, and the creation of ethanol extract from rosemary leaves (Salvia rosmarinus Spenn.) using the maceration extraction method. The extract is then concentrated and formulated into a face spray containing the ethanol extract of rosemary leaves (Salvia rosmarinus Spenn.). Afterward, the face spray formulation is subjected to physical quality testing, antioxidant activity testing using the DPPH method, and anti-aging effectiveness testing, all of which are carried out at the Integrated Laboratory of the Muslim University of Nusantara Al-Washliyah Medan.

The antioxidant activity test using the DPPH method follows several steps. The first step involves preparing the DPPH solution by weighing 10 mg of DPPH powder (2,2-diphenyl-1-picrylhydrazyl), which is then dissolved using methanol p.a in a 50 mL volumetric flask to reach a concentration of 200 ppm. Then, a blank solution is prepared, and the wavelength optimization is carried out by mixing 1 mL of the 200 ppm DPPH solution into a 5 mL volumetric flask, followed by adding methanol until the flask reaches the mark to obtain a 40 ppm concentration. The absorbance of this solution is measured in the wavelength range of 400-800 nm using a UV-Vis spectrophotometer to determine the maximum wavelength. The next step is to determine the DPPH operating time. One mL of the 200 ppm DPPH solution is added to a 5 mL volumetric flask and diluted with methanol to achieve a concentration of 40 ppm. Absorbance is measured at the maximum wavelength for 60 minutes, and the stability of the absorbance is observed from minute 0 to minute 60. To prepare the comparison solution, 10 mg of vitamin C is dissolved in methanol in a 10 mL volumetric flask to a concentration of 1000 ppm. This solution is then diluted in various series from 0.005 mL to 0.025 mL, each mixed with 1 mL of the DPPH solution and methanol up to the mark in a 5 mL volumetric flask. The absorbance of each solution is measured at the maximum wavelength corresponding to the operating time that has been determined.

The antioxidant activity of the face spray is measured by preparing 5 mL of the rosemary leaf ethanol extract, which is dissolved in methanol p.a to a concentration of 200 ppm in a 25 mL volumetric flask. Then, dilutions are made at concentrations of 30, 60, 90, 120, and 150 ppm. Each solution is added with 1 mL of the DPPH solution, diluted with methanol up to the mark, and kept in a dark place at 37°C for 30 minutes. The absorbance of the solution is measured using a UV-Vis spectrophotometer at the maximum wavelength according to the previously determined operating time. Anti-aging effectiveness testing is conducted with 15 volunteers, where the initial skin condition is measured using a skin analyzer EH-900U. The parameters measured include: sebum (oil) level, pigmentation, elasticity, and moisture level. After the initial skin condition measurements, treatment begins by spraying the face spray formulation evenly on the back of the hands, twice a day in the morning and evening. The treatment is performed daily for 21 days. Skin condition changes are measured weekly using

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the skin analyzer. The data obtained from each anti-aging parameter will be analyzed using statistical software with the ANOVA method, followed by a Tukey test to compare differences between treatment groups.

RESULTS AND DISCUSSION

Results of the Rosemary Leaf Simplisia Characterization Test

The characterization test of the rosemary leaf simplicia includes the examination of total ash content, acid-insoluble ash content, moisture content, water-soluble extract content, and ethanol-soluble extract content, as shown in Table 1below:

Table 1. Simplisia Characteristics

No.	Parameter	Test Results
1.	Moisture Content	7.56%
2.	Total Ash Content	8.78%
3.	Acid-Insoluble Ash Content	1.4%
4.	Water-Soluble Extract Content	15.9%
5.	Ethanol-Soluble Extract Content	11.42%

Based on the tests conducted, the rosemary leaf simplicia has a moisture content of 7.56%, which meets the general standard for simplicia moisture content, which should be less than 10% (Depkes RI, 1995). The total ash content was found to be 8.78%, while the acid-insoluble ash content was 1.4%. The total ash content test provides an overview of the internal and external mineral content originating from the initial processing stages up to the formation of the extract. The lower the ash content, the higher the quality of the simplicia. The water-soluble extract content was found to be 15.9%, and the ethanol-soluble extract content was 11.42%. These tests aim to determine the amount of compounds extracted using water (polar solvent) and ethanol (semi-polar/non-polar solvent) (Depkes RI, 2000).

Secondary Metabolite Phytochemical Screening

Phytochemical screening is an initial step to identify the chemical compounds present in an extract. In this study, screening was performed on the 96% ethanol extract of rosemary leaves to determine the content of secondary metabolites and to conduct a qualitative antioxidant test on the rosemary leaf extract. The results of the phytochemical screening, including tests for alkaloids, flavonoids, saponins, tannins, steroids/triterpenoids, and glycosides, are shown in Table 2 below:

Table 2. Secondary Metabolite Phytochemical Screening Results

Test	Result
Alkaloids	+
Flavonoids	+
Tannins	+
Saponins	+
Steroids	-
Triterpenoids	+
Glycosides	+

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Note:

(+) : Contains secondary metabolite compounds

(-) : Does not contain secondary metabolite compounds

Based on the results of the screening, the rosemary leaf extract was found to contain secondary metabolites such as alkaloids, flavonoids, tannins, saponins, triterpenoids, and glycosides.

Preparation of Face Spray Formulation

The formulation of the rosemary leaf extract face spray was made with varying concentrations of the extract: F0 (blank), F1 0.5%, F2 1%, F3 3%, and F4 5%. The excipients used in the preparation of the face spray formulation included glycerin, propylene glycol, phenoxyethanol, and distilled water (aquadest). The excipients were added in the same concentration for each formula created.

1. Glycerin was added at a concentration of 10%, acting as a humectant and emollient to control moisture on the skin, thereby hydrating and softening the skin.
2. Propylene glycol was added at 5%, serving as a humectant to help maintain skin hydration.
3. Phenoxyethanol was used as a preservative at a concentration of 0.5%. It is effective in extending the shelf life of the product due to its antimicrobial properties.
4. Distilled water (aquadest) was used as a solvent and as a base material.

The face spray formulation resulted in a clear solution without turbidity or sediment. The face spray formulation can be seen in Figure 1 below.

Figure 1. Ethanol Extract Rosemary Leaf Face Spray

Physical Quality Evaluation of Face Spray Formulation

Organoleptic Test Results

The organoleptic test is an assessment using human sensory organs (sight, smell, and touch) to evaluate the physical appearance of the formulated product. This test aims to assess the color, scent, and form of the prepared face spray formulation. The results of the organoleptic test for the face spray formulation are presented in Table 3 below.

Table 3. Organoleptic Test Results of Face Spray

Formula	Rosemary Extract Concentration	Color	Smell	Form
F0	0%	Clear	Odorless	Liquid
F1	0.5%	Yellow	Characteristic	Liquid

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Formula	Rosemary Extract Concentration	Color	Smell	Form
F2	1%	Yellow-Brown	Characteristic	Liquid
F3	3%	Brown	Characteristic	Liquid
F4	5%	Brown	Characteristic	Liquid

The organoleptic evaluation results of the ethanol extract rosemary leaf face spray indicate that the appearance of the formulation changes depending on the concentration of the rosemary extract. For formula F0, the spray is clear and odorless, while formulas F1, F2, F3, and F4 show a yellow to brown color with a characteristic rosemary scent. The higher the concentration of the extract in the formulation, the darker the color of the resulting face spray.

pH Test Results

The pH test on the face spray formulation was conducted to determine the acidity level of the rosemary leaf extract-based face spray. The test was performed using a pH meter, where the meter was inserted into the sample, and the measure button was pressed and left for about 1-2 minutes. The results of the pH test for the face spray formulation are presented in Table 4 below.

Table 4. pH Test Results of Face Spray

Formula	Rosemary Extract Concentration	pH Observation (Replicate)	Average ± SD
		Replicate 1	Replicate 2
F0	0%	7.26	7.26
F1	0.5%	6.28	6.28
F2	1%	6.24	6.22
F3	3%	5.84	5.80
F4	5%	5.59	5.59

Based on the pH measurements of the formulations, the pH values for formulations F1 (0.5%), F2 (1%), F3 (3%), and F4 (5%) fall within the acceptable range of pH 4.5–6.5. However, for the F0 (blank) formulation, the pH exceeds the acceptable range at 7.26, which is higher than the ideal value of 6.5. In topical formulations, pH is important for user comfort during application. If the pH is too acidic or alkaline, it can cause irritation to the skin. Therefore, the pH of the face spray formulation needs to match the skin's natural pH. If the pH is above the skin's pH, it could result in a slippery feeling, dryness, and potentially affect the skin's elasticity.

Homogeneity Test Results

The homogeneity test is a requirement for the face spray formulation. This test was performed by applying or spraying the face spray onto a glass plate or another suitable transparent material, and then observing the homogeneity of the solution. The results of the homogeneity test for the face spray formulations are presented in Table 5 below.

Table 5. Homogeneity Test Results of Face Spray

Formula	Replicate 1	Replicate 2	Replicate 3	Result
F0	Homogeneous	Homogeneous	Homogeneous	Homogeneous
F1	Homogeneous	Homogeneous	Homogeneous	Homogeneous
F2	Homogeneous	Homogeneous	Homogeneous	Homogeneous

Jurnal Eduhealth
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Formula	Replicate 1	Replicate 2	Replicate 3	Result
F3	Homogeneous	Homogeneous	Homogeneous	Homogeneous
F4	Homogeneous	Homogeneous	Homogeneous	Homogeneous

Based on the results of the homogeneity tests for formulations F0 (blank), F1 (0.5%), F2 (1%), F3 (3%), and F4 (5%) performed with three repetitions, there were no visible coarse particles or clumps on the glass surface. The face spray formulations were observed to be homogeneous, indicating that the ethanol extract of rosemary leaf face spray has a consistent composition.

Spray Dispersion Test Results

The spray dispersion test aims to ensure that the face spray formulation spreads well when applied to the skin and to evaluate the quality of the spray nozzle used. The results of the spray dispersion test are presented in Table 6 below.

Table 6. Spray Dispersion Test Results for Face Spray

Formula	Replicate 1	Replicate 2	Replicate 3	Average ± SD
F0	7.5 cm	8.5 cm	8 cm	8 ± 0.35 cm
F1	7 cm	7.5 cm	7 cm	7.16 ± 0.2 cm
F2	6.5 cm	7.5 cm	7 cm	7 ± 0.35 cm
F3	7.5 cm	7 cm	7.5 cm	7.3 ± 0.21 cm
F4	6 cm	6.5 cm	6 cm	6.16 ± 0.2 cm

The face spray was applied to a mica sheet at a distance of 5 cm. The results of the spray dispersion were affected by the spraying distance. The further the spraying distance, the wider the spray pattern diameter. Based on the spray dispersion test results, each repetition conducted on the four formulations of face spray containing the ethanol extract of rosemary leaves (F1, F2, F3, and F4) showed a good spray dispersion value. The values met the required range, which is between 5–7 cm.

Room Temperature Stability Test Results

The stability test is an initial parameter to assess the stability of a product. The stability test conducted on the ethanol extract of rosemary leaf face spray includes organoleptic tests (color, odor, form) and pH stability, which were observed over four weeks during storage at room temperature (25°C). The results of the stability test are shown in Table 7 and Table 8 below.

Table 7. Organoleptic Stability Test Results at Room Temperature

Formula	Week	Examination Type
		Color
F0	1	Clear
	2	Clear
	3	Clear
	4	Clear
F1	1	Yellow
	2	Yellow
	3	Yellow

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ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

Formula	Week	Examination Type Color
	4	Yellow
F2	1	Yellow-Brown
	2	Yellow-Brown
	3	Yellow-Brown
	4	Yellow-Brown
F3	1	Brown
	2	Brown
	3	Brown
	4	Brown
F4	1	Brown
	2	Brown
	3	Brown
	4	Brown

Based on the results of the organoleptic stability test, no significant changes in color, odor, or form were observed over the four weeks of storage at room temperature (25°C). All concentrations of the face spray maintained a consistent liquid form and distinct rosemary leaf aroma.

Table 8. pH Stability Test Results at Room Temperature

Formula	Week 1	Week 2	Week 3	Week 4
F0	7.26	7.24	7.23	7.23
F1	6.28	6.27	6.27	6.25
F2	6.24	6.24	6.22	6.22
F3	5.84	5.82	5.82	5.80
F4	5.60	5.59	5.55	5.55

In the pH stability test conducted over four weeks at room temperature (25°C), the pH values of the formulations F1 (0.5%), F2 (1%), F3 (3%), and F4 (5%) remained within the acceptable range of 4.5–6.5, meeting the required standards. However, the pH of the blank formulation (F0) exceeded the optimal range (> 6.5). If the pH of a product changes significantly and falls outside the normal pH range for the skin, it could lead to irritation. These room temperature stability test results indicate that the face spray remained stable during the four weeks of storage at room temperature.

Mechanical Stability Test Results

The mechanical stability test is performed to detect phase separation in the preparation. The test involves placing the sample into a centrifuge tube and centrifuging it at a speed of 3000 rpm for 30 minutes. This procedure simulates the gravitational effects on the preparation during 10 months of storage (Cendana et al., 2021). Based on the results of the mechanical stability test, all preparations did not show any phase separation that would form a layer above the sample. This indicates that the preparations were stable and no phase separation occurred in the formulations F0 (blank), F1 (0.5%), F2 (1%), F3 (3%), and F4 (5%).

Jurnal Eduhealth
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https://ejournal.seaninstitute.or.id/index.php/healt

Cycling Test Results

The cycling test was conducted to assess the organoleptic properties, pH, and homogeneity of the face spray preparations over six cycles. The results are presented below:

Table 9. Organoleptic Cycling Test Results

Formula	Before	After
	Color	Aroma
F0	Clear	Characteristic
F1	Yellow	Characteristic
F2	Yellow-Brown	Characteristic
F3	Brown	Characteristic
F4	Brown	Characteristic

The organoleptic test was performed to determine whether there were any changes in color, aroma, and texture before and after the cycling test. The results showed that no changes were observed in color, aroma, or texture, indicating that the aesthetic and comfort aspects of the topical preparations remained unaffected.

Table 10. pH Cycling Test Results

Formula	pH Observation
	Before
F0	7.23
F1	6.25
F2	6.22
F3	5.82
F4	5.55

The pH test was conducted to observe changes in pH before and after each cycle of the test. Based on the results from all five formulas over six cycles, there were fluctuations in pH, with slight increases and decreases. However, these pH changes were not significant and remained within the normal pH range of skin (4.5-6.5), indicating that the pH of the preparations remained stable throughout the cycling test.

Irritation Test Results

The irritation test was conducted on 15 volunteer participants by applying the face spray preparation on the inner forearm twice daily for 2 consecutive days (Satria & Siahaan, 2018). The criteria for selecting volunteers included healthy women aged 20-25 years, with no history of allergic-related conditions and in good physical and mental health. The purpose of the irritation test was to determine if any skin irritation occurred and to evaluate the characteristics of the substance when applied to the skin. Skin irritation was observed based on the appearance of redness, itching, or swelling after applying the face spray. The results of the irritation test, conducted on 15 volunteers, showed no signs of irritation such as redness, itching, or swelling. These findings demonstrate that the face spray preparation containing ethanol extract of rosemary leaves does not contain irritant substances, making it safe for use without causing any irritation.

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https://ejournal.seaninstitute.or.id/index.php/healt

Results of Antioxidant Activity Test of Face Spray

The measurement of antioxidant activity using the DPPH method is employed to determine the antioxidant activity of the ethanol extract of rosemary leaf face spray formulation against free radicals. The absorbance is measured using a UV-Vis spectrophotometer at a wavelength of 515 nm. The antioxidant activity of the sample was measured at test solution concentrations of 30 ppm, 60 ppm, 90 ppm, 120 ppm, and 150 ppm, where each concentration was added with 1 mL of DPPH solution and its absorbance was measured after 10 minutes. The results of the linear regression equation and IC50 value of the test solution can be seen in Table 13.

Table 11. Results of Linear Regression Equation and IC50 Value of Face Spray

No.	Sample Solution	Regression Equation	IC50 Value	Description
1.	F0 (blank)	y = 0.1544x + 0.6721	834.269	Very Weak
2.	F1 (0.5%)	y = 0.4951x - 1.1281	101.6976	Moderate
3.	F2 (1%)	y = 0.5309x + 0.1898	93.8172	Strong
4.	F3 (3%)	y = 0.5041x + 4.0085	90.7546	Strong
5.	F4 (5%)	y = 0.5425x + 5.8985	81.3362	Strong

A compound is categorized as very strong if the IC50 value is < 50 ppm, strong if the IC50 value is between 50-100 ppm, moderate if the IC50 value is between 100-150 ppm, weak if the IC50 value is between 150-200 ppm, and very weak if IC50 > 200 ppm (Molyneux, 2004). The antioxidant activity of the face spray formulation was tested in triplicate for each formula. The IC50 calculation results for the ethanol extract of rosemary leaf face spray show that F0 (blank) had an average IC50 of 834.269, categorized as very weak. F1 (0.5%) produced an average IC50 of 101.6976, categorized as moderate antioxidant activity. F2 (1%) resulted in an average IC50 of 93.8172, F3 (3%) resulted in an average IC50 of 90.7546, and F4 (5%) resulted in an average IC50 of 81.3362. Formulations F2, F3, and F4 were categorized as having strong antioxidant activity.

Among the four face spray formulations containing the ethanol extract of rosemary leaves, all formulations exhibited antioxidant activity, with three out of the four concentrations displaying strong antioxidant activity. It can be concluded that the greater the amount of rosemary leaf extract added to the face spray formulation, the higher the inhibition percentage and the lower the IC50 value.

Results of Anti-Aging Effectiveness Test for Face Spray Formula Using Skin Analyzer

The effectiveness of the anti-aging formula was tested using the EH-900U skin analyzer, starting with measuring the initial skin condition of the volunteers before the treatment was applied. The parameters measured included oil levels (sebum), pigmentation, elasticity, and moisture levels. The application was performed on the back of the hands twice a day every day for 21 days. The examinations were carried out on day 0, day 7, day 14, and day 21.

Oil Level (Sebum)

The oil level (sebum) was measured using the EH-900U skin analyzer by placing the camera handset on the back of the hand to be tested and then capturing the image. The

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sebum option was selected for measurement, and the result appeared on the screen. This measurement was conducted on the volunteer's skin condition before using the face spray and during the three-week treatment, with regular checks using the face spray.

Table 12. Oil Level (Sebum) Measurement Results

Formula	Volunteer	% Oil Level (Sebum)	Before Application	Week 1	Week 2	Week 3	% Recovery
F0	1	29	27	27	6.89%		
	2	20	19	19	5%		
	3	22	20	17	22.72%		
	Average	23.67	22	21.33	11.28%		
F1	4	30	20	7	76.67%		
	5	19	15	7	63.15%		
	6	13	13	9	30.77%		
	Average	20.67	16	7.67	62.9%		
F2	7	36	16	8	77.78%		
	8	27	24	5	81.48%		
	9	35	31	18	48.57%		
	Average	32.67	23.67	10.33	68.38%		
F3	10	31	20	6	80.64%		
	11	34	24	10	70.58%		
	12	20	13	9	55%		
	Average	28.33	19	8.33	70.6%		
F4	13	26	16	7	73.07%		
	14	17	11	7	58.82%		
	15	15	12	8	46.67%		
	Average	19.33	13	7.33	62.07%		

Measurement Values: 3-7 (Normal), 7-9 (Perfect), 9-25 (High), 25-30 (Too High)

According to the EH-900U skin analyzer reference, a normal oil level is between 6-7%, while a perfect oil level ranges from 7-9%. The measurement results showed varying oil levels in the volunteers' initial skin condition. After the three-week treatment, where the face spray was applied in the morning before activities and at night before bed, and measured weekly, the oil levels of the volunteers' skin progressively shifted towards normal oil levels.

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Based on the SPSS analysis, a probability value of 0.001 < 0.05 was obtained, indicating that each formulation significantly differed in the oil level changes. Post Hoc tests revealed that F0 (without concentration) showed significant differences compared to all formulas. There were no significant differences between F1, F2, and F3 formulas with a probability > 0.05. However, F4 showed significant differences compared to F1, with a probability of 0.001 < 0.05. The graph of oil level changes can be seen in Figure 2.

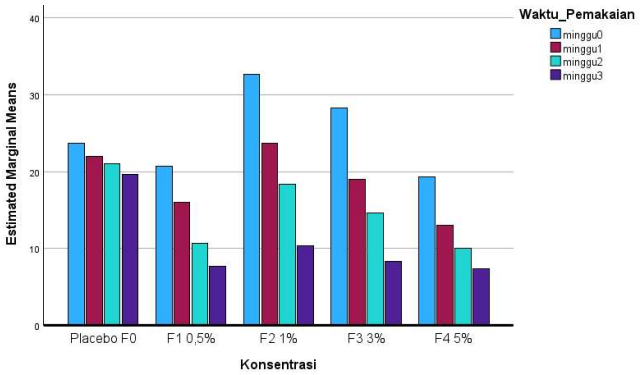

Figure 2. Diagram of Sebum Level Changes

Pigmentation

Pigmentation measurement was conducted using the EH-900U skin analyzer by placing the camera handset on the back of the hand to be examined and then capturing the image. The pigmentation option was selected for measurement, and the result appeared on the screen. This measurement was done on the volunteer's skin condition before using the face spray and during the three-week treatment with routine checks using the face spray.

Table 13. Pigmentation Measurement Results

Formula	Volunteer	% Pigmentation	Before Application	Week 1	Week 2	Week 3	% Recovery
F0	1	34	34	31	31	8.82%	
	2	22	22	25	25	13.63%	
	3	16	16	16	16	0%	
	Average	24	24	24	24	0%	
F1	4	26	25	19	19	26.92%	
	5	24	19	14	14	41.66%	
	6	43	31	31	14	67.44%	
	Average	31	34	23.33	15.67	49.45%	
F2	7	16	15	9	9	43.75%	
	8	16	15	9	9	43.75%	
	9	16	14	13	12	25%	
	Average	16	14.67	11.33	10	37.5%	
F3	10	17	16	13	12	29.41%	
	11	16	16	12	8	50%	
	12	21	18	18	12	42.85%	
	Average	18	16.67	14.33	10.67	40.72%	

Jurnal Eduhealth
Volume 16, Number 01 2025 DOI 10.54209/eduhealth.v16i01
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

Formula	Volunteer	% Pigmentation	Before Application	Week 1	Week 2	Week 3	% Recovery
F4	13	37	30	27	24	35.13%	
	14	52	45	43	34	34.61%	
	15	52	46	45	42	19.23%	
	Average	47	40.33	38.33	33.33	29.08%	

Measurement Values: 8-10 (Very Light), 10-20 (Light), 20-30 (Normal), 30-40 (Deep), 40-75 (Very Deep)

According to the EH-900U skin analyzer reference, normal pigmentation ranges from 20-30%. The pigmentation measurement results showed that the volunteers' skin had varying levels of pigmentation. It is also possible that the volunteers had used specific cosmetic products prior to the test, resulting in very light pigmentation levels. After the three-week treatment, where the face spray was applied in the morning before activities and at night before bed, and measured weekly, pigmentation on the volunteers' skin showed noticeable changes. Based on the SPSS analysis, a probability value of 0.001 < 0.05 was obtained, indicating that each formulation significantly differed in terms of pigmentation changes. Post Hoc tests showed that there was no significant difference between F0 and F1 ($p > 0.05$). However, there were significant differences between F1, F2, F3, and F4 formulations ($p < 0.05$). The graph showing pigmentation changes can be seen in Figure 3.

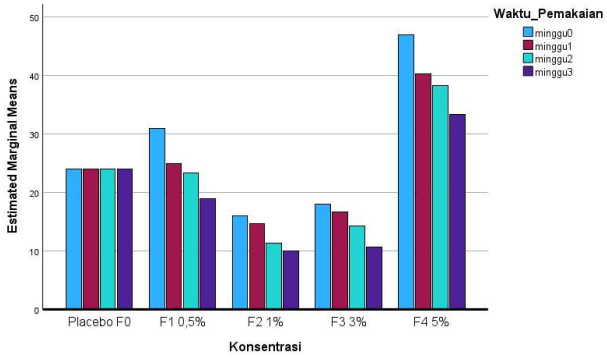

Figure 3. Pigmentation Change Diagram

Elasticity

Elasticity measurement was conducted using the EH-900U skin analyzer by placing the handset camera on the back of the hand to be examined and then taking a shot. The "elasticity" option was selected for measurement, and the results were displayed on the screen. This measurement was done on the skin of the volunteers before using the face spray and throughout three weeks of treatment with the face spray, measured routinely every week.

According to the EH-900U skin analyzer reference, normal skin elasticity ranges from 50-65%, better elasticity is between 65-70%, and the best elasticity ranges from 70-71%.

Table 14. Elasticity Measurement Results

Formula	Volunteer	% Elasticity	Before Use	Week 1	Week 2	Week 3	% Recovery
F0	1	19	15	15	15	21.05%	
	2	39	43	43	43	10.25%	

Jurnal Eduhealth
Volume 16, Number 01 2025 DOI 10.54209/eduhealth.v16i01
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https://ejournal.seaninstitute.or.id/index.php/healt

Formula	Volunteer	% Elasticity	Before Use	Week 1	Week 2	Week 3	% Recovery
	3	23	23	28	28	21.74%	
	Average	27	27	28.67	28.67	6.18%	
F1	4	37	39	46	52	40.54%	
	5	34	39	45	57	67.64%	
	6	38	40	52	61	60.52%	
	Average	36.33	39.33	47.67	56.67	55.98%	
F2	7	17	28	38	42	147%	
	8	37	42	52	57	54.05%	
	9	20	26	38	52	160%	
	Average	24.66	32	42.67	50.33	104%	
F3	10	24	26	48	53	120%	
	11	18	27	34	50	177%	
	12	43	47	48	57	32.55%	
	Average	28.33	33.33	43.33	53.33	88.24%	
F4	13	40	44	46	55	37.5%	
	14	43	48	56	59	37.2%	
	15	46	51	55	57	23.91%	
	Average	43	47.67	52.33	57	32.55%	

Measurement Values: 15-35 (Loose skin), 35-50 (Weak elasticity), 50-65 (Normal), 65-70 (Better elasticity), 70-71 (Best elasticity)

The elasticity measurement results indicate that after three weeks of treatment, with the face spray applied in the morning before activities and at night before sleep, and measured routinely every week, the elasticity of the volunteers' skin showed improvement toward the normal range.

Based on the analysis using SPSS, the probability value obtained was 0.001 < 0.05, meaning that each formulation had a significant difference in elasticity changes. Post Hoc tests showed that all formulations had significant differences between them with p < 0.05. The graph of elasticity changes can be seen in Figure 4.

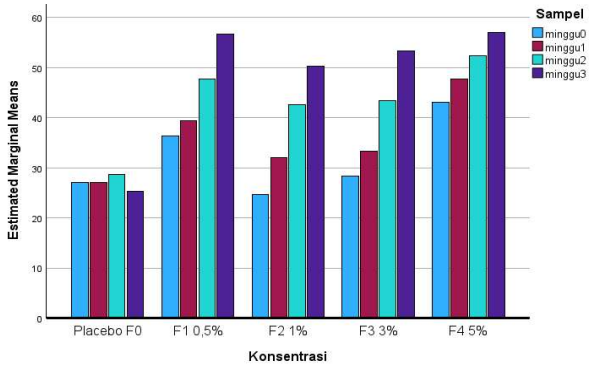

Figure 4. Diagram of Elasticity Changes

Jurnal Eduhealth
Volume 16, Number 01 2025 DOI 10.54209/eduhealth.v16i01
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

Moisture Content

The measurement of moisture content is performed by selecting the moisture option on the measurement tool, and the result will appear on the screen. This measurement is done on the volunteer's skin before using the face spray and during a three-week treatment period using the face spray, which is regularly checked. Normal skin moisture content ranges from 10-15%, and the optimal moisture content is between 30-65%.

Table 15. Moisture Measurement Results

Formula	Volunteer	% Moisture Content				
		Before Use	Week 1	Week 2	Week 3	% Recovery
F0	1	25	25	38	28	12%
	2	29	29	30	30	3.4%
	3	39	39	40	40	2.56%
	Average	31	31	36	32,67	5.38%
F1	4	38	40	57	58	52.63%
	5	26	38	45	55	111%
	6	29	29	35	39	34.48%
	Average	31	32,33	45,67	50,67	63.45%
F2	7	32	38	53	63	96.87%
	8	20	38	45	65	225%
	9	33	54	54	55	66.67%
	Average	28,33	43,33	50,67	61	115%
F3	10	29	31	52	58	100%
	11	30	46	52	58	93.33%
	12	28	37	40	52	85.71%
	Average	29	38	48	56	93.1%
F4	13	33	39	43	62	87.87%
	14	61	65	65	65	6.55%
	15	20	29	35	53	165%
	Average	38	44,33	47,67	60	57.9%

Measurement Values: 3-4 (Dry), 4-10 (Ageing Skin), 10-15 (Normal), 15-30 (Higher Water Content), 30-65 (Shiny Skin Moist)

The moisture measurement results show that the initial condition of the volunteers' skin had varying moisture levels. After undergoing treatment for three weeks with the application of face spray, the moisture content in the volunteers' skin increased. The elasticity changes are shown in Figure 5.

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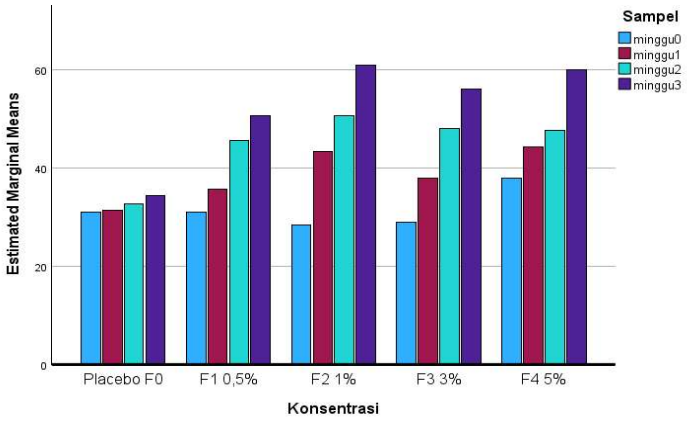

Figure 5. Moisture Content Change Diagram

Based on the analysis using SPSS, the probability value obtained is < 0.05, which indicates that each formulation has a significant difference in moisture content change. Further Post Hoc testing shows that F0 does not have a significant difference compared to F1 with p > 0.05. For F2, F3, and F4, no significant differences were found between the formulas, with probabilities > 0.05.

CONCLUSION

Based on the results of the research conducted, it can be concluded that ethanol extract of rosemary leaves can be used as an active ingredient in face spray formulations. The addition of ethanol extract of rosemary leaves influences the color and aroma of the preparation. Based on the evaluation of the physical quality of the ethanol extract of rosemary leaves face spray, the best face spray formulation was obtained at extract concentrations of F1 (0.5%), F2 (1%), F3 (3%), and F4 (5%). These formulations showed stable physical quality, with pH levels within the required range of 4.5-6.5, and a homogeneous preparation with no coarse particles or clumping. In addition, the ethanol extract of rosemary leaves face spray exhibited moderate to strong antioxidant activity. The face spray also demonstrated effectiveness in anti-aging. The increasing moisture content and skin elasticity, along with normal sebum levels, indicate that the ethanol extract of rosemary leaves face spray is effective as an anti-aging product.

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