
The Effect Of Variations In Carbopol Concentration On The Physical Characteristics And SPF Value Of Sunscreen Spray Gel With Ethanol Extract Of Kepok Banana Flowers (*Musa Acuminata X M. Balbisiana*) By UV-Vis Spectrophotometry

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Abstract

Excessive exposure to UV rays can cause various skin damage so that sunscreen preparations are needed. Kepok banana flowers (*Musa acuminata x M. balbisiana*) contain flavonoid compounds that have the potential as active ingredients in natural sunscreens, especially in the form of spray gel preparations. This study aims to determine the effect of variations in carbopol concentration on the physical characteristics and SPF value of spray gel preparations using UV-Vis spectrophotometry, and to determine the most optimal formula. Ethanol extract of kepok banana flowers was obtained by maceration method using 96% ethanol. Sunscreen spray gel from ethanol extract of kepok banana flowers was formulated with variations in carbopol concentrations of 0,5% (F1), 0,75% (F2), and 1% (F3). The resulting spray gel was tested including organoleptic, homogeneity, pH, viscosity, adhesion, spray pattern, and SPF value. The results showed that variations in carbopol concentration significantly affected the physical characteristics of the preparation, especially the organoleptic texture, pH, viscosity, and spray pattern, but did not significantly affect the SPF value of the spray gel preparation of ethanol extract of kepok banana flowers (*Musa acuminata x M. balbisiana*). Formula 2 with a carbopol concentration of 0,75% was determined as the most optimal formula with the most balanced physical characteristics and an SPF value of 15.616 with an ultra protection category.

Keywords: Carbopol 940, Kepok Banana Flower Extract, Spray Gel, Sun Protection Factor, Sunscreen.

INTRODUCTION

Ultraviolet (UV) rays are a small part of the electromagnetic spectrum with wavelengths of 100-400 nm, divided into UV-A (320-400 nm), UV-B (290-320 nm), and UV-C (100-280 nm). Excessive exposure to UV radiation can cause skin damage such as erythema, sunburn, premature aging, and even skin cancer (Anwar *et al.*, 2022). WHO data for 2022 recorded 331.722 cases of malignant melanoma globally, with 25.033 in Asia and 1.716 in Indonesia. In the same year, non-melanoma cancer cases reached 1.234.533 globally, with 120.846 in Asia and 7.841 in Indonesia. The high number of incidents shows the importance of efforts to protect the skin from exposure to UV rays..

Sunscreens work through two mechanisms: reflecting and absorbing UV radiation. Active ingredients such as ZnO, TiO₂, octyl methoxycinnamate, benzophenone, and octocrylene are commonly used, but they have the potential to cause skin irritation and damage if used excessively. Therefore, natural sunscreen alternatives are needed. Phenolic compounds, especially flavonoids, are known to be able to absorb UVA and UVB rays and have antioxidant activity that can ward off free radicals caused by UV exposure (Paongan & Vifta, 2022).

Kepok banana flower (*Musa acuminata x M. balbisiana*) known contains flavonoid, polyphenol, and saponin compounds and has an IC₅₀ value of 13.21 µg/mL (Nurhaeni *et al.*, 2019). Ethanol extract of kepok banana flowers (*Musa acuminata x M. balbisiana*) in cosmetic preparations with concentrations of 0,4%; 0,6%; and 0,8% has an IC₅₀ value of 33.83 µg/mL, 27.85 µg/mL, and 10.04 µg/mL, respectively. These results indicate that the antioxidant activity produced is included in the very strong category, namely <50 ppm (Husnani *et al.*, 2024). Therefore, the ethanol extract of kepok banana flowers has the potential to be used as an active ingredient in sunscreen preparations, one of which is *spray gel*.

Spray gelis a development of gel preparations which have advantages including a lower risk of microorganism contamination, as well as providing longer contact time on the skin (Cendana *et al.*, 2021). This superiority is influenced by the addition of important components to the formulation, one of which is a gelling agent such as carbopol 940. Carbopol 940 is a gelling agent that functions to increase viscosity and produce a clear gel, is easy to spread, provides a cool sensation, does not clog pores, and is easy to clean (Susianti *et al.*, 2021). According to Sheskey *et al.* (2017), the recommended concentration of carbopol 940 in topical formulations is 0,5-2,0%.

Based on the description, this study aims to determine the effect of variations in the concentration of carbopol 940 (0,5%; 0,75%; and 1%) on the physical characteristics and SPF value of sunscreen spray gel preparations made from ethanol extract of kepok banana flowers (*Musa acuminata x M. balbisiana*) by UV-Vis spectrophotometry.

RESEARCH METHODS

Data Analysis Instruments and Techniques

The tools used were dry cabinet, blender, sieve, maceration vessel, stirring rod, filter paper, evaporator cup, rotary evaporator (*DLAB*), analytical balance (*Kern*), moisture balance (*Ohaus*), beaker glass (*pyrex*), measuring cup (*pyrex*), mortar, stamper, spatula, horn spoon, watch glass, pH meter, mica plastic, Brookfield viscometer, spray gel container, measuring flask, dropper pipette, cuvette, and UV-Vis spectrophotometer (*Shimadzu UV-1280*). The materials used are kepok banana flowers (taken from the inside of the banana heart which is shaped like fingers and is old), 96% ethanol, carbopol 940, triethanolamine, propylene glycol, methyl paraben, propyl paraben, distilled water, HCl, FeCl₃, CH₃COOH, H₂SO₄, Mg powder.

Research Procedures

Making Simple Powder

The kepok banana flowers used are the inner, finger-shaped, mature part of the banana heart. 3,5 kg of kepok banana flowers were wet sorted and cleaned by washing under running water. Then, they were chopped and dried using a dry cabinet to obtain dry herbal preparations. Afterward, dry sorting was carried out to remove foreign matter during drying and the herbal preparations were ground using a blender to obtain herbal powder. The powdered herbal preparations were then stored in a tightly closed container (Husnani *et al.*, 2024).

Standardization of Simple Drugs

Carefully weigh 2 grams of the crude drug and place it in a covered porcelain crucible for thirty minutes. Then, spread the crude drug evenly in the crucible and place it in an oven, remove the lid, and heat it at 105°C until the weight remains constant (Dayanti *et al.*, 2022).

Water content

Moisture content was measured using a moisture balance at 105°C for 15 minutes. Two grams of the crude drug was weighed, placed evenly on an aluminum dish, and then covered until a constant moisture content was achieved. The results were then recorded (Samodra *et al.*, 2023).

Ash Content

Place 2 grams of the crude drug into a silica crucible. Heat slowly to 600°C for 4 hours, then cool in a desiccator and weigh (Dayanti *et al.*, 2022).

Extract Preparation

The extract was made using the maceration method using 96% ethanol solvent with a ratio of 1:10. A total of 500 grams of kepok banana flower powder was placed in a maceration container and 5 L of 96% ethanol solvent was added. Soak for the first 6 hours while stirring, then let it stand for 18 hours. Next, filtering was carried out to separate the filtrate and sediment. Repeat the extraction process with the same type of solvent and half the volume of the solvent from the previous volume to obtain a second filtrate. The re-maceration process was carried out once again with the same procedure to obtain a third filtrate. All filtrates from the maceration results were collected, then concentrated

using a rotary evaporator at a temperature of 40°C until a thick extract of kepok banana flowers was obtained. After obtaining the thick ethanol extract of kepok banana flowers, the % yield was calculated (Hita et al., 2025).

Extract Standardization

Water content

A total of 2 grams of extract was evenly distributed on an aluminum dish in a moisture balance. Close the device and heat it at 105°C for 15 minutes until the device automatically reads, then record the moisture content reading in percent (Samodra et al., 2023).

Ethanol Free

As many as 1 gram of thick extract was added to a test tube, 2 drops of H₂SO₄ and 2 drops of acetic acid were added, and then heated. The extract was considered ethanol-free if it did not exhibit the characteristic ester odor of ethanol (Tivani et al., 2021).

Metal Free

This is done using ethanol divided into two parts. For the lead (Pb) test, 1 ml of sample solution is placed in a test tube, and 0,5 ml of K₂CrO₄ is added. For the cadmium (Cd) test, 5 drops of NaOH are added to 5 ml of the sample, then shake briefly and observe the changes that occur. A positive result for Pb is if a yellow precipitate forms, and a positive result for Cd is if a white precipitate forms (Eka et al., 2024).

Phytochemical Screening

Phytochemical screening tests are carried out to determine the chemical properties contained in the plants to be studied. These tests include flavonoid tests, saponin tests, and polyphenol tests.

Kepok Banana Flower Ethanol Extract Spray Gel Formulation

Table 1.Spray Gel Formula

Material	Concentration (%)			Function
	F1	F2	F3	
Ethanol extract of kepok banana flowers	0,8	0,8	0,8	Active ingredient
Carbopol 940	0,5	0,75	1	Gelling agent
Triethanolamine	0,5	0,5	0,5	Alkalizing agent
Propylene glycol	10	10	10	Humectant
Methyl Paraben	0,18	0,18	0,18	Preservative
Propyl Paraben	0,02	0,02	0,02	Preservative
Aquadest	ad 100	ad 100	ad 100	Solvent

Making a Spray Gel from Kepok Banana Flower Ethanol Extract

Carbopol 940 was dispersed in water until completely dispersed, then triethanolamine was added and stirred until a transparent gel mass was formed (mixture A). Methylparaben and propylparaben were dissolved in propylene glycol (mixture B). Mixture B was added to mixture A and stirred until homogeneous, then ethanol extract of kepok banana flowers (*Musa acuminata x M. balbisiana*) was added and stirred again until homogeneous. Next, the remaining distilled water was added, homogenized, and the preparation was put into a spray gel container

Evaluation of Spray Gel Preparation

Organoleptic Test

Visual inspection of the physical form, including the color, odor and texture of the spray gel preparation.

Homogeneity Test

Homogeneity testing aims to determine the uniformity and homogeneity of the spray gel formulation. The test preparation must exhibit a homogeneous composition and no visible solid or foreign particles.

pH test

The pH test aims to determine the acidity level of the preparation and to see whether the preparation is safe or not when used on the skin. The test was performed using a pH meter. One gram of spray gel was diluted with 10 mL of distilled water. Then, a calibrated pH meter was inserted into the sample and the pH reading was measured. The recommended pH range is 4,5-6,5 (Anindhita & Oktaviani, 2020).

Viscosity Test

A total of 100 grams of spray gel was put into a 100 mL beaker glass and measured using a Brookfield viscometer with spindle 3 and rpm 30. The viscosity results were recorded after the viscometer showed a stable number. The viscosity requirements for spray gel preparations are 500-5000 mPas (Thomas *et al.*, 2025).

Spray Pattern Test

The preparation was sprayed onto a sheet of mica plastic at a distance of 5 cm. The test was performed three times, and the resulting spray pattern was observed (Cendana *et al.*, 2021).

Adhesion Test

The preparation is sprayed onto the skin of the upper arm from a distance of 3 cm and counted for 10 seconds to see whether the preparation sticks or drops from the spray drip down (Akbar *et al.*, 2020).

SPF Value Test of Spray Gel Preparation

Sunscreen activity was determined in vitro by determining the SPF value using a UV-Vis spectrophotometer. A total of 0,02 grams of each spray gel formula was dissolved in 5 mL of 96% ethanol until homogeneous, then the absorbance was measured at a wavelength of 290-320 nm at 5 nm intervals using 96% ethanol as a blank. The test was carried out in three replicates, and the SPF value was calculated using the Mansur method (Akbar *et al.*, 2020).

Data analysis

A Data analysis includes qualitative descriptive for organoleptic, homogeneity, spray pattern, and adhesion (presented in the table), as well as quantitative for pH, viscosity, SPF with the calculation of the mean of three replications using Microsoft Excel. Inferential analysis uses One Way ANOVA ($\alpha=0.05$) to test for significant differences between carbopol variations, with the optimal formula determined based on the quality criteria of the spray gel preparation and the highest SPF value.

RESULTS AND DISCUSSION

Determination of Kepok Banana Plants

The determination was carried out at the Biology Science Laboratory of Tanjung Pura University. The results showed that the plant used was a kepok banana plant with the Latin name (*Musa acuminata x M. balbisiana*). The purpose of the determination was to determine whether the type of plant used was appropriate and that there were no errors in sampling.

Making Kepok Banana Flower Simple Medicine

In this study, 3,5 kg of kepok banana flowers were wet sorted, which is the process of selecting fresh kepok banana flowers. Wet sorting was carried out with the aim of reducing impurities carried during the collection of raw materials. Then the kepok banana flowers were washed with clean running water to remove dirt attached to the kepok banana flowers. After that, the kepok banana flowers were chopped, the purpose of chopping was to reduce the size and speed up the drying process. The kepok banana flowers were then dried using a dry cabinet with the aim of reducing the water content in the kepok banana flowers, where high water content allows for fungal growth, thereby reducing the quality of the simplicia and can affect the content of compounds contained in the simplicia (Husnani *et al.*, 2024).

The characteristics of dried kepok banana flower simplicia are that it can be crushed or broken easily. The dried simplicia is then dry sorting to remove any remaining impurities in the simplicia.

The dried kepok banana flowers were weighed and obtained a weight of 619 grams. After that, the dry simplicia was ground using a blender and sieved using a No. 40 mesh sieve with the aim of increasing the surface area and thus speeding up the extraction process because increasing the surface area will increase the contact between the powder and the solvent. After the simplicia was ground, it was packed and stored in a closed dry container and the yield was calculated to determine the percentage of the simplicia powder yield produced as a result of various processing processes (Husnani *et al.*, 2024).

Table 1. Yield of Kepok Banana Flower Simplex

Wet Weight	Weight of Dry Simplicia	Yield
3,500 grams	619 grams	17,69%

Based on Table 1 shows that the yield of the kepok banana flower simplicia was 17,69%, meeting the requirements for simplicia yield, which is more than 10%. The higher the simplicia yield, the greater the compound content.

Standardization of Kepok Banana Flower Simplicia

Standardization of kepok banana flower (*Musa acuminata x M. balbisiana*) simplicia includes drying loss, water content, and ash content which aims to ensure the quality and stability of the material before the extraction process.

Table 2. Results of Standardization of Kepok Banana Flower Simplicia

Test Parameters	R1	R2	R3	Average	Condition
Drying Loss	5,75%	5,90%	5,45%	5,70%	
Water content	5,33%	5,27%	5,05%	5,22%	<10% (FHI, 2017)
Ash Content	5,95%	5,60%	5,15%	5,56%	

Based on Table 2, the drying loss value was 5,70%. This value meets the requirements because it is <10%. Drying loss describes the amount of components lost during the heating process at 105°C, which reflects not only water content but also other volatile compounds. A low value indicates that the drying process is optimal and the loss of non-water mass is relatively small, thus maintaining the quality of the medicinal plant (Marpaung & Septiyani, 2020).

The water content of the medicinal plant was 5,22% and the ash content was 5,56%, both of which also met the <10% requirement. A low water content indicates good storage stability because it can minimize the growth of microorganisms such as fungi and bacteria. Meanwhile, the ash content reflects the mineral or inorganic content of the medicinal plant. An ash content value that is still within standard limits indicates that the material was not contaminated with excessive inorganic substances during the preparation process (Juniasty, 2024).

Kepok Banana Flower Extraction

The extraction process of kepok banana flowers (*Musa acuminata x M. balbisiana*) was carried out using the maceration method with 96% ethanol solvent in a ratio of 1:10. This method was chosen because it is easy and simple, in addition, this method does not require heating, making it suitable for extracting compounds that are not heat resistant, especially flavonoid compounds. The choice of 96% ethanol as a solvent because 96% ethanol can prevent the growth of germs and molds, has the ability to extract polar to semi-polar compounds, in addition to having good absorption, and does not require high heating to evaporate it (Candra *et al.*, 2021).

The extract preparation begins with 500 grams of kepok banana flower powder being placed in a maceration container and 5 L of 96% ethanol solvent added. The maceration process is carried out for 3 days, with re-maceration every 24 hours to obtain more filtrate and optimal compound extraction. The mixture is stirred occasionally during the first 6 hours of soaking to accelerate the diffusion of active compounds from within the simplicia cells into the solvent and prevent solvent saturation around the powder surface, then left for 18 hours. Next, filtration is carried out to separate the filtrate and sediment. This filtration aims to obtain a clear macerate and minimize the solid particles carried (Setya *et al.*, 2025).

The maceration process is repeated on the second and third days (Remaceration) using the same solvent with half the volume of the previous extraction. The use of a smaller solvent volume in continued maceration is intended to increase the efficiency of solvent use without significantly reducing the extraction yield. Next, all the macerate results obtained are collected and concentrated using a rotary evaporator at a temperature of 40°C until a thick extract of kepok banana flowers is obtained (Husnani *et al.*, 2024).

Table 3. Yield of Kepok Banana Flower Extract

Weight of Simplisia Powder	Extract Weight	Yield
500 grams	63,9 grams	12,78%

Based on Table 3 shows that the weight of the kepok banana flower extract was 63,9 grams and the extract yield was 12,78%, with a blackish-brown color and a distinctive aroma of kepok banana flowers. The higher the extract yield, the higher the compound produced or extracted from the raw material. A yield of more than 10% is considered good. A yield of less than 10% indicates that the extraction process may not be optimal or that the desired compound is not effectively dissolved (Mewar, 2023).

Standardization of Kepok Banana Flower Extract

Standardization of kepok banana flower extract (*Musa acuminata x M. balbisiana*) includes parameters of water content, ethanol free, and metal free.

Table 4. Water Content of Kepok Banana Flower Extract

Replication	Results	Average	Condition
R1	5,44%		
R2	5,12%	5,31%	<10% (FHI, 2017)
R3	5,37%		

Based on Table 4, the extract water content was 5,31%, meeting the requirement of <10%. The low water content indicates optimal solvent evaporation and inhibits microbial growth, thus maintaining the quality and stability of the extract.

Table 5. Ethanol-Free Results of Kepok Banana Flower Extract

Test Parameters	Reagent	Results
Ethanol Free Test	H ₂ SO ₄ + CH ₃ COOH	No ester smell

The ethanol-free test was carried out to determine whether or not ethanol was still contained in the extract (Tivani *et al.*, 2021). The results of the ethanol-free test in Table 5 show that no ester odor was detected after the addition of H₂SO₄ and CH₃COOH, which indicates that the extract is free from residual ethanol solvent.

Table 6. Metal-Free Results of Kepok Banana Flower Extract

Test Parameters	Reagent	Results
Lead (Pb) Test	K ₂ CrO ₄	No yellow precipitate is formed
Cadmium (Cd) Test	NaOH	No pink precipitate formed

The metal-free test was carried out to ensure the presence or absence of metal contamination in the kepok banana flower extract using the tube method. Based on Table 6, the Pb and Cd metal contamination test showed negative results because no yellow precipitate formed when K₂CrO₄ was added, nor a pink precipitate formed when NaOH was added. These results indicate that the extract meets safety requirements and is suitable for further formulation into a preparation.

Phytochemical Screening of Kepok Banana Flower Extract**Table 7. Phytochemical Screening of Kepok Banana Flower Extract**

Compound	Reagent	Positive Results	Identification Results	Information
Flavonoid	Concentrated HCl + Mg powder	Red, orange or yellow	Orange	+
Saponin	Aquadest	Formation of stable foam	Stable foam is formed	+
Polyphenols	FeCl ₃	Blue-green in color	Blackish green	+

Information :

(+) contains metabolite compounds

Based on Table 7 shows the results of the test tube in the phytochemical screening of ethanol extract of kepok banana flowers (*Musa acuminata x M. balbisiana*) showing that it contains secondary metabolite compounds flavonoids, saponins, and polyphenols.

Identification of flavonoid compounds in the ethanol extract of kepok banana flowers (*Musa acuminata x M. balbisiana*) was carried out by adding concentrated HCl + Mg powder reagents which aimed to reduce and hydrolyze flavonoid compounds into simpler aglycone forms. The formed aglycones then reacted to form a flavilium complex which could cause color changes, such as red, yellow, to orange. (Razoki *et al.*, 2023). The results obtained from the flavonoid group test in this study were the formation of an orange color so that the ethanol extract of kepok banana flowers was positive for flavonoids.

Identification of saponins in ethanol extract of kepok banana flowers (*Musa acuminata x M. balbisiana*) showed positive results, indicated by the presence of stable foam. This foam indicates the presence of glycosides, which can form foam in water and hydrolyze into glucose and other compounds (Wardani *et al.*, 2022).

Identification of polyphenol compounds in ethanol extract of kepok banana flowers (*Musa acuminata x M. balbisiana*) was carried out by adding FeCl₃ reagent which was indicated by the formation of a blue or blackish green color. This color change occurs due to the formation of a complex between Fe³⁺ ions and phenolic groups in the sample. Polyphenol compounds will release H⁺ and form phenoxy ions which then bind with FeCl₃ to produce a blue or blackish green complex compound (Bonor *et al.*, 2024). The results obtained from the polyphenol group test in this study were the formation of a blackish green color so that the ethanol extract of kepok banana flowers was positive for polyphenols.

Making Kepok Banana Flower Extract Gel Spray

The spray gel preparation was made with a concentration of ethanol extract of kepok banana flowers of 0,8%. The spray gel formulation was made with varying concentrations of carbopol 940, namely 0,5%; 0,75%, and 1%. Carbopol was developed with the aim of helping polymer particles spread more evenly and form a gel with a better and more homogeneous structure (Zatalini *et al.*, 2025). The use of carbopol functions as a gelling agent or gel former. Carbopol is easily dispersed in water and plays a role in providing viscosity to the preparation. The use of carbopol also produces a preparation with a clear appearance. Triethanolamine functions as an alkalizing agent that aims to neutralize the acidic carbopol because the base will form well, in addition, the addition of triethanolamine can also make the gel base thicker. Propylene glycol functions as a humectant that can attract and bind water molecules, thereby helping to maintain skin moisture (Zendrato *et al.*, 2025). A combination of methylparaben and propylparaben is used as a preservative to provide broader antimicrobial protection, both against bacteria and fungi, thereby maintaining microbiological stability and extending the shelf life of the preparation and distilled water as a solvent.

Evaluation of Kepok Banana Flower Extract Spray Gel Organoleptic Test

Table 8. Organoleptic Test Results of Spray Gel

Formula	Color	Aroma	Texture
F1	Yellow	Typical Kepok banana flower	Less viscous liquid
F2	Yellow	Typical Kepok banana flower	Slightly thick liquid
F3	Yellow	Typical Kepok banana flower	Thick liquid

Based on the observation results in Table 8, it is known that the spray gel preparation of ethanol extract of kepok banana flowers F1, F2, and F3 has the same color and aroma, namely yellow and the distinctive aroma of kepok banana flowers. The similarity in color and aroma in the three formulas is due to the use of kepok banana flower extract in the same amount, so that the difference in carbopol 940 concentration does not affect the color and aroma of the preparation. Meanwhile, the textures produced in F1, F2, and F3 have different textures. In F1 with a carbopol concentration of 0,5% has a less thick liquid texture, F2 with a concentration of 0,75% has a slightly thick liquid texture, and F3 with a concentration of 1% has a thick liquid texture. The higher the concentration of carbopol 940, the thicker the texture of the preparation will be because carbopol 940 functions as a gel-forming agent that forms a denser gel network. This is in line with the research of Thomas *et al.* (2023) which states that increasing the concentration of carbopol 940 can affect the texture of the preparation without causing changes to the color and aroma of the preparation.

Homogeneity Test

Table 9. Spray Gel Homogeneity Test Results

Formula	Results
F1	Homogeneous
F2	Homogeneous
F3	Homogeneous

Based on the homogeneity test results in Table 9, it shows that the spray gel preparation of ethanol extract of kepok banana flowers (F1, F2, and F3) is a homogeneous preparation because there are no foreign particles or lumps or coarse grains in the preparation. This is in line with the research of Maulidya *et al.* (2020) which stated that variations in carbopol concentration do not cause irregularities or phase separation, which indicates that carbopol is able to form a stable and uniform gel system, so it can be concluded that all spray gel preparation formulas meet the requirements in the homogeneity test.

pH test

A pH test is performed to determine the acidity level of the preparation and to determine whether it is safe for use on the skin. The results of the pH test on the kepok banana flower ethanol extract spray gel are shown in Table 10.

Table 10. Spray Gel pH Test Results

Formula	Replication			Average
	1	2	3	
F1	6,25	6,28	6,22	6,25
F2	5,50	5,56	5,54	5,53
F3	4,69	4,71	4,77	4,72

Based on Table 10, the pH values for F1 6,25; F2 5,53; and F3 4,72, respectively. This indicates a decrease in pH in the formulation of the kepok banana flower ethanol extract spray gel preparation but is still within the skin pH requirement range for topical preparations, namely 4,5-6,5. The results of statistical analysis using One Way ANOVA showed that variations in the concentration of carbopol 940 had a significant difference ($p < 0.05$). This indicates that increasing the concentration of carbopol 940 can impact the pH of the preparation, where the greater the concentration of carbopol 940 used, the lower the pH of the preparation because carbopol 940 has acidic properties (Cendana *et al.*, 2021).

A pH value that is too low can cause irritation and itching of the skin, while a higher pH value can cause dry skin and affect skin elasticity.

Viscosity Test

The viscosity test aims to determine the viscosity level of a preparation. In spray gel preparations, the viscosity level affects how easily the preparation can be sprayed (Anindhita & Oktaviani, 2020). The results of the viscosity test on the spray gel of ethanol extract of kepok banana flowers can be seen in Table 11.

Table 11. Spray Gel Viscosity Test Results

Formula	Replication (mPas)			Average (mPas)
	1	2	3	
F1	985	1025	957	989
F2	1719	1786	1793	1766
F3	2790	2721	2817	2776

Based on Table 11, it is known that the formula with a carbopol concentration of 0,5% (F1) has the lowest viscosity value among the other formulas, namely 989 mPas, so it will feel thinner when applied. Meanwhile, formulas F2 (0,75%) and F3 (1%) are 1766 mPas and 2776 mPas, respectively. The viscosity values of the three formulas are still within the viscosity range of spray gel preparations, namely 500–5000 mPas. The results of the One Way ANOVA test showed that there was a significant difference in viscosity values between formulas ($p < 0.05$). This indicates that variations in carbopol concentration have a significant effect on the viscosity of the spray gel preparation. The increase in viscosity occurs along with the increasing concentration of carbopol as a gelling agent that forms a denser gel network, thereby increasing the flow resistance of the spray gel preparation (Uzma *et al.*, 2024). These results align with previous research, which found that increasing carbopol concentration significantly affects the viscosity of spray gel preparations (Prihandini *et al.*, 2023). Spray gel viscosity values that are too close to the lower or upper limits of the required range can affect the characteristics of the preparation, so a viscosity balance is desirable to achieve appropriate physical characteristics.

Adhesion Test

An adhesion test is performed to determine the spray gel's ability to adhere and maintain contact with the skin surface after application. A preparation is considered adherent if it does not drip within 10 seconds (Nurdianti *et al.*, 2025).

Table 12. Spray Gel Adhesion Test Results

Formula	Replication (seconds)			Conclusion
	1	2	3	
F1	10	10	10	Attached
F2	10	10	10	Attached
F3	10	10	10	Attached

Based on Table 12, the results of the adhesion test of the kepok banana flower ethanol extract spray gel preparation in F1, F2, and F3 showed that all formulas could adhere after being sprayed on the skin of the upper arm for a test time of 10 seconds. In addition, the spray gel formed a fairly strong layer on the skin surface without dripping, thus increasing contact between the active ingredient in the preparation and the skin surface (Puspita *et al.*, 2020). This indicates that the three formulas with carbopol concentrations of 0,5%; 0,75%, and 1% did not affect the adhesion of the spray gel preparation.

Spray Pattern Test

The spray pattern test aims to evaluate the spray quality of a spray gel preparation. This test is conducted to ensure that the preparation produces an even, stable, and consistent spray pattern, allowing the active ingredient to be distributed homogeneously over the skin surface. Furthermore, this test is used to assess the performance of the spray system and the comfort and effectiveness of topical application (Zubaydah *et al.*, 2022).

The spray pattern of a spray gel preparation is categorized as very poor if the preparation cannot be sprayed. If the preparation can be sprayed but in the form of clumps, the spray pattern is categorized as poor. A spray pattern is considered poor if the resulting particles are too large, while a spray pattern is categorized as good if the sprayed preparation produces small and uniform particles (Montella *et al.*, 2024).

Table 13. Results of Spray Gel Spraying Pattern Test

Formula	Replication			Conclusion
	1	2	3	
F1	Spread	Spread	Spread	Good
F2	Spread	Spread	Spread	Good
F3	Clot	Clot	Clot	Bad

Based on the results of the spraying pattern of the kepok banana flower ethanol extract spray gel in Table 13, it shows that the kepok banana flower ethanol extract spray gel preparation with a carbopol 940 concentration of 0,5% (F1) and 0,75% (F2) provided a spraying pattern that spread and was categorized as good, while the carbopol 940 concentration of 1% (F3) produced a clumped pattern and was categorized as bad.

This is because increasing the concentration of carbopol 940 causes the viscosity of the preparation to increase, so that the flow from the spray applicator becomes more inhibited, resulting in larger droplets, a narrower spray angle, and a tendency for the product to come out as clumps (Sutiswa *et al.*, 2025). Therefore, variations in the concentration of carbopol 940 have an impact on the spray pattern of the spray gel preparation.

SPF Value Test of Kepok Banana Flower Extract Spray Gel

SPF Value of Kepok Banana Flower Extract

The SPF value test of the extract was conducted to ensure the sunscreen activity of the ethanol extract of kepok banana flowers in the wavelength range of 290-320 nm which is the UV B wavelength. A sunscreen is said to provide protection if it has a minimum SPF value of 2 and a good category if the test sample has an SPF value above 15 which is classified as an ultra protection sunscreen (Puspita *et al.*, 2023). The test results showed that the ethanol extract of kepok banana flowers has an SPF value ranging from 15.514 to 19.111, which indicates the presence of sunscreen activity in the ultra protection category.

The SPF value found in the ethanol extract of kepok banana flowers shows that the extract has strong potential as an active sunscreen ingredient in spray gel formulations. SPF Value of Kepok Banana Flower Extract Spray Gel Preparation. The Sun Protection Factor (SPF) value is a parameter that indicates the ability of a preparation to protect the skin from ultraviolet radiation, which is mainly determined by the ability of the active component to absorb UV rays.

Determination of the SPF value of the spray gel of ethanol extract of kepok banana flowers (*Musa acuminata x M. balbisiana*) using a UV spectrophotometer and calculating the absorbance at a wavelength of 290-320 nm using the Mansur equation.

Table 14. SPF Value of Spray Gel

Formula	SPF value	Category
F1	15.901	Ultra
F2	15.616	Ultra
F3	15.403	Ultra

Based on Table 14, the SPF value of the kepok banana flower ethanol extract spray gel (*Musa acuminata x M. balbisiana*) with carbopol concentration variations of 0,5%; 0,75%, and 1% were 15.901, 15.616, and 15.403, respectively. All formulas are included in the ultra category, which indicates an SPF value >15 so that it has high protection against ultraviolet radiation. The results of statistical analysis using One Way ANOVA showed that variations in carbopol concentration 940 did not have a significant effect on the SPF value of the kepok banana flower ethanol extract spray gel

preparation ($p > 0.05$). The results of this study are in line with previous research which stated that carbopol did not show a significant effect on the SPF value (Khafifa *et al.*, 2022).

In sunscreen preparations, the SPF value is more influenced by the type and concentration of active ingredients that have the ability to absorb or reflect UV radiation. Active compounds in the ethanol extract of kepok banana flowers, such as flavonoids, are known to have photoprotective activity through the mechanism of absorbing UV radiation and antioxidant activity that can neutralize free radicals caused by UV exposure (Nurhaeni *et al.*, 2025). Therefore, these components play a direct role in producing the SPF value. Meanwhile, base components such as carbopol function more in shaping the physical characteristics of the preparation, such as viscosity, pH, and spray pattern, without contributing directly to UV protection activity (Debi *et al.*, 2024).

Carbopol 940 is a polyacrylic acid polymer used as a gelling agent and viscosity regulator in pharmaceutical preparations. Structurally, carbopol 940 lacks an active chromophore group capable of absorbing ultraviolet radiation energy, so it does not significantly contribute to the SPF value of the kepok banana flower ethanol extract spray gel preparation. Therefore, increasing or decreasing the carbopol concentration does not significantly impact the SPF value of the resulting kepok banana flower ethanol extract spray gel (Shabrina & Nurwaini, 2023).

CONCLUSION

Based on the results of the research that has been conducted, it can be concluded that variations in carbopol concentration have a significant effect on the physical characteristics of the preparation, especially on the organoleptic texture, pH, viscosity, and spraying pattern, but do not have a significant effect on the SPF value of the spray gel preparation of ethanol extract of kepok banana flowers (*Musa acuminata x M. balbisiana*).

The spray gel formulation of ethanol extract of kepok banana flower (*Musa acuminata x M. balbisiana*) with a carbopol concentration variation of 0,75% (F2) was determined as the optimal formula because it fulfilled all the test parameters of the spray gel preparation and had the most balanced physical characteristics, and had an SPF value of 15.616 with an ultra protection category.

REFERENCES

- Anindhita, M.A., & Oktaviani, N. (2020). Formulasi Spray Handsanitizer Ekstrak Daun Pandan Wangi Sebagai Antiseptik Tangan. *Parapemikir*, 9(1), 14-21.
- Anwar, A., Anisa, G. M. S., Subagiyo, L., & Nuryadin, A. (2022). Effectiveness of sprout extract (*Vigna radiata*) as a sunscreen material using UV-Vis spectrophotometer. *Jurnal Ilmiah Biologi Eksperimen dan Keanekaragaman Hayati*, 9(2), 38-42.
- Cendana, Y., Adrianta, A. K., & Suen, S. D. M. N. (2021). Formulasi spray gel minyak atsiri kayu cendana (*Santalum album L.*) sebagai kandidat sediaan antiinflamasi. *Jurnal Ilmiah Medicamento*, 7(2), 84-89.
- Debi, A. R., Salsabila, S. A., Shabrina, A., Arifin, I., & Fresiva, U. (2024). Karakterisasi Fisik Dan Penentuan Nilai Spf Spray Gel Berbahan Foam-Mat Drying Bayam Merah (*Amaranthus Tricolor L.*) Dengan Variasi Karbopol. *Cendekia Eksakta*, 9(2), 99-106.
- Handayani, R., Qamariah, N., & Satika, F. (2024). Uji Parameter Non-Spesifik Simplisia Umbi Sarang Semut Asal Kalimantan Tengah. *Jurnal Ilmiah Farmasi Akademi Farmasi Jember*, 7(2), 116-124.
- Hasninal, S., Amin, A., & Mirawati, M. (2024). Teknik Ekstraksi, Nilai Rendemen dan Identifikasi Kandungan Metabolit Sekunder Ekstrak Daun Tembelekan (*Lantana camara L.*) Asal Kota Kendari. *Jurnal Kesehatan Poltekkes Kemenkes RI Pangkalpinang*, 12(2), 185-192.

- Husnani., Handayani, N. P., & Puspa, N. (2024). Uji Aktivitas Antioksidan Lotion Ekstrak Etanol Bunga Pisang Kepok (*Musa acuminata x M. balbisiana*) Menggunakan Metode DPPH (1, 1-diphenyl-2-picrylhidrazil). *Jurnal Komunitas Farmasi Nasional*, 4(1), 2-4.
- Khafifa, I. N., Shabrina, A., & Rochman, M. F. (2022). Stability and Sunscreen Activity Of Nutmeg Seed Oil Emulgel With Carbopol 940 Variation as Gel Base. *Jurnal Farmasi Sains dan Praktik*, 8(2), 167-176.
- Marpaung, M. P., & Septiyani, A. (2020). Penentuan Parameter Spesifik dan Non Spesifik Ekstrak Kental Etanol Batang Akar Kuning (*Fibraurea chloroleuca Miers*). *Journal of Pharmacopolium*, 3(2), 58-67..
- Maulidya, M., Aryati, F., & Sastyarina, Y. (2020). Optimasi Formula Spray Gel Ekstrak Bawang Tiwai (*Eleutherine americana (Aubl) Merr*). *Proceeding of Mulawarman Pharmaceuticals Conferences*, 11, 11-16.
- Mewar, D. (2023). Standarisasi Parameter Spesifik dan Non-Spesifik Ekstrak Etanol Daun Gatal (*Laportea decumana* (Roxb.) Wedd) sebagai Bahan Baku Obat Herbal Terstandar. *Jurnal Penelitian Kesehatan Suara Forikes*, 14(4), 266-270.
- Montella, C., Noval, N., & Kurniawati, D. (2024). Formulation And Evaluation Of Karamunting Fruit Extract Nano Spray Gel (*Rhodomyrtus tomentosa (Aiton) Hassk.*) With Carbopol 940 Concentration Variations. *Jurnal Surya Medika*, 10(2), 117-128.
- Nurhaeni, F., Yuliana, P., & Fitriasisari, A. (2019). Skrining Fitokimia dan Uji Aktivitas Antioksidan Pelepeh Batang dan Bunga Pisang Kepok (*Musa acuminatae, L.*). *Jurnal Ilmu Kesehatan Bhakti Setya Medika*, 4, 29-35.
- Paongan, A. O., & Vifta, R. L. (2022). Penentuan nilai sun protection factor (SPF) ekstrak terpurifikasi bunga telang (*Clitoria ternatea L.*) sebagai tabir surya alami. *Indonesian Journal of Pharmacy and Natural Product*, 5(1), 1-9.
- Prihandini, E. A., Halid, N. H. A., & Rafiuddin, A. T. (2023). Formulasi Dan Penentuan Nilai SPF (Sun Protection Factor) Sediaan Gel Spray Ekstrak Etanol Bunga Rosella (*Hibiscus sabdariffa L.*). *Journal Pharmacia Mandala Waluya*, 2(5), 251-263.
- Puspita, W., Puspasari, H., & Restanti, N. A. (2020). Formulasi Dan Stabilitas Fisik Gel Semprot Ekstrak Etanol Daun Buas-Buas (*Premna serratifolia L.*). *Jurnal Ilmiah Farmako Bahari*, 11(2), 145-152.
- Shabrina, D. R., & Nurwaini, S. (2023). Formulasi Dan Evaluasi Fisik Sediaan *Spray Gel* Tabir Surya Dari Ekstrak Daun Kersen (*Muntingia calabura L.*). *Usadha: Journal of Pharmacy*, 2(2), 247-254.
- Subaryanti, S., Meianti, D. S. D., & Manalu, T. R. (2022). Potensi Antimikroba Ekstrak Etanol Daun Gatal (*Urticastrum decumanum* (Roxb.) kuntze) Terhadap Pertumbuhan *Staphylococcus* dan *Candida albicans*. *Jurnal Ilmu Kefarmasian*, 15(2), 93-102.
- Thomas, N. A., Tungadi, R., Hiola, F., & Latif, M. S. (2023). Pengaruh Konsentrasi Carbopol 940 Sebagai *Gelling Agent* Terhadap Stabilitas Fisik Sediaan Gel Lidah Buaya (*Aloe Vera*). *Indonesian Journal of Pharmaceutical Education*, 3(2), 316-324.
- Zatalini, D. F., Bhagawan, W. S., & Norachuriya, Z. (2025). Pengaruh Kombinasi Kitosan dan Karbopol 940 terhadap Karakteristik Fisik dan Stabilitas Sediaan Gel Ekstrak Daun Kelor (*Moringa oleifera L.*). *Journal of Islamic Pharmacy*, 10(1), 1-5.