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SPF Activity Sunscreen Spray Gel Ethanol Extract of Cinnamon Bark (*Cinnamomum burmanii* Ness. BI, Syn)

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Abstract

This cinnamon bark contains cinnamaldehyde, which is a secondary metabolite compound derived from aldehydes, including the polyphenolic group, which activity as a sunscreen and antioxidant by absorbing UV rays, so it can protect the skin from direct sun exposure (sunscreen). The study aimed to determine whether there was an effect of the concentration of the ethanol extract of cinnamon bark (Cinnamomum burmanii Ness. BI, Syn) on the physical characteristics and SPF value of spray gel preparations and to determine the concentration of the ethanol extract of cinnamon bark that produced spray gel with physical characteristics and SPF value. best. The study was conducted by extracting cinnamon bark by the maceration method using 96 % ethanol for 3 days. The extract obtained was then subjected to phytochemical screening TLC and then applied to a spray gel preparation with concentrations of FI (10%), FII (15%), and FIII (20%), followed by testing the activity of sunscreen using the UV-Vis spectrophotometry method. The results of phytochemical screening and TLC on the ethanol extract of cinnamon bark showed positive results for containing flavonoids, alkaloids, tannins, steroids, and antioxidants. The statistical test results showed that there was a difference with a sig value of 0.05. It was concluded that the ethanol extract of cinnamon bark affected pH, viscosity, spreadability, stickiness, drying time, and SPF value. The formula that gave the best physical characteristics and SPF value was found in the concentration of sunscreen spray gel: the ethanol extract of cinnamon bark with a concentration of FIII (20%).

Keywords: Cinnamon bark ethanol extract, physical characteristics, SPF, spray gel

Introduction

Cinnamon (Cinnamomum burmanii Ness. BI, Syn) is a plant that is cultivated for its skin to be used as an anti-diarrhea medicine, for stomach cramps, and can reduce secretions in the intestine. Cinnamon (Cinnamomum burmanii Ness. BI, Syn) belongs to the Lauraceae family, the simplicia family which is widely found in Indonesia where part of the bark can be used as an additive by the community. Cinnamon which has been further processed to obtain its essential oil is used as a flavoring and aroma agent in the food, beverage, pharmaceutical, cigarette, and cosmetic industries, often used as incense in traditional religious ceremonies (Idris & Mayura, 2019).

Several research journals suggest that cinnamon contains cinnamaldehyde compounds, flavonoids, alkaloids, tannins, saponins, coumarins, steroids, eugenols, and phenols which function as antibacterial, antitumor, antioxidant, anti-inflammatory, anticancer, and antidiabetic. Cinnamon bark has a chromophore group in the form of an aromatic core which is conjugated with a carbonyl group in the active compound cinnamaldehyde which has the potential to absorb UV-B rays at a wavelength of 312 nm (Indarto et al., 2022).

Cinnamon bark essential oil obtained from the steam distillation process of leaves and twigs has a sharp taste, pungent odor, yellowish to brown, and will turn darker due to the influence of storage or outside air. The main content of cinnamon bark essential oil is 80–95% aldehydes, 60–70% cinnamaldehyde, 80–90% eugenol, terpenes (limonene, p-cementine, (-) linalool and β-caryophyllene, eugenol (Endarini, 2016). essential oils containing sugars, proteins, simple fats, pectin, and others. Cinnamon bark (Cinnamomum burmanii Ness. BI, Syn) besides that cinnamon bark also has antioxidant activity (Sari et al., 2015).

Differences in the soil as a place to grow cinnamon bark affect the content of active substances in it. The components of cinnamon bark essential oil from Loksado consist of cinnamaldehyde (75.59%), cinnamyl alcohol (17.40%), bornyl acetate (1.74%), copaena (1.63 %). 1,8 - cineol (1.35%), limonene (0.59%), α -

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terpineol (0.77%), pinene (0.48%), and bicyclo 3,1.0 heptane (0.44%) (Astuti et al., 2018). The use of solvents and the drying process of simplicia powder in the extraction process of cinnamon bark affect the content of the active compounds produced. The yield of cinnamon bark oleoresin using 70% ethanol was higher than 95% ethanol but the active compounds contained in cinnamon bark oleoresin without standing with 95% ethanol were more, namely benzyl benzoate, kaur – 16 - ene, acetoacetic acid n. -amyl ester, methyl 2–ethyl - 2, methyl butanoate, methylene, 2-nonaonone, and linalool (Khasanah et al., 2018). Cinnamon bark contains a compound that has activity as a strong antioxidant, namely cinnamaldehyde. Antioxidants are substances that can neutralize free radicals so that they can protect the body from various diseases by binding to free radicals (Rusita & Indarto, 2017).

Ultraviolet light (UV) is the main component emitted by sunlight. UV light is oxidative because it can produce a free radical compound called a reactive oxygen species (ROS). ROS that accumulate on the skin hurt the skin because they can induce cell damage, premature aging, and skin cancer (Hassan et al., 2013). Sun radiation comes from infrared light, which has a wavelength of more than 760 nm; visible light, with a wavelength of 400 - 760 nm, and UV (ultraviolet) light, which consists of UV-A (320 - 400 nm), UV-B (290 - 320 nm) and UV - C (200 - 290 nm). Sunlight that reaches the surface of the earth and has an impact on the skin is made up of UV-A and UV-B rays (Wang et al., 2008). The body's response to sun exposure to the skin can be in the form of sweating, melanin formation, and thickening of horn cells, but excessive sun exposure so that the body's protection system is insufficient or due to excessive environmental influences sooner or later can damage skin tissue (Putri et al., 2019).

UV protection factor (UPF) = the ratio of average effective UV radiation irradiance transmitted and calculated through the air to the average effective UV radiation irradiance transmitted and calculated through the fabric (indicates how much longer a person can stay in the sun when fabric covers the skin, erythema being the endpoint). Grading of UPF:

1) good protection (UPF 15 to 24)
2) very good protection (UPF 25 to 39)
3) excellent protection (UPF 40 to 50+)
4) Fabric SPF is similar to SPF, except that fabric is used to protect the skin while testing, instead of sunscreen (Kaimal & Abraham, 2011)

The habit of people to do outdoor activities is the main cause of the increase in the incidence of skin cancer which globally can touch 3.000,000 cases in 1 year. Therefore, sun protection programs are very urgent to be carried out as an effort to increase awareness of the dangers of UV radiation on the skin and change habits to suppress the worst effects of UV exposure (Siampa et al., 2023). Routine use of cosmetic products that contain Sun Protection Factor (SPG) can help reduce the possible harmful effects of ultraviolet radiation which can cause erythema, and skin cancer (Dutra et al., 2004).

Cinnamon bark extract has antioxidant activity with an IC_{50} value of 0.398 µ ± 0.075, which means it has very strong antioxidant activity (Priani et al., 2014). Subsequent studies stated that the activity of sunscreen and the physical stability of the spray gel formula from the extracts of Intersection Giring (Curcuma heyneana Val) and Cinnamon Extract (Cinnamomum burmanii Ness) with a combination of Carbopol and HPMC showed that Formula I had an IC_{50} value of 1.21 with an average SPF value. an average of 10.48 has a strong affinity; Formula II's IC_{50} value of 1.23 with an average SPF value of 19.29 means it has a strong affinity; and Formula III's average IC_{50} value of 1.18 with an average SPF value of 12.52 has a strong affinity (Rusita & Indarto, 2017). Sunscreen activity and SPF value of the lotion combination of cinnamon bark extract and pomegranate peel extract belong to the ultra category, and there is no difference in sunscreen activity in sun exposure and closed spaces (Rusita & Indarto, 2017).

The dosage forms of sunscreen that are widely used by women are in the form of creams, gels, or lotions. There are not many products that make sunscreen preparations in the form of spray gels, especially those made from natural ingredients. The spray gel form was chosen because it is easy to apply, can be taken anywhere, and can dry quickly, so it can provide a pleasant experience when using it. Spray gel preparations have advantages such as being safer because the level of microorganism contamination is lower, the drug contact time is relatively longer than other preparations, and it is more practical in its use. Based on this background, the researchers aim to develop the ethanol extract of cinnamon bark into a type of spray gel preparation that is easy to apply with one spray that is evenly distributed on the skin and can prevent exposure to UV rays. In addition, considering the important role of sunscreen in preventing side effects due to prolonged exposure to UV rays on the skin, it is necessary to test the activity of sunscreen gel spray ethanol extract of cinnamon bark by determining the SPF value.

Methods

Tools and materials

The tools used in this study were glassware (Pyrex), mortar and pestle porcelain OD 06 80 mm (Rofa), flannel cloth, porcelain cup (Iwaki), Analytical Balance (Shimadzu ATX224), Philips blender (HR - 2222), Mesh Sieve 40/60 (ABM), Vacuum Rotary Evaporator (Heidolph), Digital water bath DWB 6H (Maskot), chamber (Iwaki), Tube clamp (CNC), Oven (Binder BD 115®), pH meter (Hanna HI 2210 - 2 Benchtop pH meter with electrode and probe), Viscometer Brookfield (DV-1 Prime), and spectrophotometer UV-Vis (Shimadzu 1240).

The materials used were cinnamon bark powder, 96% technical ethanol, pa ethanol, standard cinnamaldehyde, toluene, ethyl acetate, Molisch reagent, Biuret reagent, vanillin, sulfuric acid, TLC plate, carbopol, HPMC, TEA, methyl paraben, propyl parabens, propylene glycol, NaCl, and aqua distillate.

Extraction process

Dried cinnamon bark (Cinnamomum burmanii Ness. BI, Syn) was then powdered and sieved using sieve no. 40. Extraction was carried out by the maceration method using 96% ethanol solvent for 7 consecutive days with several stirrings. A total of 1000 grams of cinnamon powder were weighed, and 750 mL of solvent was added. The container was then closed tightly and soaked for 5 days. During the maceration process, occasional stirring is carried out every day. Then it was filtered and separated from the solvent with a "Heidolph" vacuum rotary evaporator until a thick extract was obtained. Process advantage maceration includes no special skills required and less loss of alcohol as a solvent, such as in percolation or soxhletation processes (Endarini, 2016). In general process maceration used ethanol solvent is the most widely used solvent in the maceration process because of its large polarity distribution (Handoyo, 2020).

Phytochemical screening of extracts and TLC identification

Phytochemical screening was carried out to determine the bioactive components contained in the ethanol extract of cinnamon bark. The phytochemical screening carried out included the examination of alkaloids, flavonoids, saponins, and tannins. Examination of the content in the extract was aimed at identifying the cinnamaldehyde compound, which was carried out by thin layer chromatography (TLC) using the mobile phase of dichloromethane and the stationary phase of silica gel GF254, anisaldehyde - sulfuric acid spot reagent, and pure cinnamaldehyde as a comparison. Then the TLC plate was heated at 110 °C for 2 minutes in the oven. Phytochemical screening was carried out, namely. The thin Layer Chromatography method is a physical separation technique using the principle of distributing a substance in two stationary phases and the mobile phase. This separation occurs because of differences in the migration of each component. The use of the TLC method is increasingly widespread considering that TLC is a good method of separation, especially for qualitative analysis (Charismawati et al., 2021)

Examination of alkaloids

The alkaloid test was carried out using 3 methods, namely the Meyer, Wagner, and Dragendorf methods. Cinnamon bark ethanol extract samples were reacted with 5 mL of chloroform and 5 mL of ammonia, then heated, shaken, and filtered. Added 5 drops of 2 N sulfuric acid to each filtrate, then shaken and allowed to stand. The top layer of each filtrate was taken and tested with Meyer, Wagner, and Dragendorf reagents. Positive alkaloid results are indicated by the formation of orange, brown, and white precipitates (Mondong et al., 2015).

Examination of flavonoids

The ethanol extract sample of cinnamon bark was heated with 10 mL of aqua distillate until it boiled for 5 minutes, then filtered, and an aqueous extract was obtained. Put 5 mL of the filtrate into a test tube, and then add sufficient magnesium powder, 2 mL of 2 N HCl, and 5 mL of amyl alcohol. The sample in the test tube is shaken vigorously, indicating that it contains flavonoids if orange color forms on the amyl alcohol layer (Handayani et al., 2018).

Saponin examination

The ethanol extract sample of cinnamon bark was heated with 10 mL of distilled water until it boiled for 5 minutes, then filtered, and an aqueous extract was obtained. 10 mL of aqueous extract was shaken vertically for 10 minutes, then a few drops of 2N HCl were added if a steady foam formed, which indicated it contained saponins (Handayani et al., 2018).

Examination of tannins ($FeCl_3$ reagent)

The powder and ethanol extract of cinnamon bark were each added to 10 mL of distilled water, boiled for 15 minutes, and filtered. In the first filtrate test tube, add as much as 2 mL plus 2 - 3 drops of 1% $FeCl_3$ solution. Positive for tannins if the color is blue-black or green–brown (Handayani et al., 2018).

Sunscreen spray gel formulation cinnamon bark extract

Sunscreen spray gel ethanol extract of cinnamon bark in this study will be made with a composition based on **Table 1.**

The formula for sunscreen spray gel with ethanol extract of cinnamon bark was prepared by expanding Karbopol 940 with hot water until it dispersed homogeneously, then adding triethanolamine and stirring until it became a transparent gel. The HPMC was dispersed with aqua distillate until all of it was homogeneously dispersed into a clear and quite viscous liquid. Then methyl paraben and propyl paraben are dissolved in glycerin. The carbopol 940 and HPMC gel masses were mixed until homogeneous in a beaker glass, then methylparaben and propylparaben, which had been dissolved with glycerin, were added and stirred until homogeneous. Cinnamon bark ethanol extract and aqua distillates were added little by little to the mixture and then stirred with a mortar until homogeneous. Put the preparation into the spray gel container. Preparation of spray gel ethanol extract of cinnamon bark and then testing the characteristics of the preparation, including.

Table 1. Formula sunscreen spray gel cinnamon bark ethanol extract

Ingredient Name	Concentration (%)
Cinnamon extract	10; 15; dan 20
Karbopol 940	0.5
HPMC	0.5
Trietanolamin	8 drop
Propylene glycol	15
Methylparaben	0.18
Propylparaben	0.2
Aethanolum	20
Natrii Chloride	0.27

Organoleptic testing

Organoleptic testing of the cinnamon bark spray gel preparation was carried out by observing the physical appearance of the preparation, including shape, color, and smell (Departemen Kesehatan RI, 1995).

Homogeneity testing

Homogeneity testing of cinnamon bark spray gel preparations was carried out visually with a sliding glass, observing whether or not the distribution of particles formed visually or whether there were particles that were not mixed homogeneously (Zubaydah et al., 2022).

pH testing

The pH of the preparation was measured using a pH meter that had previously been calibrated using a solution of pH 7 and pH 4. The pH meter electrode was inserted into the cinnamon bark gel spray preparation to be tested. The requirements for testing the pH of the preparation correspond to the pH of the skin, namely 4.5 – 6.5 (Sari et al., 2021).

Viscosity testing

The viscosity test for the preparation of cinnamon bark spray gel was measured using a Brookfield LVT-RVT viscometer. The preparations were prepared in a 100 mL beaker glass, and then the viscometer was set using a spindle with the number R5 and a speed of 30 rpm. The tool is run until it shows a viscosity value (cPs), which is the viscosity value of the preparation (Sari et al., 2021).

Testing the spraying pattern

Testing the spray pattern of the cinnamon bark gel spray preparation is carried out using transparent plastic that has been weighed beforehand. The preparation is sprayed on the plastic, and the time it takes for the preparation to dry is recorded using a stopwatch. The pattern of spray formation was observed, then the diameter was measured, then the plastic was weighed, and the difference in weight was calculated as the number of preparations that came out of each spray. Tests were carried out in triplicate with different spraying distances, namely 3, 5, 10, 15, and 20 cm (Zubaydah et al., 2022).

Testing of adhesion to the skin

Testing the adhesion to the skin of spray gel cinnamon bark gel is carried out by spraying the preparation on the skin of the arm above from a distance of 3 cm, waiting for 10 seconds, and observing whether the preparation sticks to the skin or drips down. The longest and shortest diameters of the spray are measured, then tested on other formulas with the same working procedure (Martono & Suharyani, 2018).

Stability testing (freeze-thaw cycling test)

Stability testing of the cinnamon bark gel spray preparation was carried out by the cycling method by storing the preparation at 4 ± 2 °C for 48 hours and then storing it at 40 ± 2 °C for 48 hours. This treatment is included in one cycle, and preparation testing is continued for up to three cycles. Organoleptic, homogeneity, viscosity, and pH observations were carried out on the preparations before and after treatment (Kartikasari & Anggraini, 2018).

Testing SPF

Testing sunscreen spray gel preparations of cinnamon bark gel in each formula dissolved in ethanol at 96% p.a. (2 mg/2 mL) The absorbance of each sample was determined with a UV - visible spectrophotometer, and readings of the absorbance values were taken every 5 nm interval from a wavelength of 290 nm to 320 nm. The determination of the SPF value was carried out in triplicate for each test sample (Sari et al., 2015).

Data processing and analysis

Data obtained from phytochemical screening in the form of color reactions and TLC was compared with standard standards to qualitatively determine the content contained in the extract. The SPF value test was carried out using the equation from the research results of Mansur et al. (1986) and the EE values in **Table 2.**

The SPF value of each preparation with different extract concentrations was analyzed by normality and homogeneity tests using Shapiro-Wilk statistical analysis. If the data is normally distributed and homogeneous, then proceed with the parametric test using one-way ANOVA statistical analysis, but if otherwise, proceed with the Mann - Whitney non - parametric test to determine the significance of the difference in extract concentration to the SPF value of the preparation.

$$SPF_{spectrophotometric} = CF \times \sum_{290}^{320} EE\ (\lambda) \times I\ (\lambda) \times Abs\ (\lambda) \quad (1)$$

Information:
CF = Correction factor
EE = Efficiency of erythema
I = Intensity spectrum of the sun
Abs Absorbance

Table 2. EE value × I

Wavelength (nm)	EE × I
290	0.0150
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0839
320	0.0180
Total	1

Results and Discussion

This study aims to determine the effect of the concentration of ethanol extract of cinnamon bark (Cinnamomum burmanii Ness. BI, Syn) on the physical characteristics and SPF value of the cinnamon bark gel spray preparation. The cinnamon bark used in this study was obtained from cinnamon bark plantations in the Sumowono area of Semarang Regency, Central Java. The plants to be used in this study were terminated at the STIFAR Pharmaceutical Biology Laboratory, Semarang Pharmaceutical Foundation. Determinations were made to ensure that the plants used in the study were indeed cinnamon bark plants and to avoid misuse of the plants during the research.

This research was started by carrying out wet sorting, washing, drying, dry sorting, pollination, and sieving using mess number 44, and then the extraction of cinnamon stick powder was carried out by the maceration method using 96% ethanol solvent for 7 days. Drying is the most activity important in the processing of medical plants because can affect the product quality generated, drying will reduce the moisture content and stop the enzymatic reaction and prevent degradation of quality or damage to simplicial (Syafrida et al., 2018).

The extraction method used in this research is the maceration method, based on immersing the sample in a solvent that penetrates the cell wall and enters the cell cavity containing the active compound. The active compound will dissolve in the appropriate solvent because of the difference in concentration between the active substance inside the cell and outside the cell, so the high - concentration adjacent solution will be pushed out. This event occurs continuously until a concentration balance is reached between the solution outside and that inside the cell. Soaking the simplicia using solvent was carried out for 72 hours while stirring occasionally for the first 24 hours, and then the macerate was first filtered and collected. The extraction process was repeated several times for 3 days, and the extract obtained from the entire maceration process was evaporated using a rotary evaporator to separate the ethanol from the liquid extract to form a thick extract. The longer the maceration process that will be carried out, the more capable it will be the yield value of the resulting simplicial (Handoyo, 2020). The result of the extraction is a reddish-brown extract with a distinctive aromatic cinnamon odor. From 2.699 grams of simplicia powder, 877.1707 grams of viscous extract were produced, so the yield of the extract obtained was 32.5%. This fulfills the yield requirements according to the Indonesian Herbal Pharmacopoeia, where the percentage yield obtained from the extraction process is not less than 25.4% (Kementerian Kesehatan RI, 2017).

The results of the phytochemical screening of the viscous extract of cinnamon bark showed that the extract contained alkaloids, flavonoids, saponins, and tannins. Further analysis of the compounds using thin-layer chromatography (TLC) was carried out to confirm the compounds contained in macerate and viscous extracts. The stationary phase used in this test was silica gel GF 254 nm, and observations were made under UV light at 254 nm with the addition of a spot sight. Testing of chemical compounds by thin-layer chromatography (TLC) was carried out to confirm that the phytochemical compounds contained in cinnamon bark extract contain alkaloids, flavonoids, saponins, and tannins. Based on the TLC results, both macerate and extract contained alkaloids, flavonoids, saponins, and tannins.

Cinnamon bark ethanol extract is formulated in a spray gel preparation for a sunscreen with a combination of carbopol 940 and HPMC as gelling agents, triethanolamine as a base, glycerin as a humectant, and methylparaben and propylparaben as preservatives. The choice of base for the manufacture of spray gel can affect the characteristics of the spray gel that is formed. The use of a single spray gel base is less effective for forming a spray gel. At a small concentration, carbopol 940 can produce a high viscosity value but has a small adhesive power, while HPMC can increase the adhesive power. Variations in the use of HPMC and carbopol simultaneously will affect the

physical properties of the gel; HPMC can affect spreadability, and adhesion, while carbopol affects viscosity (Tambunan & Sulaiman, 2018). The results of the physical characteristic test of spray gel with concentrations of cinnamon bark extract of 10% (F1), 15% (F2), and 20% (F3) included organoleptic, homogeneity, pH, viscosity, spray pattern, spreadability, stickiness, and time to dry on the skin.

Table 3. Results of phytochemical screening of ethanol extract of cinnamon bark ((+): contains compounds (-): does not contain compounds)

Reactant	Compounds	Positive Result in the Research	Result Library
Alkaloid	Mayer's	Formed white or yellow precipitate	(-) No precipitate formed
	Dragendorff	Formed brick red precipitate	(+) Formed brick red precipitate
	Wagner	An orange precipitate forms (Abdurrahman et al., 2021)	(+) An orange precipitate is formed
Flavonoid	Mg + HCl + amyl alcohol	The amyl alcohol layer is red, yellow, and orange (Abdurrahman et al., 2021)	(+) A red color is formed on the amyl alcohol layer
Saponin	Aqua destilata hot + HCl 2N	Formed froth after shaking for 10 seconds with a foam height of 1 - 10 cm and stable for not less than 10 minutes (Abdurrahman et al., 2021)	(+) Formed stable foam
Tanin	$FeCl_3$ 1%	A blue/green-black precipitate is formed	(+) A blue-black color is formed
	Gelatine 10%	A white precipitate formed (Abdurrahman et al., 2021)	(+) A white precipitate is formed

Table 4. TLC test results for cinnamon bark ethanol extract ((+): contains compounds (-): does not contain compounds)

Reactan Compounds	Positive Result in Research (Harbone, 1987)	Result Library	Value Rf		Description
			Condensed	Extract Maserate	
Alkaloids	Formed greenish-brown stains on a yellow background	Formed greenish-brown stains on a yellow	0.87	0.90	(+)
Flavonoids	Formed pale yellow, green-yellow, orange, brown, and blue stains	Formed light yellow to orange stains	0.80	0.75	(+)
Saponin	Formed pink, mauve, and bluish-green stains	Formed brownish-red stains	-	0.74	(+)
Tanin	Formed yellow-brown stains	Formed brownish-yellow stains	0.75	0.75	(+)

Based on organoleptic testing of the three formulas, the preparations were obtained in the form of a gel with a slightly thick consistency. The preparation has a characteristic aromatic odor of cinnamon sticks and a brick-red color due to the addition of cinnamon bark extract, which has a characteristic odor and brick red color. Organoleptic testing and homogeneity of the preparations were carried out using visual observations (five senses). Observation of homogeneity is carried out by spraying the preparation to be tested on a glass object and observing whether or not there are particles or other substances that have not been dispersed homogeneously in the preparation.

Homogeneous preparations will facilitate the penetration of active substances evenly on the surface of the skin so that the expected effect can be achieved. An observation of homogeneity in the preparations was carried out on days 0, 7, and 14 to determine the possibility of damage to the preparations after storage. In the resulting cinnamon bark spray gel preparation, the higher the concentration of cinnamon bark extract used, the more concentrated the color of the spray gel. From the results of the observations, it was shown that the preparation was homogeneous on days 0, 7, and 14, which showed that the extract was evenly distributed on a gel base, no lumps were formed,

and there was no water coming out on the surface of the preparation.

Table 5. Organoleptic results and homogeneity of spray gel preparations

Test the Physical Characteristics of the Preparation	Test Result		
	F1	F2	F3
Organoleptic	Form: Semi-thick gel Color: Brick red Smell: Typical of cinnamon form	Form: Semi-thick gel Color: Brick red Smell: Typical of cinnamon form	Form: Semi-thick gel Color: Brick red Smell: Typical of cinnamon form
Homogeneity on 0, 7, and 14 days	Homogeneous	Homogeneous	Homogeneous

Table 6. Test results for pH and viscosity of spray gel preparations

Day	F1		F2		F3	
	pH	Viscosity	pH	Viscosity	pH	Viscosity
0	5.43 ± 0.07	2086.67 ± 126.01	5.32 ± 0.02	2246.67 ± 45.46	5.15 ± 0.03	1899.33 ± 165.26
7	5.38 ± 0.07	1979 ± 64.82	5.19 ± 0.02	1898.67 ± 103.65	5.13 ± 0.09	1757.00 ± 80.29
14	5.24 ± 0.05	1937 ± 54.08	5.12 ± 0.02	1865.00 ± 82.94	5.05 ± 0.01	1758.00 ± 48.54

Information:
- Centipoise viscosity units
- Results are the mean of 3 replicates ± SD

pH testing is needed to ensure the safety of the preparation and the degree of acidity of the preparation when applied to the skin surface, and topical preparations that have a pH that is too acidic or alkaline can irritate. Spray gel preparations that are too acidic can irritate the skin, whereas if the pH of the preparation is alkaline, it can cause the skin to become dry. Good topical preparations have a pH similar to the pH of the skin surface, which is between 4.5 - 6.5 (Sari et al., 2021). The results of tests carried out on the three formulas found that all preparations met the safe pH range for use, namely the pH range of 4.5 - 6.5. The pH test showed that the higher the concentration of the extract in the spray gel preparation, the lower the pH value would be. This is because the ethanol extract of cinnamon bark contains compounds belonging to the class of flavonoids, which are phenolic compounds. Phenolic compounds that decompose into polyphenolic compounds are found in the ethanol extract of cinnamon bark.

Decomposition causes the amount of H^+ to increase as the concentration of the ethanol extract of cinnamon bark increases, causing a decrease in the pH of the spray gel. However, the pH of the spray gel can be said to be good because it still meets the skin's pH requirements, namely 4.5–6.5. The addition of triethanolamine can also affect the pH value of the spray gel. This is because triethanolamine is an alkalizing agent that can neutralize the acidity of carbopol 940. The combination of HPMC and carbopol 940 can be used to cover the deficiencies of carbopol 940. The 0.5% will form a gel at a pH of 6 – 11, but the viscosity will decrease at a pH of less than 3 or more than 12 (Rowe et al., 2009).

Gel dosage form with a combination of HPMC base and carbopol can produce good gel mass physically, has a high viscosity, good drug release, dissolution, and bioavailability. HPMC produces a neutral gel, clear, stable at pH 3 to 11, stable in long-term storage, and has good resistance against microbial attack. Carbopol is a strong and safe gel base used topically because it is not cause hypersensitivity in humans and adheres well to the skin (Tambunan & Sulaiman, 2018). If the concentration of carbopol 940 is increased, the pH will also be more acidic. So a combination of HPMC and carbopol 940 is needed to reduce the concentration of carbopol 940 so that the gel that is formed is not too acidic (Deshpande & Shah, 2012).

Measurement of the viscosity of the preparation was carried out using a Brookfield viscometer with spindle number 63 and a stirring speed of 50 rpm. Viscosity is one of the most important parameters in the manufacture of spray gel preparations. A viscosity that is too high will reduce the comfort level of use because it will be difficult to spray. Low viscosity is also not expected; this is because if the preparation is too runny, it will drip when applied to the skin so that the preparation does not stay completely on the skin surface.

Based on the results obtained, it shows that the higher the extract added to the preparation, the resulting viscosity decreases. This is because the extract has a pH that tends to be acidic, as evidenced by the higher the concentration of the extract, the lower the pH of the preparation (Iskandar et al., 2021). This decrease in pH results in a decrease in the consistency of the carbopol gel, where carbopol will form a gel under alkaline conditions. The difference in the pH value obtained was due to the difference in the addition of cinnamon bark extract. However, the difference in pH has no effect because it is still in the required pH range (close to the normal pH of the skin). The viscosity of the preparation affects the ability of the preparation to be sprayed from the container and the spreadability of the preparation when applied to the skin surface.

Table 7. Test results of spraying patterns and spreadability of spray gel preparations

Spray Distance (cm)	Spray Pattern (mg)			Spread Power (cm)		
	F1	F2	F3	F1	F2	F3
3	132.13 ± 2.40	132.97 ± 1.72	128.13 ± 6.29	3.38 ± 0.06	4.10 ± 0.09	3.62 ± 0.19
5	124.70 ± 0.26	131.60 ± 1.22	130.67 ± 0.68	6.82 ± 0.06	6.53 ± 0.25	7.57 ± 0.76
10	125.80 ± 2.43	130.00 ± 0.95	129.07 ± 0.57	9.50 ± 0.25	10.53 ± 0.26	8.60 ± 0.51
15	126.00 ± 3.21	128.77 ± 1.79	126.33 ± 0.42	12.40 ± 0.23	12.38 ± 0.13	12.38 ± 0.32
20	125.10 ± 1.65	129.10 ± 0.61	127.97 ± 0.60	14.40 ± 0.13	14.95 ± 0.75	14.62 ± 0.32

Note: Results are the mean of 3 replicates ± SD

This spreadability test aims to determine the ability of the preparation to spread when applied to the skin surface, as well as the appropriate spray distance so that the spreadability of the preparation meets the requirements. Spreadability is the relationship between the softness of the preparation and its ease of use. The lower the viscosity, the wider the diameter spread.

Spreadability is one of the characteristics that can be responsible for the effectiveness of releasing active substances. Factors that can affect the spreadability are the viscosity of the preparation, the duration of pressure, and the temperature of the action. Good spreadability will guarantee a satisfactory release of the drug substance (Voight, 1994).

The good spreadability of topical preparations is between 5 - 7 cm (Wasitaatmadja, 1997). Based on the test results, it shows that the appropriate spraying distance is 5 cm to obtain good coverage. In addition to the spreadability, observations were also made on the spraying pattern, which was intended to find out how much of the preparation was able to be removed from the container in one spray at a certain distance. The test results show that Formula 1 has a smaller average when compared to other formulas. This is because Formula 1 preparations have a higher viscosity, and the thicker the preparation, the more difficult it is for the preparation to be sprayed out of the container.

Table 8. Test results for sticking resistance and drying time of spray gel preparations on respondent's skin surface

Spray Distance (cm)	Sticky Resistance			Drying Time		
	F1	F2	F3	F1	F2	F3
3	Attached	Attached	Attached	8 minutes 23 seconds	8 minutes 47 seconds	8 minutes 31 seconds
5	Attached	Attached	Attached	7 minutes 29 seconds	7 minutes 31 seconds	7 minutes 31 seconds
10	Attached	Attached	Attached	7 minutes 3 second	6 minutes 56 seconds	7 minutes 1 second
15	Attached	Attached	Attached	5 minutes 29 seconds	5 minutes 32 seconds	5 minutes 27 seconds
20	Attached	Attached	Attached	2 minutes 40 seconds	3 minutes 40 seconds	2 minutes 25 seconds

The next test was to determine the adherence resistance of the preparation, which was tested on the surface of the forearm skin of several respondents. The preparation is sprayed at a certain distance, and if the preparation drips after 10 seconds, it is said not to stick to the skin surface, whereas if it does not drip after 10 seconds, the preparation is said to be able to adhere to the skin surface (Kamishitta et al., 1992). Based on the test results, it was found that all formulations had good adhesion resistance on the skin surface because they did not drip after 10 seconds. The adherence of the drug to the skin surface will, of course, affect the duration of the pharmacological effects provided by the compounds contained in the drug.

The drying ability of the preparations was also tested on the skin surface of the forearms of many respondents. Good topical preparations have a drying time of less than 5 minutes (Shafira et al., 2015). The test results showed that the three formulas met the test requirements if sprayed at a minimum distance of 15 cm from the skin surface. The long-distance of spraying causes the spread of the preparation to be wider, and the evaporation process, which is affected by body temperature, becomes faster.

After testing the physical characteristics of the 3 formulations of spray gel cinnamon bark extract, then the SPF value of the preparations was determined. Determination of the value of SPF (Sun Protection Factor) aims to determine the ability of spray gel ethanol extract of Cinnamon Bark (in resisting ultraviolet rays. SPF is a value that indicates the ability of sunscreen to protect the skin from ultraviolet rays. Preparations are said to protect if they have an SPF value of 2 – 100 (Mulyani et al., 2015). This test was carried out using the UV-Vis spectrophotometry method at a wavelength of 290

nm to 320 nm, where the wavelength represents the wavelength of UV-B light. The test results can be seen in **Table 9.**

Table 9. Results of determination of SPF value of extract spray gel preparations cinnamon bark

Concentration (ppm)	SPF value ± SD		
	F1	F2	F3
200	0.8215 ± 0.01	1.2653 ± 0.03	1.3794 ± 0.04
400	1.4728 ± 0.02	2.3317 ± 0.04	3.0165 ± 0.04
600	2.1681 ± 0.04	3.3813 ± 0.01	4.4612 ± 0.03
800	2.9693 ± 0.03	4.3846 ± 0.06	5.5917 ± 0.03
1000	3.5441 ± 0.07	6.0698 ± 0.48	7.3311 ± 0.54

Note: Results are the mean of 3 replicates ± SD

The test was carried out by making each preparation into a different concentration of test solution, namely 200, 400, 600, 800, and 1000 ppm to find out at what concentration the preparation gives the maximum SPF value. The test results showed that the higher the concentration of the test solution, the higher the SPF value obtained, namely at a concentration of 1000 ppm test solution. In addition, it can be seen that the higher the extract contained in the preparation, the higher the SPF value, namely formula 1 (10% extract) gives an SPF value of 3.5441 ± 0.07, formula 2 (15% extract) gives an SPF value of 6 .0698 ± 0.48 and in formula 3 (20% extract) it gives an SPF value of 7.3311 ± 0.54. Based on the obtained SPF value, it shows that at a concentration of 1000 ppm test solution, formula 1 has a minimum SPF value (SPF value between 2 - 4), while formulas 2 and 3 have an extra SPF value (SPF value between 6 - 8). The higher the SPF value is caused by the higher the concentration of the extract in the preparation which results in the higher the active compound that has activity as a sunscreen.

Conclusions

Phytochemical screening and thin-layer chromatography on the ethanol extract of cinnamon bark showed positive results for containing flavonoids, alkaloids, tannins, steroids, and antioxidants. The statistical test results showed that there was a significant difference of < 0.05, so it could be concluded that there was an effect of kaffir lime leaf ethanol extract on pH, viscosity, spreadability, stickiness, drying time, and SPF value. The higher the SPF value is caused by the higher the concentration of the extract in the preparation which results in the higher the active compound that has activity as a sunscreen. The formula that provides the best physical characteristics and SPF value is at a concentration of 20%.

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