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Determination of SPF (Sun Protection Factor) Value and Antioxidant Activity of Potato Peel Extract Gel (*Solanum tuberosum* L.) Combined with Honey as a Humectant

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ABSTRACT

Free radicals come from body metabolism, cigarette smoke, free radical-triggering substances from food, various pollutants, and UV radiation. Gel preparations are an alternative facial treatment to prevent various skin problems. In addition to having antioxidant activity, preparations with benefits such as sunscreen are also needed to protect the skin from UV exposure that causes various skin problems. Potato peel waste (Solanum tuberosum L.) from the kitchen of Pondok Modern Darussalam Gontor has not been widely utilized, although it contains phenolic compounds as natural antioxidants. This study aims to determine the effect of potato peel extract and honey concentration on physical characteristics, antioxidant activity, and protection as a sunscreen. This research method is an experimental study consisting of five formulas with variations of potato peel extract and honey: F0 (0%:0%); F1 (0%:10%); F2 (2%:15%); F3 (4%:20%); and F4 (6%:25%). Characteristics include organoleptic tests, homogeneity, viscosity, spreadability, pH, stability, antioxidant activity using the DPPH method, and sunscreen activity using the Mansur method. The results showed that antioxidant activity and SPF increased in direct proportion to the concentration of potato peel extract and honey. F4, with a concentration of 6% potato peel extract and 25% honey, had the highest antioxidant activity and SPF. The best characteristics in F2 based on organoleptic tests, pH, homogeneity, viscosity, adhesiveness, spreadability, and drying time of the preparation. The conclusion is that the gel preparation in F4 is a very strong category antioxidant of 11.60 ppm and an SPF value of 12.2669 in the maximum protection category.

Keywords: *Antioxidant, Humectant, Potato, Peel-off, SPF*

INTRODUCTION

Free radicals are molecules with one or more unpaired electrons; they are unstable and highly reactive, causing the body to withdraw other electrons to achieve stability (Prihandini et al., 2023). Free radicals are produced by both internal and external factors. Internal factors result from the body's metabolism, while external factors include cigarette smoke, free radical-producing substances from food, various pollutants, and UV radiation (Furi et al., 2023). Excessive exposure to sunlight can cause various skin problems such as premature aging, hyperpigmentation, damage to skin texture, and most dangerous is causing skin cancer (Donglikar & Deore, 2016). The impact of UV radiation causes acute effects such as erythema, phototoxic reactions, photoallergies, and photosensitivity, as well as chronic effects such as photoaging, skin cancer, and immunosuppression (Widyawati et al., 2019). Naturally, the skin can synthesize melanin pigment when exposed to UV rays (Sawitri et al., 2025). Excessive UV exposure causes the skin to need additional protection to avoid the negative effects of UV (Nopiyanti & Aisiyah, n.d.). This additional protection can be in the form of substances that can reduce the transmission of UV rays to the skin, known as sunscreens, or as free radical scavengers from the environment (Lalu et al., 2017).

Excessive exposure to UV radiation can cause degenerative diseases or premature aging of the skin (Rachmawati et al., 2021). This is a problem for some women in Indonesia, as it is

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a tropical region with abundant sunlight. Gel is a semi-solid preparation with a water base and the addition of a gelling agent to achieve a chewy, jelly-like texture (Jumariati et al., 2025). In addition to the use of gelling agents, the addition of humectants has a moisturizing effect on the skin, thus preventing the skin from becoming dry and dull and maintaining the stability of the preparation during the shelf life (Sukmawati et al., 2017). Some examples of frequently used humectants are propylene glycol, glycerin, sorbitol, hyaluronic acid, aloe vera and honey (Pratiwi et al., 2018). Honey is a natural humectant that has many health benefits (Dongke et al., 2025). In the Qur'an, many benefits of honey are mentioned, so besides being good for health, honey is also a humectant that is halal to use.

In Surah An-Nahl [16] verses 68-69 Allah says:

وَأَوْحَى رَبُّكَ إِلَى النَّحْلِ أَنِ اتَّخِذِي مِنَ الْجِبَالِ بُيُوتًا وَمِنَ الشَّجَرِ وَمِمَّا يَعْرِشُونَ (68) ثُمَّ كُلِي مِنْ كُلِّ الثَّمَرَاتِ فَاسْلُكِي سُبُلَ رَبِّكِ ذُلُلا يَخْرُجُ مِنْ بُطُونِهَا شَرَابٌ مُخْتَلِفٌ أَلْوَانُهُ فِيهِ شِفَاءٌ لِلنَّاسِ إِنَّ فِي ذَلِكَ لآيَةً لِقَوْمٍ يَتَفَكَّرُونَ (69)

Which mean:

(68) And your Lord inspired the bees, "Make nests in the mountains, in wooden trees, and in places made by humans; (69) then eat of all (kinds of) fruit and walk the path of your Lord which has been made easy (for you)." From the stomach of the bee comes a drink (honey) of various colors, in which there is a medicine that heals humans. Indeed, in that there really is a sign (of Allah's greatness) for those who think. (QS. An-Nahl [16]:68-69).

The specialty of honey as medicine is explained by Az-Zuhaili in his interpretation, saying that the drink that comes out of the bee's stomach is honey. The colors vary including white, yellow and red. Honey contains medicine and is very useful for curing various human diseases. Honey is still included in the category of herbal medicine and medicine (pharmaceuticals). In addition to its use as a humectant in pharmaceutical formulations, honey also offers antioxidant benefits.

Antioxidants based on their source consist of synthetic and natural antioxidants (Butkeviciute et al., 2022). Natural antioxidants can be obtained from spices, grains, cereals, and fruits and vegetables. One plant that is a source of natural antioxidants is the potato (Solanum tuberosum L.), especially the skin. Unida Business Unit (U3) is one of the business units at Unida Gontor Putri Mantingan Campus, which processes several foods (bread, chips, etc.) from processed potatoes. As a result, potato peel waste is produced that is no longer utilized. Until now, there has not been much research that utilizes potato peel as a raw material for making gel preparations, therefore researchers want to utilize potato peel extract. Potato peel is known to contain phenolic compounds consisting of chlorogenic acid, gallic acid, protocatechuic acid, and caffeic acid. Previous research stated that potato peel extract at various concentrations showed very strong antioxidant activity, almost the same as the synthetic antioxidants butyled hydroxyanisole (BHA) and butyled hydroxytoluene (BHT) (Chellaram et al., 2014). Based on research conducted in vivo, phenolic compounds have anticancer, antiproliferative and antioxidant activity (Patricia et al., 2023).

MATERIALS AND METHODS

Equipment and Materials

The tools used in this study were analytical scales (AND, A&D Weighing), maceration bottles, aluminum voil, spectrophotometer (Shimadzu UV-1900), rotary evaporator (LabTech), water bath (Memmert), Brookfield viscometer (Viscolead ADV), pH meter (ATC 190012), beaker glass (Pyrex), stirring rod (Pyrex), test tube (Pyrex), measuring cup (Pyrex), dropper pipette (Pyrex), filter paper, object glass, mortar (Pyrex), stamper (Pyrex), petri dish (Pyrex),

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caliper, oven (Memmert), micropipette, wooden clamp, hot plate (AND, A&D Weighing), horn spoon, ose needle, bunsen, vortex (Eyela).

The materials used were potato peel powder (*Solanum tuberosum* L.) from the waste of Unida Gontor kitchen which was determined at UPT Materia Medika Malang, HCl pro-analytic, methylene blue technical, Dragendorff reagent technical, chloroform pro-analytic, Mg, $FeCl_3$ pro-analytic, 96% ethanol technical, Polyvinyl alcohol (PVA) technical, honey (Ajwa honey Al Madina), Hydroxy Propyl Methyl Cellulose (HPMC) technical, methyl paraben (nipagin) technical, propyl paraben (nipasol) technical and distilled water.

Methods

This research method uses a laboratory experimental method with the formulation and characterization of potato peel extract gel preparations (*Solanum tuberosum* L.) based on variations in the concentration of potato peel extract (*Solanum tuberosum* L.) and honey as a natural humectant.

Extraction Method

Potato peel (*Solanum tuberosum* L.) simplicia as much as 500 g was macerated using 1 L of 96% ethanol solvent. The simplicia was soaked for 24 hours and re-macerated. The resulting macerate was filtered and the dregs were removed, then the maceration results were measured. The resulting filtrate was then concentrated using a rotary vacuum evaporator at a pressure of 70 Psi and a temperature of 50^o C until a thick extract was obtained.

Phytochemical screening

Phytochemical screening for the identification of secondary metabolite content in potato peel extract includes the identification of alkaloids, flavonoids, tannins, and saponins. The alkaloid test uses Dragendorff's reagent, resulting in the formation of orange to brownish-red precipitates. Flavonoid identification is carried out by adding Mg powder and 2N HCl solution. Positive results are indicated by a color change from red, yellow, to orange. The tannin compound test with the addition of 1% $FeCl_3$ reagent produces a blackish-green color. Saponin identification shows a positive result when foam forms with a height of 1-10 cm and is stable for 10 minutes, and does not disappear when 1 drop of 2N HCl is added (Sawitri et al., 2025).

Formulation Potato Peel Extract Gel

The gel preparation was made using various combinations of potato peel extract (Solanum tuberosum L.) concentrations with honey as a humectant F0 (0:10), F1 (2:15), F2 (4:20), and F3 (6:25). Based on the formula, F4 is the best formulation because it contains the highest concentration of potato peel extract, thereby yielding the most potent antioxidant activity and SPF. The preparation formula can be seen in the table below.

Table 1. Gel Preparation Formula Potato Peel Extract (*Solanum tuberosum* L.)

Material	Concentration % (w/v)					Function
	F0	F1	F2	F3	F4	
Potato peel extract	0	0	2	4	6	Active substance
Honey	0	10	15	20	25	Humectant
HPMC	2	2	2	2	2	Gelling agent
PVA	7	7	7	7	7	Filming agent
Methyl paraben	0,18	0,18	0,18	0,18	0,18	Preservative
Prophyl paraben	0,02	0,02	0,02	0,02	0,02	Preservative
Aquadest *ad*	100	100	100	100	100	Solvent

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Description:
F0: Gel formula with 0% extract and 0% honey
F1: Gel formula with 0% extract and 10% honey
F2: Gel formula with 2% extract and 15% honey
F3: Gel formula with 4% extract and 20% honey
F4: Gel formula with 6% extract and 25% honey

Evaluation of the quality of the preparation

Evaluation of the quality of the skin extract gel preparation includes organoleptic tests, homogeneity tests, pH tests, spreadability tests, adhesiveness tests, drying time tests followed by tests on the antioxidant and sunscreen activity of the preparation.

Viscosity Test Method

Viscosity testing was performed using a Brookfield viscometer. A 100 mL sample was placed in a beaker, and the viscosity of the formulation was measured using spindle No. 4 at a rotational speed of 60 rpm. An optimal viscosity range for facial serum formulations is 230–5000 cPs.

Spreadability Test Method

The spreadability test is used to determine how well a facial serum spreads when applied to the skin. The ideal spreadability for semi-solid topical preparations is 5–7 cm. One gram of the preparation is weighed onto a Petri dish, covered with another Petri dish, and subjected to a 500 g weight; after 10 minutes, the diameter of the resulting spread is measured.

Antioxidant activity using DPPH method

A total of 2 mL of each sample concentration was taken and 2 mL of 40 ppm DPPH solution was added to the test tube and then vortexed for 2 minutes. The samples were incubated in the dark at room temperature for 30 minutes. After that, the absorbance was measured using a UV-Vis spectrophotometer with a wavelength of 517 nm. Next, the absorbance of each sample was recorded to calculate the free radical scavenging activity and IC_{50} value of the sample.

$$\%\ inhibisi = \frac{\text{Absorbansi DPPH} - \text{Absorbansi Sampel}}{\text{Absorbansi DPPH}} \text{ x } 100\%$$

Sun Protection Factor activity using Spectrophotometry

The SPF value was determined by measuring the absorbance of the solution in each formula using a UV-Vis spectrophotometer. The test solution was prepared by weighing 0.5 g of sample, then diluting it with 25 mL of ethanol (p.a) (20 mg/ml or 20,000 ppm) and reading the absorbance at 5 nm intervals. The absorbance results for each concentration were recorded and then the SPF value was calculated using the following formula:

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

Description:
CF : Correction factor (10)
EE : Effectiveness of erythema caused by UV light at a wavelength of λ nm.
I : UV light intensity at a wavelength of λ nm.
Abs : Sample absorbance.

Analysis data

Data analysis using SPSS included a normality test. If the data were normally distributed, the analysis was continued with a one-way ANOVA. Test results showing significant differences were then followed by a Kruskall-Wallis test. If there were significant differences for related tests, the Mann-Whitney test was continued.

RESULTS AND DISCUSSION

Extraction Result

The results of the extraction of potato peel (*Solanum tuberosum* L.) simplex with 96% ethanol solvent can be seen in the table below.

Table 2. Characteristics Potato peel extract

No	Characteristic	Result
1	Color	Dark brown
2	Aroma	Potato specialties
3	Consistency	Thick like caramel
4	Simple ingredients	500 g
5	Extract	26,7 g
6	Yield	5,34%

A total of 500 g of potato peel (Solanum tuberosum L.) powder was macerated using 96% ethanol. The resulting macerate was then evaporated using a rotary evaporator. The extract was thickened using a water bath at 50^{o}C to obtain a thick extract of 26.7 g. The yield results showed a percentage of extract obtained of 5.34%. Factors affecting the yield were the solvent used, the surface area of the powder, the method, and the length of soaking time (Sawitri et al., 2025).

Phytochemical screening result

The results of phytochemical screening of potato peel extract can be seen in the following table:

Table 3. Phytochemical screening test

No	Chemical Content	Procedure	Result	Information	Picture
1	Alkaloids	Extract + HCl + distilled water → heated + Dragendorff reagent	Orange color is formed	+	
2	Flavonoids	Extract + Chloroform: distilled water (1:1) + Mg powder + HCl	A yellow-orange color is formed	+	

No	Chemical Content	Procedure	Result	Information	Picture
3	Tannin	Extracted from distilled water + 1% $FeCl_3$	A blackish green color is formed	+	
4	Saponin	Extract + hot distilled water → cooled and shaken vigorously for 10 seconds	A stable foam is formed for 10 minutes	+	

Phytochemical screening aims to determine the content of potato skin (*Solanum tuberosum* L.). The phytochemical screening method uses a color change reaction. Based on Table 3, positive results were obtained for the secondary metabolite content of potato skin extract for alkaloids, flavonoids, tannins, and saponins. This is consistent with previous research that potato skin contains active compounds such as phenolics, flavonoids, alkaloids, anthocyanins, terpenoids, tannins, and saponins (Tiarasanti et al., 2024).

Evaluation of the quality result

The results of the organoleptic and homogeneity tests can be seen in the table below:

Table 4. Organoleptic and Homogeneity test

No	Formulation	Color	Aroma	Texture	Homogeneity
1	F0	Clear White	Gel Base	Liquid ++	Homogeneous
2	F1	Yellowish	Honey special	Liquid +	Homogeneous
3	F2	Light brown	Potato specialties	Thick +	Homogeneous
4	F3	Brown	Potato specialties	Thick ++	Homogeneous
5	F5	Dark brown	Potato specialties	Thick +++	Homogeneous

Organoleptically, the characteristics of the preparations can be seen in Table 4. Preparation F0 is clear white because there is no addition of honey or extract. Preparation F1 has a clear, slightly yellowish color due to the influence of the addition of honey to the preparation. While F2, F3 and F4 are brown to dark brown due to the influence of the addition of potato peel extract and the increasing concentration of honey. The aroma in F0 resembles the base of the gel preparation, preparation F1 has a distinctive aroma of honey, while in F2, F3, and F4 produce a distinctive aroma of potato peel extract. It is recommended that there is an addition of fragrance to the preparation for comfort when used and can be better accepted by consumers. Preparation F0 has a gel texture but in F1 the liquid is rather thick because there is the addition of honey with a low concentration. Meanwhile, preparations F2, F3 and F4 are thick where the viscosity increases directly proportional to the increasing concentration of honey and potato peel extract.

The homogeneity test results showed that the potato peel extract gel preparation was homogeneous and met the preparation quality standards. A homogeneous preparation is indicated by the absence of separated particles in the preparation, accompanied by an even color of the preparation and no lumps in the preparation. A homogeneous preparation indicates that the active substance is evenly distributed in the base. So if the preparation is not homogeneous, the active substance in the preparation will not be evenly distributed when applied to the skin. The homogeneity of the potato peel extract gel preparation is determined by the preparation of HPMC before mixing all ingredients. The HPMC gel base is made by dissolving 2 g of HPMC in 40 mL of distilled water, then left for 24 hours until mucilage forms so that the resulting gel is homogeneous.

pH Test of the Preparation

The results of the pH test of the preparation can be seen in the following table:

Table 5. pH Test

pH test results				
F0	**F1**	**F2**	**F3**	**F4**
7.00	7.00	5.47	5.29	5.17

The pH values of the five gel preparations according to Table 5 show that the lowest pH is F4 at 5.17, and the highest pH is F0 at 7. F0 exhibited the highest pH, as the pH of the formulation decreased with increasing concentrations of potato peel extract and honey. Studies by Javed et al. (2019) and Ijaz et al. (2024) reported that potato peel extract has a pH value in the 5.0–6.0 range, whereas honey has a pH range of 3.2–4.5, with an average value of approximately 3.9. Preparations containing extracts have a more acidic pH compared to preparations that do not contain extracts. This is because the content of secondary metabolites, especially phenolics, tannins, and flavonoids, can affect the pH of the preparation, making the pH more acidic (Wijayanti et al., 2023). Based on this data, the pH values for F2, F3, and F4 meet the skin pH standard of 4.5-6.5. If the gel is too acidic, it can cause skin irritation, while if it is too alkaline, it can cause dryness or flaking (Purwanto et al., 2025).

Analysis of pH test data using Shapiro Wilk showed a significance value of >0.05, which means the data is normally distributed. A homogeneity of variance test obtained a significance value of >0.05, meaning the variation in pH data was homogeneous. A parametric test with one-way ANOVA resulted in a significance value of 0.000 (<0.05), which means that variations in the concentration of potato peel extract and honey had a significant effect on the pH of the preparation. A post hoc test with Duncan showed that the pH values of F0 and F1 preparations were not significantly different because they were located on the same table, but were significantly different from F2, F3, and F4 because they were located on different tables.

Viscosity Test of the Preparation

The results of the viscosity test of the preparation can be seen in the following table:

Table 6. Viscosity Test

Viscosity test results (cps)				
F0	**F1**	**F2**	**F3**	**F4**
659.5	1567.6	2644.5	4625.0	6830.3

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Viscosity test of gel preparation using a viscometer with spindle no. 4 at a speed of 20 rpm (Sawitri et al., 2024). Based on Table 6 above, the viscosity value of the preparation is directly proportional to the thickness of the preparation. The higher the viscosity value, the thicker the preparation. The viscosity of the preparation is influenced by HPMC, which functions as a viscosity enhancer. Increasing the concentration of honey and extracts increases the viscosity of the preparation because the water used in the preparation will decrease, thus affecting its viscosity (Dongke et al., 2025). Increasing the viscosity of the preparation will reduce the spreadability of the preparation on the skin and will make it more difficult to flow.

Honey, as a humectant, can increase the viscosity of a preparation because it can bind water. The use of honey can affect the viscosity of a preparation, which is directly proportional to its concentration (Pratiwi et al., 2018). The lowest viscosity at F0 was 659.5 cps, and the highest viscosity at F4 was 6830.3 cps. The formula meets the standards for a good gel preparation because its viscosity is in the range of 3000-50000 cps (Wahidah et al., 2024). If the viscosity of the preparation is less than 3000 cps, it will be too runny, making it difficult to apply and not adhere to the skin. Meanwhile, a preparation with a viscosity of more than 50,000 cps will produce a preparation that is too thick, making it difficult to pour or apply.

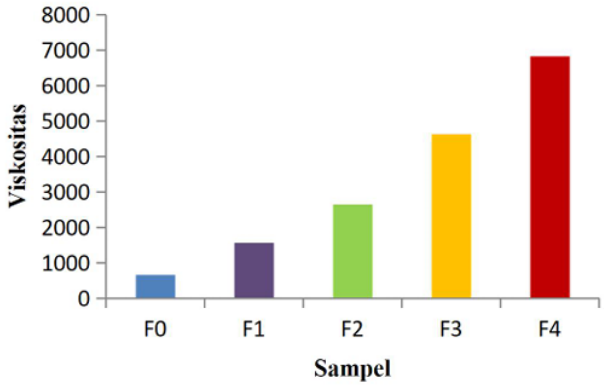


Figure 1. Viscosity test results

The viscosity test data were analyzed using Shapiro Wilk and showed a significance value of >0.05, which means the viscosity test data were normally distributed. Then, the homogeneity of variance test obtained a significance value of >0.05, which means the viscosity data variation was homogeneous. The parametric test with one-way ANOVA showed a significance result of 0.000 (<0.05), which means that the variation in the concentration of potato peel extract and honey had a significant effect on the viscosity of the preparation. In the post hoc test with Duncan, the viscosity of each formula was significantly different because it was located in a different table. There is a significant difference in viscosity among the formulations due to the varying concentrations of potato peel extract and honey (as a humectant).

Adhesive Test of the Preparation

The results of the adhesive strength test of the preparation can be seen in the following table:

Table 7. Adhesive Test

Adhesive test (second)				
F0	**F1**	**F2**	**F3**	**F4**
0.67	1.35	6.30	23.73	34.32

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The adhesion test aims to determine the ability of the gel preparation to adhere to the skin when applied. The adhesion test results in Table 7 F0 were 0.67 seconds and F4 was 34.32 seconds. The adhesion of the preparation tends to increase according to the increasing concentration of extract and honey. Therefore, the thicker the preparation, the longer the adhesion time. Good adhesion of semi-solid preparations is more than 1 second. The adhesion test results F0 were 0.67 seconds (<1 second). According to Forestryana et al., (2022) the longer the adhesive power, the more active substances will be released into the skin, because the contact between the gel preparation and the skin will be longer so that the desired therapy will be maximized. (Forestryana et al., 2022).

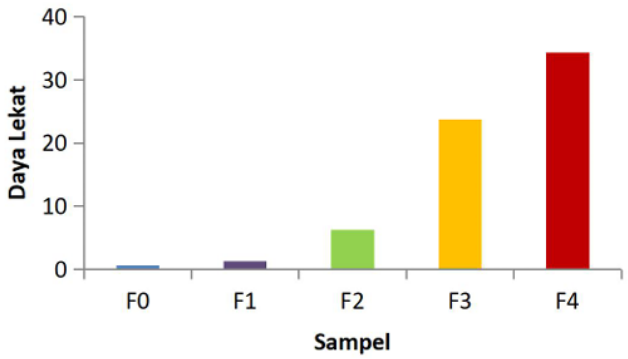


Figure 2. Adhesive test results

Analysis of the adhesion test data using Shapiro Wilk showed a significance of >0.05, which means that the adhesion data of the gel preparation is normally distributed with a significance value of homogeneity of variances >0.05, meaning that the variation in the adhesion data is homogeneous. Then, a parametric test with one-way ANOVA obtained a significance of 0.000 (<0.05), which means that the variation in the concentration of potato peel extract and honey has a significant effect on the adhesion of the preparation. A post hoc follow-up test with Duncan showed that the adhesion of the F0 and F1 preparations was not significantly different because they were located in the same table, but significantly different from F2, F3 and F4 because they were located in different tables.

Spreadability Test of the Preparation

The results of the spreadability test of the preparation can be seen in the following table:

Table 8. Spreadability Test

Spreadability (cm)				
F0	**F1**	**F2**	**F3**	**F4**
7.9	7.6	6.7	6.2	5.6

The gel spreadability test aims to determine the gel's ability to spread over the skin surface when applied. The greater the spreadability of a preparation, the easier it is for the active ingredient to diffuse into the skin. Along with the wider spread area, it will provide a larger membrane surface area for the active ingredient to diffuse into the skin, so that the amount of active ingredient penetrates more. Table 8 shows the lowest spreadability of the preparation, namely F4, at 5.6 cm, and the highest spreadability is F0, at 7.9 cm. Preparations F0 and F1 have the greatest spreadability and do not meet the standards for good spreadability. Meanwhile, preparations F2, F3, and F4 meet the good spreadability range, namely between 5-7 cm (Sawitri et al., 2024). Based on the results of the gel preparation spreading power test, it was shown that spreading power is inversely proportional to viscosity. The lower the spreading

power of the preparation, the higher the viscosity or the thicker the preparation and the more difficult it will be to apply to the skin (Fitrian et al., 2025). This is due to the retention of the solvent liquid absorbed by the gelling agent.

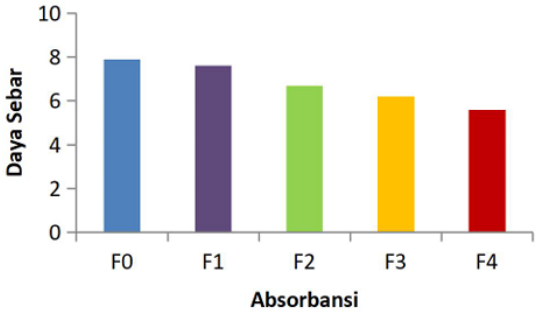


Figure 3. Spreadability test results

Analysis of the data from the spreadability test using Shapiro Wilk showed a significance value of >0.05, which means that the data on the adhesive power of the gel preparation were normally distributed. The results of the homogeneity of variances test obtained a significance of >0.05, meaning that the variation in the spreadability data was homogeneous. Furthermore, the one-way ANOVA test showed a significance value of 0.000 (<0.05), which means that the variation in the concentration of potato peel extract and honey had a significant effect on the spreadability of the gel preparation. Further tests with Duncan showed that the spreadability of the F0 and F1 preparations was not significantly different because they were located on the same table, but was significantly different from the spreadability of F2, F3, and F4 because they were located on different tables.

Drying Time of the Preparation

The results of the drying time test for the preparation can be seen in the following table:

Table 9. Drying Time Test

Drying time (minutes)				
F0	**F1**	**F2**	**F3**	**F4**
12.25	15.26	16.33	17.34	19.32

The drying time test of the preparations aims to determine how long it takes for the preparation to dry on the skin surface and form a film layer. The fastest drying time of the four formulas based on Table 9 is F0 at 12.25 minutes and the longest drying time is F4 at 19.42 minutes. The formula that does not contain extracts, namely F0, has a faster drying time than the other four formulas that contain extracts and honey. This is because the addition of extracts and honey prolongs the drying time of the preparation.

According to previous research, the use of honey increases the drying time of the preparation due to its humectant and hygroscopic nature, meaning it readily absorbs and retains water molecules from the surrounding air. This maintains the stability of the surrounding water by absorbing moisture and reducing the evaporation of water from the preparation (Sinulingga et al., 2018). Of the five formulas that meet the drying time requirements for good gel preparations are F1, F2, F3, and F4, which show a time range of between 15-30 minutes (Fitrian et al., 2025).

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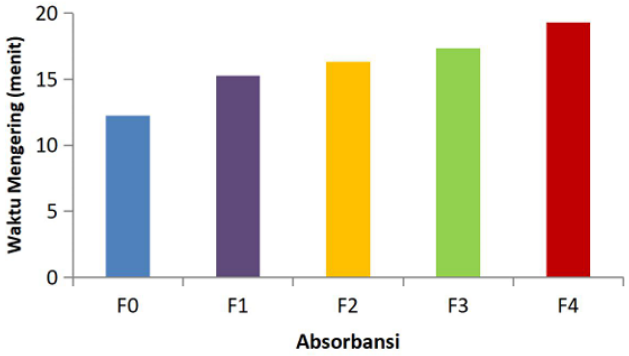


Figure 4. Drying time test results

The data analysis of the drying time test results with Shapiro Wilk showed a significance of >0.05, which means the drying time data is normally distributed. The results of the homogeneity of variances test showed a significance value of >0.05, which means the variation in the spreadability data is homogeneous. Furthermore, the one-way ANOVA test obtained a significance value of 0.000 (<0.05), which means that the variation in the concentration of potato peel extract and honey had a significant different effect on the drying time of the preparation. The post hoc test with Duncan showed that the drying time of each formula was significantly different because it was located in a different table.

Antioxidant Activity of Gel Preparation

The results of the antioxidant activity test of the potato peel extract gel preparation combined with honey as a humectant can be seen in the table below:

Table 10. Antioxidant Activity

Average IC_{50} Value (ppm)					
Vitamin C	**F0**	**F1**	**F2**	**F3**	**F4**
4.817	272.733	93.068	25.035	17.313	11.600
Very Strong Activity	No Antioxidant Activity	Strong Activity	Very Strong Activity	Very Strong Activity	Very Strong Activity

Based on the data in table 8, the IC_{50} value of vitamin C as a positive control was 4.817 ppm, which is included in the category of very strong antioxidant activity. Meanwhile, the IC_{50} value in the gel preparation shows that the higher the concentration of potato peel extract combined with honey, the higher the resulting antioxidant activity. In F0 as a base without the addition of extract, the results showed that the gel base had no activity in protecting the skin against free radical exposure. The highest antioxidant activity was shown by F4 with a variation in the concentration of potato peel extract of 6% with a combination of 25% honey with a value of 11.600 ppm which is included in the category of very strong antioxidant activity. Based on the results of the data analysis, the normality test obtained a significance value of $p > 0.05$, indicating that the data were normally distributed so that it would be continued to the parametric test. The parametric test with one-way ANOVA obtained a significance value of 0.001, meaning that there was a significant difference between the treatment groups. This means that the influence of variations in the concentration of honey as a humectant significantly influenced the antioxidant activity of the resulting gel preparation.

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Sunscreen Activity of Gel Preparation

The results of the sunscreen activity test of the potato skin extract gel preparation can be seen in the table below:

Table 11. Sunscreen Activity

Average SPF Value					
Extract	**F0**	**F1**	**F2**	**F3**	**F4**
8.0321 Maximal Protection	0.2951 No Protection	3.2524 Medium Protection	4.0580 Medium Protection	5.2387 Medium Protection	12.2669 Maximal Protection

Based on the calculation results of the SPF value of the gel preparation in Table 9, it was found that the potato peel extract itself has sunscreen activity in the maximum protection category. In F0 as a base without the addition of extract, the results showed that the gel base had no activity in protecting the skin against ultraviolet light exposure. Meanwhile, increasing the concentration of potato peel extract and honey also provided positive effectiveness by increasing the sunscreen activity of the preparation. The highest sunscreen activity was obtained from F4 with a variation of 6% potato peel extract concentration with a combination of 25% honey with an SPF value of 12.2669 which is included in the maximum protection category. Based on the results of the data analysis, the normality test obtained a significance value of $p > 0.05$, indicating that the data were normally distributed so that it would be continued to the parametric test. The parametric test with one-way ANOVA obtained a significance value of 0.000, meaning that there was a significant difference between the treatment groups. This means that the influence of variations in the concentration of potatoes peel extract and honey as a humectant significantly affected the sunscreen activity of the resulting gel preparation.

CONCLUSION

Based on the results of the quality test of the gel preparation, it shows that the F0-F4 preparation meets the quality standards for gel preparations. The results of the activity test show that F4 with a concentration of potato peel extract (*Solanum tuberosum* L.) 6% combined with 25% honey has antioxidant activity in the very strong category with an IC_{50} value of 11,600 ppm. While the sunscreen activity of F4 is included in the maximum protection category with an SPF value calculation of 12.2669. The results of the data analysis show that the significance value is <0.05, which means that variations in the concentration of potato peel extract and honey as humectants have a significant effect on the antioxidant and sunscreen activity of the gel preparation.

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