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FORMULATION AND EFFICACY TESTING OF SPF (*Sun Protecting Factor*) SUNSCREEN GEL EXTRACT OF RAMBUSA LEAVES (*Passiflora Foetida* L)

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ABSTRACT

The rambusa plant contains flavonoid compounds found in rambusa leaves which are good antioxidants because they have hydroxyl groups attached to aromatic carbon rings. This makes rambusa leaves able to ward off free radicals. The choice of gel composition is based on practical considerations because gel not only provides effective protection against sunlight but also has non-sticky properties, provides a soft feel and forms a film that adheres well to the skin. This research aims to determine the flavonoid content in rambusa leaves, which are antioxidants that can be formulated into sunscreen gel preparations to help protect the skin from sunlight. Determination of antioxidant levels in sunscreen gel preparations made from rambusa leaf extract was carried out by measuring the SPF (Sun Protection Factor) value at three different concentrations, namely 2%, 4%, and 6% using UV-Vis spectroscopy. The research results showed that all formulas had good physical quality values of the gel preparations. All formulas have varying SPF values, where the 2% concentration has maximum protection with an SPF value of 11.7 and the 4% and 6% concentrations have ultra protection with SPF values of 18.8 and 33.9. The conclusion of this research is that rambusa leaf extract has the potential to be an effective natural ingredient in sunscreen preparations and shows the ability to protect the skin from sunlight, where formulation 3 only has the highest SPF number, namely 33.90 (super protection).

Keywords: Rambusa leaves, Protection, Sunscreen, SPF

INTRODUCTION

Indonesia is a tropical country that benefits from sunlight every year. The sun is a useful source of energy for human life. This energy source can also cause harm to our bodies (Avianka *et al.*, 2022). Excessive exposure to ultraviolet (UV) rays can pose various health risks, making skin protection crucial in maintaining a balance between the benefits and risks of UV radiation. Negative effects include skin redness and the possibility of skin cancer. Sunscreen is essential for protection against potentially cancer-causing sun rays (Rosyidi *et al.*, 2018).

According to its function, sunscreens are divided into two types, namely sunscreen and sunblock. The basic function of sunscreen is to reflect sunlight. The primary function of sunscreen is to act as a barrier between the skin and harmful UV rays, helping to prevent skin cancer more effectively (Isfardiyana and Safitri, 2014). Gel formula is chosen in the production of sunscreen products because it provides optimal permeability to help the product penetrate the dermis, has a cooling effect on the skin, is easily washed off with water, and does not cause irritation. It is gentle and able to release active ingredients optimally. Gel is a semi-solid preparation that does not move much in the dispersing medium due to its small particle size (Facione *et al.*, 2009).

The Rambusa plant (*Passiflora foetida* L) is well-known among the community Central Kalimantan, especially Palangka Raya, is also known for the Cemot Factory. People recognize this plant as a wild plant that grows in bushes and highlands, often producing fruits for fresh consumption. The bioactive components in this plant can contribute to disease treatment efforts. One of the components of rambusa is volkening, which can have positive effects on the body. As a result, people worldwide use rambusa for medicinal purposes. Previous research has shown that rambusa plants have high antioxidant content, with rambusa leaves producing total flavonoids (extract 30.98 mg/g; QC extract 25.03 mg/g) and saponins (extract 32.27 mg/g). The research findings indicate that rambusa leaf extract holds promising therapeutic value as a natural antioxidant (Ajane and Patil, 2019).

Phenolic compounds and flavonoids in rambutan leaves can also help reduce lipid peroxidation and free radical activity. Phenolic compounds include flavonoids and tannins. This group has the ability to protect against sunlight because they contain chromophores (double bonds) that can absorb UV A and UV B rays. Some physical activities of these plants, such as leaves, flowers, fruit skins, and seeds, are also physically active (Purwaningsih *et al.*, 2015). This research aims to determine the flavonoid content in rambusa leaves as an antioxidant that can be formulated as a sunscreen gel to help protect the skin from sunlight.

RESEARCH METHOD

Tools and Materials

The equipment used includes chemical glassware (25 mL, 50 mL), a stirrer, an analytical balance (Fujitsu FS AR 210), a spatula, parchment paper, filter paper, a mortar, a stirring rod, a ceramic crucible, pH paper, pipettes, a hot plate (msh 20D Daihan Scientific), tube clamps, reaction tubes, a watch glass, a glass funnel, a stopwatch, measuring cylinders (5 mL, 10 mL, 100 mL, 1000 mL), glass slides, beakers, UV-Vis spectrophotometry (Shimadzu No A125358), and a rotary evaporator (B-ONE RE-1000 HN). The required materials are dried rambusa leaves, Na-CMC, propylparaben, glycerin, distilled water, 70% ethanol, concentrated H2SO4, acetic acid, and 2N HCl.

Research Procedure

Plant Determination

The Rambusa plant (*Passiflora foetida* L) was obtained from Bandung. Identification was conducted at PT Materia Medika, paying attention to plant morphology characteristics based on documents, to avoid errors in document collection.

Extraction Process

The leaf extract of rambusa is obtained using the maceration method. The powdered rambusa leaf simplicia is weighed at 600 grams and soaked in 70% ethanol with a ratio of 1:5. Soak for 3 days and then evaporate the result using a rotary evaporator at 60°C, followed by concentration in a water bath until a thick extract is obtained (Damogalad *et al.*, 2013).

Identification of Flavonoid Compounds

The flavonoid compound was tested by adding 0.3 grams of rambusa leaf extract into a reaction tube. Then, 3 mL of n-hexane was added several times until the n-hexane extract became colorless. Next, 0.5 mL of concentrated HCl was added to the solution and the color change was observed. The mixture was then heated in a water bath and the color change was observed again. If the color gradually changes to bright red or purple, it indicates the presence of leucoanthocyanidin compounds If the extract does not change color, then there is no compound present (Auliani, 2020).

Gel Making Process

The equipment to be used is prepared and the ingredients are weighted according to the formula in Table I. Na-CMC is developed using water in a beaker as mixture 1. Propylparaben is mixed with glycerin until homogeneous in another beaker as mixture 2.

Combine both mixtures and stir until homogeneous, then add the rambusa leaf extract along with the remaining distilled water and homogenize (Auliani, 2020).

Table I. Formula Sunscreen Gel Extract of Rambusa Leaves

Material Name	Concentration		
	F1	F2	F3
Extract rambusa leaves	2%	4%	6%
Na-CMC	3%	3%	3%
Propylparaben	0.2%	0.2%	0.2%
Glycerin	10%	10%	10%
Aquadest	Ad 100 g	Ad 100 g	Ad 100 g

Quality Evaluation of the Preparation

The sunscreen gel formulation made from rambusa leaf extract is then tested for its physical quality and effectiveness using organoleptic parameters, homogeneity, pH, spreadability, adhesion, and SPF value.

a. Organoleptic and Homogeneity Test

Organoleptic testing is carried out without using special equipment and only using the five senses. The testing includes observing the smell, color, and texture of the preparation. Uniformity testing of the gel is conducted to determine the consistency of the materials used in gel production. The testing is done by applying the composition to a glass surface. Take 0.1 gram of gel and apply it, then check whether the gel preparation has uniform composition and no stains (Puspitasari and Setyowati, 2019)

b. pH Test

Testing the pH is done by dissolving 1 gram of the sample in 10 mL of distilled water, and then measuring it with a pH meter until a constant value is obtained (Gunarti and Fikayuniar, 2020). The ideal pH value for good skin is between 4.5 and 6.5, while the pH value for gel formulations typically ranges from 4 to 6 (Erwiyanti et al., 2017 & Slamet *et al.*, 2020).

c. Spreadability Test

Testing begins by weighing 1 gram of the preparation, which is then placed between two flat plates. A 100 gram load is added to the compositio for 1 minute. The spreading power is determined by measuring the spread of the preparation on the plate. A good spread for a semi-solid composition is around 5–7 cm (Nurlelly *et al.*, 2021).

d. Adhesion Test

Testing is done by weighing 1 gram of the preparation, then placing it on glass and placing another glass on top with the weight still locked. After the preparation adheres between the glass, the filling button is released. A good grip test standard is more than 1 second (Auliani, 2020).

e. Test SPF Value

The SPF value is measured to determine the amount of light absorbed by a composition. The instrument used is a UV-Vis spectrophotometer with a wavelength range of 290–320 nm. The SPF value is determined by measuring the absorption of each formulation solution using the UV-Vis spectrophotometer. Each sunscreen gel is transferred to a 100 mL volumetric flask and diluted with 70% ethanol. The absorption value is measured using the spectrophotometer at every 5 nm (Puspitasari and Setyowati, 2019).

Data Analysis

The research findings obtained were analyzed using a normality test first to determine whether the research data is normally distributed or not. The next test conducted was the One Way Anova test in SPSS 20 with a confidence level of 95%.

RESULTS AND DISCUSSION

Plant Determination Results

This research begins by identifying the plant materials used by the researchers. The goal is to verify the macro-morphological characteristics of the leaf of rambusa plant (*Passiflora foetida* L) reported in letter of determination number 067/926/102.20/2023. The purpose of this step is to ensure accurate plant identification for the study and to avoid errors. The results obtained based on the determination in the Herbal Materia Medica Batu Malang laboratory are accurate, specifically using the leaf of the rambusa tree from the *Passifloraceae* family with the species *Passiflora foetida* L.

Extraction Results

This research initiates the extraction process by using 600 grams of powdered leaves of *Passiflora foetida* L, which are extracted in 3 liters of 70% ethanol solvent. The choice of 70% ethanol solvent is based on the consideration that the solvent used in the extraction process should have the same polarity as the identified compounds. The selection of 70% ethanol solvent not only considers the compatibility of polarity levels but also optimizes antioxidant activity, especially in the context of flavonoid compounds in the rambusa leaf extract (Guna *et al.*, 2020). The result of the extraction process obtained an extract of 15.72 grams, and its yield is 26.2%. The higher the yield, the higher the active substance content in the extract, and a good yield value is >10% (Subaryanti *et al.*, 2022).

Identification Results of Flavonoid Compounds

Phytochemical screening aims to identify the presence of specific compounds in the extract of rambusa leaves. This process utilizes the Bate-Smith method by mixing the rambusa leaf extract with n-hexane and concentrated HCl, followed by heating. If a gradual red color appears, it indicates the presence of flavonoids from the flavonol and flavanon groups (Susiloningrum and Indrawati, 2020). The test results can be seen in Figure 1, where the test results on rambusa leaf extract indicate the presence of flavonoids, which can be determined by a color change to red.

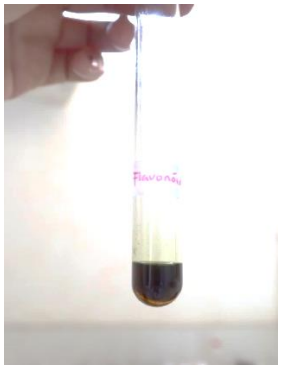

Figure 1. Flavonoid identification results

Manufacturing Process of Gel Preparations

The decision to choose a gel formulation is also based on practical considerations as an ideal carrier for sunscreen. Gel formulations offer several advantages, including their non-sticky nature, providing a gentle and elegant sensation on the skin, and the ability to form a well-adhering film layer, offering optimal protection against the harmful effects of sunlight (Rosita *et al.*, 2010). The formulation process of sunscreen gel involves careful steps Na-CMC is used as the base material to produce a gel that is clear, neutral, and has strong binding properties for active ingredients. Mixing is done using a stirrer at 10 rpm so that Na-CMC can quickly dissolve in hot water and form a clear mixture as mixture 1 (Asmoro, 2018). Glycerin functions as a humectant to maintain skin moisture and protect it from potential dryness (Andini *et al.*, 2017). Propylparaben, as an antibacterial and antifungal agent, is added to prevent the growth of microorganisms that could compromise the quality

and stability of the preparation. Glycerin is mixed with propyl paraben until homogenous as a blend (Dhurhania, 2019). The next step is to mix mixture 2 into the previously developed mixture 1. Finally, the rambusa leaf extract is added according to the predetermined formula percentages (2%, 4%, and 6%), resulting in a homogeneous gel containing various benefits from the rambusa leaf extract.

Quality Evaluation of Gel Preparations

Sunscreen gel made from extracted rambusa leaves is placed in a tube and undergoes physical quality testing. The test results and parameters are as follows :

a. Organoleptic Test Results and Homogeneity

Sensory testing and uniformity are conducted to visually observe the appearance, smell, and color of the gel preparation extracted from rambusa leaves. The sensory observations of the rambusa leaf extract gel can be seen in Table II.

Table II. Organoleptic Test Results

Type of Observation	F1	F2	F3
Texture	Thick	Thick	Thick
Smell	Distinctive	Distinctive	Distinctive
Color	Blackish green	Blackish green	Blackish green
Homogeneity	Homogeneous	Homogeneous	Homogeneous

Information:
F1 : Gel formulation with 2% extract concentration
F2 : Gel formulation with 4% extract concentration
F3 : Gel formulation with 6% extract concentration

The observation results indicate that all preparations have a semi-solid form with a color that tends towards blackish green, which is the extract color from rambusa leaves. According to the defined characteristics, gel preparations are semi-solid formulations containing small inorganic particle suspensions or large organic molecules soaked in liquid. Additionally, the three formulas containing rambusa leaf extract also have a distinct aroma that sets them apart from other preparations. The homogeneity of the preparations shows that the extract and gel base can mix uniformly, without any particle clumps (Kaur and Guleri, 2013).

b. pH Value Result

The process begins by dissolving a small amount of the product in distilled water. The pH of the resulting solution is then measured using a pre-calibrated pH meter. The pH testing process is important to ensure that acidic products meet skin health standards and do not cause irritation to users (Astuti *et al.*, 2018). The pH test results can be seen in Figure 2.

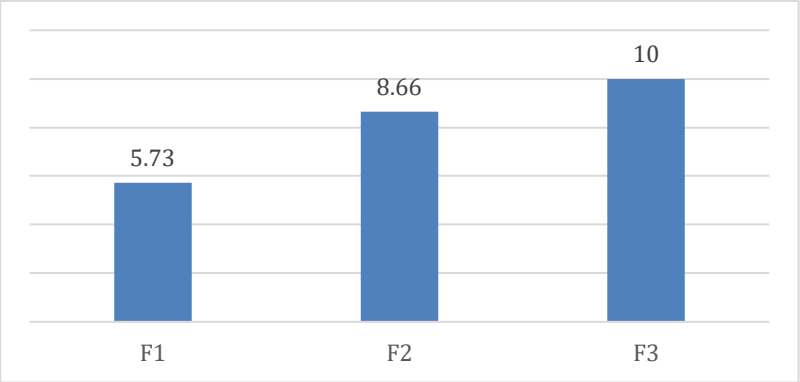

Figure 2. pH test results

Information:
F1 : Gel formulation with 2% extract concentration
F2 : Gel formulation with 4% extract concentration
F3 : Gel formulation with 6% extract concentration

The pH values of the sunscreen gel formulations containing 2%, 4%, and 6% extract from rambusa leaves have been tested. The average pH ± SD for each formulation is as follows: formulation I 6.29 ± 0.42, formulation II 6.00 ± 0.47, and formulation III 5.52 ± 0.24. According to the Indonesian National Standard (SNI) 16-4399, the optimal pH range for gel formulations is between 4–6, while the normal pH range for human skin is between 4.5–6.5. The pH test results for the sunscreen gel with rambusa leaf extract in this study comply with the SNI requirements. The findings indicate that higher extract concentrations result in lower pH values, where low pH indicates acidic formulation.

c. Spreadability Test Result

This test is conducted to evaluate the extent to which the gel formulation spreads evenly, provides optimal protection, and gives a comfortable application sensation on the skin (Yati *et al.*, 2018). The test results of spreadability help us understand how well this gel formulation can evenly distribute on the skin, while also providing important information to enhance the quality of skincare products. The results can be seen in Figure 3.

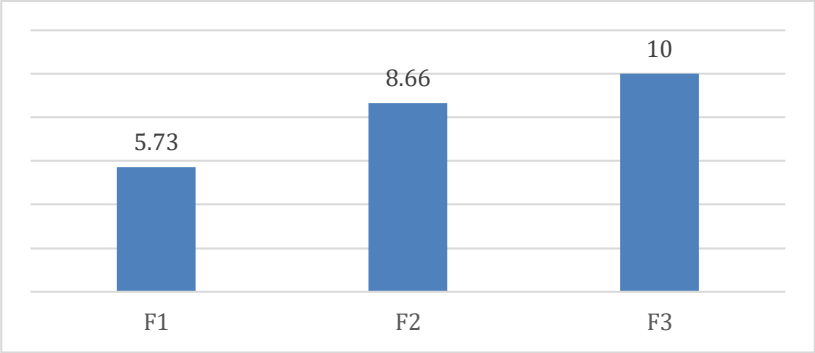

Figure 3. Spreadability test results

Information:
F1 : Gel formulation with 2% extract concentration
F2 : Gel formulation with 4% extract concentration
F3 : Gel formulation with 6% extract concentration

The scattering power measurements for each formulation are as follows: formulation I has a scattering power of 6.18 ± 1.55 cm, formulation II has a scattering power of 6.16 ± 1.25 cm, and formulation III has a scattering power of 5.98 ± 0.40 cm. Based on the research conducted by (Sayuti, 2015). The optimal spread thickness for gel formulations is generally within the range of 5–7 cm, and the SNI standard establishes a range between 5 to 7 cm as an acceptable spread thickness. The larger the obtained spread thickness value, the greater the active substance's ability in the formulation to evenly cover the desired surface area (Putri and Anindhita, 2022).

The dispersion test results meet the specified criteria, indicating that this gel formulation has a semi-solid consistency, making it comfortable to use. Changes in the spread of the sunscreen gel formulation, which is based on extract from rambusa leaves, with varying concentrations of 2%, 4%, and 6% extract, result in differences in the spread value of the sunscreen. These differences can affect the rate of diffusion of the active ingredients across the membrane, with greater diffusion increasing the diffusion coefficient and thus the diffusivity of the active ingredients (Mutmainah *et al.*, 2014).

d. Adhesion Test Result

Testing the adhesive strength of gel is an important procedure to evaluate the level of adhesion of the formulation on the skin. Common characteristics of gel formulations include their ability to adhere to the applied surface for an extended period of time before requiring rinsing or cleaning (Firdaus and Muazham, 2017). The adhesive strength test results can be seen in Figure 4. The average adhesive strength measurements ± SD for each formulation are as follows: formulation I has an adhesive strength of 5.73 ± 1.25 seconds, formulation II has an adhesive strength of 8.66 ± 0.40 seconds, and formulation 3 has an adhesive strength of 10.00 ± 1.55 seconds. A good gel preparation will have an adhesive strength of more than 1 second, and the longer the adhesive strength, the better the gel preparation. The formulation with the best adhesive strength is formula 3.

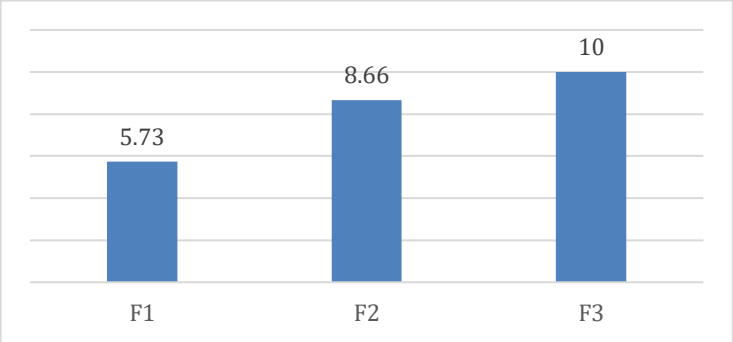

Figure 4. Adhesion test results

Information:
F1 : Gel formulation with 2% extract concentration
F2 : Gel formulation with 4% extract concentration
F3 : Gel formulation with 6% extract concentration

e. Test SPF Value

The determination of the effectiveness of sunscreen gel containing *Passiflora foetida* L leaf extract is carried out by measuring the SPF value using UV-Vis spectrophotometry. The testing steps involve diluting the sunscreen gel formulation with *Passiflora foetida* leaf extract at a concentration of 5000 ppm (Fahira *et al.*, 2021). The spectrophotometry method provides an accurate approach to assess the effectiveness of a sunscreen product in protecting the skin from UV radiation (Nathaniel *et al.*, 2020). The absorbance of each concentration of sunscreen gel was recorded, and the SPF value was calculated based on that data. The results of the SPF value testing for the extract of rambusa leaf sunscreen gel can be seen in Table III.

Formula I, with the addition of 2% rambusa leaf extract, has an SPF value of 11.7, which falls under the category of maximum protection activity. The decrease in SPF value in Formula 1 compared to the base may be due to interactions between the extract and the formula base, as well as residual gel particles during filtration. Formula 2 and Formula 3, with the addition of 4% and 6% rambusa leaf extract respectively, have SPF values of 18.8 and 33.9, meeting the criteria for ultra protection. Among the three tested formulations, Formula 3 shows the highest SPF level at 33.9. This result indicates that Formula 3 can be considered the most effective formulation in protecting the skin from sun exposure (Cahyani and Erwiyani, 2021).

Table III. Results of SPF Protection Test

Formula	SPF Value	Activity	Range SPF
1	11.7	Maximal Protection	8-15
2	18.8	Ultra Protection	>15
3	33.9	Ultra Protection	>15

The mechanism of action of flavonoid compounds contained in rambusa leaf extract is by absorbing ultraviolet rays, particularly UV B rays, thereby reducing energy and preventing erythema. This is similar to the mechanism of action of methoxycinnamate compounds found in commercial sunscreen gel formulations, which were used as a positive control in this study. These flavonoids play an important role in protecting the skin from sun damage. Therefore, the higher the concentration of rambusa leaf extract, the greater the active flavonoid content that contributes to increasing the SPF value (Ngoc *et al.*, 2019). This research shows that the higher the concentration of rambusa leaf extract, the higher the SPF value of the sunscreen gel. In other words, the more extract a formula contains, the better the sunscreen's ability to protect the skin from sunlight. This can be explained by the increased flavonoid content in the sunscreen gel and the higher concentration of the extract (Novitasari and Amboro, 2021).

CONCLUSION

Based on the research conducted, it can be concluded that sunscreen gel preparations extracted from rambusa leaves with varying concentrations of 2%, 4%, and 6% extract have good physical quality The SPF value using formula 3 shows the best effectiveness.

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