FARMASAINS: JURNAL FARMASI DAN ILMU KESEHATAN
Volume 9, Number 1, 2024. p-ISSN: 2086-3373 I e-ISSN: 2620-987X
https://ejournal.umm.ac.id/index.php/farmasains

Research Article

Physicochemical Characteristics and SPF Value of Kepok Banana (*Musa paradisiaca* L.) Corm Extract Cream

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ARTICLE INFO

Article History
Submitted May 27, 2024
Revised May 28, 2024
Accepted, June 04, 2024
Published, June 04, 2024

Keywords
Kepok Banana Corm extract
Sunscreen cream
Physical characteristics
SPF value

DOI:
10.22219/farmasains.v9i1.33835

ABSTRACT

Banana Corm is banana plant waste that has not been utilized optimally and contains flavonoids which have the potential as natural UV repellents. This study aims to determine the physicochemical characteristics and preferences of respondents as well as the SPF value of kepok banana corm extract creams. Three cream formulations were carried out using concentration variants of 10% (F1), 20% (F2) and 30% (F3) with physical property tests including organoleptic tests, cream type tests, homogeneity tests, spreadability tests, centrifugation tests and SPF value. The test results show that the three formulations have different colors and aromas and are o/w cream types and have a homogeneous texture. All formulas meet the skin's pH range. In the test results there was a significant difference ($p<0.05$) in the order of highest spreading power in diameter F3 (5.725 ± 0.01 cm), F2 (5.24 ± 0.2 cm), F1 (5.24 ± 0.092 cm), whereas for the centrifugation test results there was no phase separation. The results of respondents' preferences for cream showed that the overall cream preparation formulas are acceptable and liked by respondents. Based on the research results, it can be concluded that the banana corm extract cream meets the physical quality requirements based on predetermined parameters and the banana corm extract cream can be accepted by respondents. Cream with variations in banana corm concentration of 10%, 20% and 30%, obtained an SPF value in the maximum protection category.

1. Introduction

In recent years, there has been a significant shift towards the use of natural and plant-based ingredients in cosmetic formulations (Gibielle et al., 2023; Rahman & Herdaningsih, 2021; Tan et al., 2022). This trend is driven by growing consumer demand for products that are perceived to be safer, more environmentally friendly, and potentially more effective due to the presence of bioactive compounds (G et al., 2019; Hamid et al., 2022; Hamouda & Felemban, 2023; Бахмач, 2021). Among various natural ingredients, the corm extract of the Kepok banana (*Musa paradisiaca*) has garnered attention due to its rich content of beneficial phytochemicals (Lumowa & Bardin, 2018; Rahmawati et al., 2021). The corm, which is the underground stem of the banana plant, is traditionally used in various cultures for its medicinal properties, suggesting its potential utility in modern skincare products.

The Kepok banana corm is particularly noted for its high levels of polyphenols, flavonoids, and other antioxidants (Andini, Sari, et al., 2023; Rahmawati et al., 2021). These compounds are known for their capacity to combat oxidative stress by neutralizing free radicals, thereby protecting the skin from damage and premature aging (Sumiyati & Ginting, 2019). Additionally, antioxidants play a critical role in enhancing the skin's natural defense mechanisms and promoting overall skin health (Ghadigaonkar et al., 2021; Mathew & Negi, 2017). Given these attributes, the inclusion of Kepok banana corm extract in cosmetic formulations, especially creams, warrants thorough investigation.

One crucial aspect of formulating any skincare product is understanding its physicochemical properties. The physicochemical characteristics, such as pH, viscosity, and stability, are critical determinants of a product's quality, efficacy, and consumer acceptability (Hanum et al., 2019; Tan et al., 2022). For instance, an ideal skin cream should have a pH that is compatible with the skin's natural pH, a viscosity that ensures ease of application, and stability that guarantees a long shelf-life without degradation of its active ingredients (Indarto et al., 2022). This study aims to analyze these parameters in cream formulations containing Kepok banana corm extract to assess their suitability and performance.

Moreover, with the increasing prevalence of skin-related issues due to ultraviolet (UV) radiation, the demand for effective sunscreens is higher than ever (Indarto et al., 2022; Rahman et al., 2021). The Sun Protection Factor (SPF) is a critical measure of a product's ability to protect the skin from UVB rays, which are primarily responsible for sunburn and can contribute to skin cancer (Rahman et al., 2021). Natural extracts, such as those derived from the Kepok banana corm, have shown potential as UV absorbers (Andini, Maisa, et al., 2023). This study will evaluate the SPF value of the cream formulated with Kepok banana corm extract to determine its efficacy as a natural sunscreen.

Through this research, we aim to provide a comprehensive evaluation of the Kepok banana corm extract cream, focusing on its physicochemical properties and SPF value. The findings from this study could offer valuable insights into the potential of this natural ingredient in developing effective and safe skincare products. By leveraging traditional knowledge and modern scientific methods, this study aspires to contribute to the advancement of natural cosmetic formulations and promote the use of sustainable resources in the beauty industry

2. Materials and Methods

The materials used in this research include kepok banana corm (*Musa paradisiaca* L), analytical grade ethanol, TEA, stearic acid, acetyl alcohol, nipagin, nipasol, glycerin, cera alba, liquid paraffin, and distilled water. The equipment used in this research includes an analytical balance (Ohaus), beaker glass (Pyrex), Weighing

bottle, rotary evaporator (Ika), beaker glass (Pyrex), UV-Vis spectrophotometer (Genesys), volumetric flask (Pyrex), test tube (Iwaki), and grinder (Mierrui).

The preparation stage includes the formulation of a cream preparation from banana corm extract. The detailed formulation is as follows:

Preparation of Kepok Banana Corm Simplicia (Andini, Maisa, et al., 2023)

Three banana corms from the banana plant stem are thoroughly washed. They are drained and cut into pieces approximately 1x1 cm in size. Dried using an oven at 60°C. The dried material is then blended until smooth. The dry weight is measured.

Preparation of Kepok Banana Corm Extract (*Musa paradisiaca* L.) using the Maceration Method (Kemenkes, 2017)

Weigh 300 g of the banana corm simplicia. Add 600 mL of 70% ethanol, place it in a container, and seal tightly, letting it sit for 2x24 hours. Filter to obtain the filtrate, then concentrate the filtrate using a rotary evaporator at 50-60°C. Repeat the maceration process twice.

Preparation of Cream Formulation with Concentrated Banana Corm Extract (Syarifah et al., 2022)

Table 1. Formulation of Cream with Kepok Banana Corm Extract

Ingredient	Formula I (%)	Formula II (%)	Formula III (%)
Extract	10	20	30
Acetyl alcohol	2.00	2.00	2.00
Stearic Acid	5.00	5.00	5.00
Glycerin	20.00	20.00	20.00
TEA	2.00	2.00	2.00
Nipasol	0.02	0.02	0.02
Nipagin	0.12	0.12	0.12
Liquid Paraffin	5.00	5.00	5.00
Cera Alba	20.00	20.00	20.00
Fragrance	0.5	0.5	0.5
Distilled water	35.36	25.36	15.36

Procedure for Preparing Cream Formulation (Syarifah et al., 2022)

Weigh all the ingredients. Place the stearic acid, paraffin, acetyl alcohol, cera alba, and nipasol (oil phase) into a porcelain dish. Heat to a temperature of 70°C. Dissolve triethanolamine (TEA), glycerin, and nipagin (water

phase) in a beaker glass with hot water. Transfer the oil phase into a preheated mortar. Gradually add the water phase into the oil phase mixture in the hot mortar while continuously stirring. Continuously stir the mixture of the water phase and the oil phase until a cream mass forms and reaches room temperature. Gradually add the banana corm extract into the cream base while continuously stirring until homogeneous.

Organoleptic Test

Observation of the cream's shape, color, texture, and aroma is conducted (Rahman & Herdaningsih, 2021).

Cream Type Test

The cream is placed in a beaker glass. A few drops of methylene blue solution are added. (- If the blue color immediately disperses throughout the emulsion, the emulsion type is O/W (oil-in-water). - Conversely, if the blue color does not fully disperse, the emulsion type is W/O (water-in-oil)) (Indarto et al., 2022).

Homogeneity Test

1 gram of cream is taken. It is spread on a transparent glass slide. The cream is observed to ensure it shows a homogeneous structure with no coarse grains visible (Eryani et al., 2023).

pH Test

1 gram of cream is weighed. It is diluted with 10 mL of distilled water. A pH meter is used to measure the pH of the cream (Eryani et al., 2023). A good cream pH should match the skin's pH, which is 4.5 – 6.5 (Aritonang et al., 2021; Eryani et al., 2023; Sari & Susiloningrum, 2022).

Spreadability Test

0.5 grams of cream is weighed. It is placed in the center of a petri dish in an inverted position. It is left to stand for 1 minute. Weights ranging from 50 grams to 250 grams are added every 1 minute. The standard spreadability of cream is 5 cm – 7 cm (Fatmasari, 2022; Noviardi et al., 2019; Nur Endah & Suhardiana, 2020).

Centrifugation Test

5 grams of the preparation is placed in a centrifuge tube. It is centrifuged at 3750 rpm for 5 hours or 5000-10000 rpm for 30 minutes (Nurhidayati, 2020; Tan et al., 2022).

Acceptability Test

Conducted on 10 respondents. Each formula is applied to the back of willing and healthy respondents, ensuring no wounds on the back of the hand to avoid worsening skin conditions (Sayuti, 2015).

Determination of Sun Protection Factor Value

Weigh 0.1 g of the cream containing banana corm extract, and repeat this for three samples. Dissolve each sample in 10 ml of ethanol. Measure the SPF value by placing each concentration into the UV-Vis spectrophotometer and scanning at wavelengths from 290 to 320 nm. Record the absorbance values at each wavelength interval. Measure the SPF value using the Mansur's formula (Indarto et al., 2022; Rahman et al., 2021).

Data Analysis

The data analysis in this study uses a pre-experimental design method. Acceptability results are obtained from the average panelist responses divided by the maximum score multiplied by 100%. The results of the physical quality testing and SPF value of the Kepok banana corm extract cream is obtained from each test result and further analyzed using statistical testing with One Way Anova in Microsoft Excel to observe the differences in the physical quality testing results.

3. Results and Discussions

The results of the physical and chemical quality tests on creams containing varying concentrations of banana corm extract can be seen in the following table:

Table 2. Results of Tests on Cream with Kepok Banana Corm Extract

Test	Formula I (%)	Formula II (%)	Formula III (%)	Description
Organoleptic	Semi solid, yellowish white	Semi solid, light brown	Semi solid, tan	All three creans, have a soft texture, spread easily, and form a semi-solid consistency, having a fragrance that matches the used perfume
Cream Type	O/W	O/W	O/W	Oil in Water
Homogeneity	Homogeneous	Homogeneous	Homogeneous	Homogeneous
pH	5.84±0.072	5.87±0.089	5.873±0.0737	Meets the pH requirements of the cream*
Spreadibility	5.24±0.2	5.43±0.01	5.72±0.095	Meets cream spreadability requirements**
Centrifugation	No phase separation occurs	No phase separation occurs	No phase separation occurs	Stable
SPF Value	9.17	10.43	11.24	Max protection

***:** around 4.5-6.5
****:** 5-7 cm

Organoleptic Test

The organoleptic test results indicate that all three cream formulations produced have a semisolid form. The colors obtained are pale yellowish white for F1, light brown for F2, and tan for F3. It is observed that the higher the concentration of banana corm extract, the darker the resulting color, which aligns with the findings of a previous study (Syarifah et al., 2022), which stated that the addition of natural ingredients can influence changes in the color of formulations. All three creams, have a soft texture, spread easily, and form a semi-solid consistency.

Cream Type Test

The cream produced in this study is of the O/W type because, according to research conducted by (Amini et al., 2020), creams with an oil-in-water type have excellent spreadability and protective properties compared to water-in-oil type creams. Additionally, oil-in-water creams can slow down the skin drying process and do not cause irritation, making them suitable for individuals with sensitive skin (Indarto et al., 2022).

Cream type testing was conducted by staining with methylene blue dye. Methylene blue dye is soluble in water and spreads evenly. Therefore, if this dye spreads evenly on the external phase of the cream preparation, then the preparation is classified as O/W type, in accordance with the research conducted by Indarto et al (2022).

Homogeneity Test

The observation results of the homogeneity test indicate that the cream preparations from all three base formulations are homogen as there are no visible lumps or separations in the cream. The testing and observation of homogeneity in the three creams containing kepok banana corm extract aim to ensure that all ingredients, including the water phase, oil phase, and extract, are thoroughly mixed homogeneously. This ensures that when applied to the skin requiring therapy or medication, all parts of the skin have an equal opportunity to benefit from the active ingredients contained in the cream formula (Sari & Susiloningrum, 2022).

The preparations exhibit good homogeneity, indicating that when the cream preparations are used, they will provide effective therapeutic effects when applied to the body skin. The homogeneity of a cream preparation is influenced by several factors such as the accuracy of temperature for melting and mixing. If the temperature used for melting a substance does not match its melting point, the substance will not dissolve and mix with other substances, resulting in fine particles in the final product as indicated by the homogeneity testing (Hendrawati et al., 2020; Rahman & Herdaningsih, 2021; Sumiyati & Ginting, 2019).

pH Test

The purpose of pH measurement is to determine whether the cream is acidic or basic, while the facial skin pH according to SNI cream 16-4399-1996 is around 4.5-6.5, making it safe for use and non-irritating to the skin (Tranggono and Latifah, 2007). The results for the rice bran extract cream showed that F1 had an average pH of 5.84 ± 0.072, F2 had an average pH of 5.87 ± 0.089, and F3 had an average pH of 5.873 ± 0.0737, indicating that these pH results fall within the required skin pH range. The pH measurement results of the Kepok banana corm extract cream were also statistically analyzed using One Way Anova. This statistical analysis was conducted to determine if there were any differences in pH at each concentration. The statistical test resulted in a p-value > 0.05 (p-value 0,9371), indicating that there were no significant differences across all concentration variants. This shows that increasing the concentration of the extract affect the pH of the Kepok banana corm extract cream.

Spreadability Test

The spreadability test is conducted to measure the cream's ability to spread on the skin surface without requiring significant pressure. A cream that spreads well will be easier to apply on the skin surface. Additionally, the active ingredient will distribute more evenly on the skin, optimizing its effect. The data from the spreadability test of the three formulas showed a range of 5-5.7 cm. This indicates that the cream meets the spreadability requirement of 5-7 cm (Fatika Sandhi et al., 2022; Noviardi et al., 2019; Sari & Susiloningrum, 2022). The spreadability measurement results of the Kepok banana corm extract cream were also statistically analyzed using One Way Anova. This statistical analysis was conducted to determine if there were significant differences in spreadability at each concentration. The statistical test resulted in a p-value is 0,8875 that’s mean p-value > 0.05, indicating that there were no significant differences across all concentration variants. This shows that increasing the concentration of the extract does not affect the spreadability of the Kepok banana corm extract cream.

Centrifugation Test

The centrifugation test was conducted to assess the stability of the cream after shaking at high speeds, as changes in the cream's phase indicate the stability of an emulsion. In all three formulas of the Kepok banana corm extract cream, there was no phase separation after the centrifugation test. Therefore, these three cream formulas demonstrate a shelf life of one year, as indicated by the lack of phase separation during centrifugation (Nurhidayati, 2020; Sari & Susiloningrum, 2022).

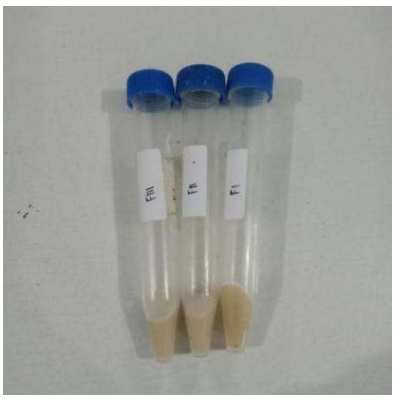

Figure 1. The centrifugation test results for the three formulas.

Acceptability Test

The final evaluation is the acceptability test conducted on 10 respondents. This acceptability test is important to measure consumer preferences towards the tested product, with criteria ranging from poor to excellent. The percentage of acceptability test results from 10 respondents regarding formulations F1, F2, and F3 regarding color, aroma, stickiness impression, and ease of washing. The acceptability test results of the three formulations of Kepok banana corm extract cream can be seen in the following figure 2.

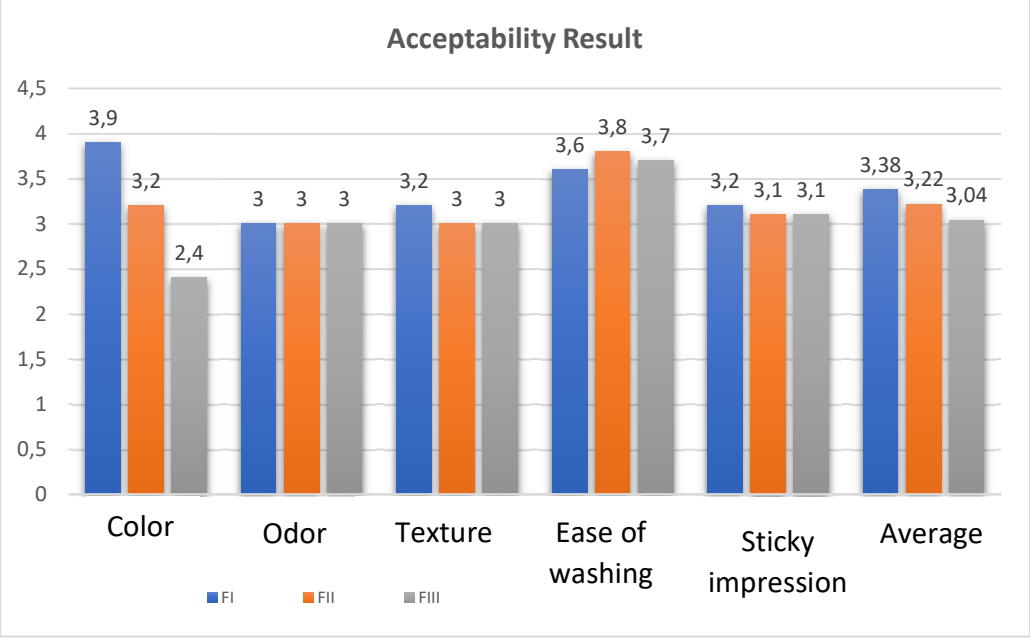

Figure 2. Diagram of acceptance test results from respondents.

The diagram above shows the results of distributing questionnaires to respondents. Not only calculating the averages of the results, but researchers also calculated the statistics for each questionnaire parameter, drawing conclusions from the percentage values obtained using the following formula:

$$N = \frac{Sp}{Sm} \; x \; 100\%$$

N = Value being sought
Sp = Total average score
Sm = Maximum score

This statistical calculation aims to determine whether there is a significant difference between F1, F2, and F3. The statistical results for the color parameter using the above formula show F1 at 78%, F2 at 64%, and F3 at 48%. Subsequently, statistical calculations were performed using the One Way Anova method, it can be seen from the One Way Anova results that the p-value < 0.05 (p-value 0,0021), indicating a significant difference in color between F1, F2, and F3. In the percentage calculated from the average questionnaire results, it is evident that the most preferred color is from formula one, and the least preferred color is from formula three. This is likely because the higher the concentration of the preparation, the more distinctive the resulting color. Therefore, respondents generally prefer lighter colors.

For the aroma parameter, the percentage of the average results for each formula is F1 at 60%, F2 at 60%, and F3 at 60%. It can be seen that the average percentage of the overall results is the same, which is 60%. The statistical results were then calculated using the One Way Anova method. It can be seen from the One Way Anova that the p-value is 0,9997 that's mean p-value > 0.05, which means the data are not significantly different. This indicates that the aroma of all preparations is almost the same and is well accepted by the respondents.

For the texture parameter, the average percentage results are F1 at 64%, F2 at 60%, and F3 at 60%. It can be seen from the One Way Anova that the p-value > 0.05 (p-value 0,6917), which means the data are not significantly different. Therefore, it can be concluded that the texture obtained from all concentrations is almost the same and is well accepted by the respondents.

For the ease of washing parameter, the average percentage results are F1 at 76%, F2 at 74%, and F3 at 72%. From the One Way Anova, it can be seen that the p-value > 0.05 (p-value 0,7897) , which means the data are not significantly different. Therefore, it can be concluded that the ease of washing obtained from all concentrations is almost the same and is well accepted by the respondents.

Lastly, for the stickiness impression parameter, the average percentage results are F1 at 64%, F2 at 62%, and F3 at 62%. Then, a statistical analysis was performed using the One Way Anova method, showing that the p-value > 0.05 (p-value 0,8417), which means the data are not significantly different. Therefore, it can be concluded that the stickiness impression obtained from all concentrations is well accepted by the respondents.

Determination of Sun Protection Factor Value

From the absorbance measurements conducted on the cream containing banana corm extract with ethanol at wavelengths ranging from 290 nm to 320 nm, the research yielded results of 9.17 at a concentration of 10%, 10.43 at a concentration of 20%, and 11.24 at a concentration of 30%. Statistical analysis of the three formulas with SPF values showed a significant difference, with ($p < 0.05$). These results meet the criteria for a substance to be used as an active sunscreen agent for skin protection, with maximum protection within the range of 8-15, implying the ability to protect the skin from sun exposure for approximately 1 hour 20 minutes to 2 hours (Hendrawati et al., 2020; Mugitasari & Rahmawati, 2020; Sari & Susiloningrum, 2022). Compounds present in kepok banana corm extract, such as flavonoids, play a role in increasing the SPF value. Flavonoids

have potential as sunscreens because they contain chromophore groups, which are unsaturated groups capable of absorbing ultraviolet radiation in both the UVA and UVB ranges (Hendrawati et al., 2020; Wibisono, 2020).

4. Conclusions

The Kepok banana corm extract cream preparation in this study was made with 3 concentration variants, namely 10%, 20%, 30%. Based on the research results, it can be concluded that the cream preparation meets the physical quality criteria for cream preparations for all concentration variants. Meanwhile, for the acceptability test on 10 respondents, it was found that overall, the cream formula was acceptable and had almost the same liking score, only the F3 cream was not so liked in terms of color. SPF values with varying concentrations of 10%, 20% and 30% and SPF values obtained were 9.17, 10.43 and 11.24 respectively with the maximum protection category.

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