Jurnal Crystal: Publikasi Penelitian Kimia dan Terapannya
Vol. 7, No. 1, Page. 001-119, 2025
e-ISSN 2685-7065

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KARAKTERISTIK NANOKRIM TABIR SURYA KOMBINASI BONGGOL PISANG KEPOK (*Musa paradisiaca* L.) DAN MESOKARP SEMANGKA MERAH

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Riwayat Article
Received: 5 November 2025; Received in Revision: 27 February 2025; Accepted: 2 March 2025

Abstract

Plant parts deemed as waste, such as banana corm and watermelon mesocarp, show promise as raw materials for cosmetics when processed using nanocream technology. This study aimed to assess the characteristics of nanocream creams combining these extracts. The characterization of the nanocream creams included organoleptic testing, homogeneity testing, pH testing, nanocream type testing, spreadability testing, stability testing, viscosity testing, antioxidant activity testing using the DPPH method, and sunscreen activity evaluation through SPF determination using UV-Vis spectrophotometry. The research results show that the organoleptic properties of all formulations are semi-solid, with a white to yellowish color. The type of cream for all formulations is oil-in-water, and homogeneous. The pH values for FI, FII, and FIII are 6.37, 6.2, and 6.2, respectively (pvalue=0.017), the spreadability values are 5.94, 5.72, and 5.64 respectively (p=0.024), the viscosity values are 5635, 5339, and 5181, respectively (p<0.05), the antioxidant activity is indicated by IC_{50} values of 66.39, 24.50, and 56.45 respectively, while the SPF values are 0.95, 0.87, and 1.01 repectively. The resulting nanocream demonstrate favorable organoleptic characteristics, pH, homogeneity, spreadability, and viscosity meeting the required standards, with the highest antioxidant activity observed in FII and no significant sunscreen potential in any of the formulations.

Keywords: *antioxidant, characteristic, nanocream*

Abstrak

Bagian tanaman yang dianggap limbah, seperti bonggol pisang dan mesokarp semangka, menunjukkan potensi sebagai bahan baku kosmetik ketika diproses menggunakan teknologi nanokrim. Penelitian ini bertujuan untuk menilai karakteristik nanokrim yang menggabungkan ekstrak tersebut. Karakterisasi nanokrim meliputi uji organoleptis, uji homogenitas, uji pH, uji tipe nanokrim, uji daya sebar, uji stabilitas, uji viskositas, uji aktivitas antioksidan menggunakan metode DPPH, dan evaluasi aktivitas tabir surya melalui penentuan nilai SPF menggunakan spektrofotometri UV-Vis. Hasil penelitian menunjukkan bahwa sifat organoleptis dari semua formulasi adalah semi-solid, dengan warna putih hingga kekuningan. Tipe krim untuk semua formulasi adalah minyak dalam air dan homogen. Nilai pH untuk FI, FII, dan FIII adalah 6,37; 6,2; dan 6,2, secara berturut-turut (nilai p=0,017), nilai daya sebar adalah 5,94; 5,72; dan 5,64 (p=0,024), nilai viskositas adalah 5635; 5339; dan 5181 (p<0,05), aktivitas antioksidan ditunjukkan oleh nilai IC_{50} sebesar 66,39; 24,50; dan 56,45, secara berturut-turut, sedangkan nilai SPF adalah 0,95; 0,87; dan 1,01. Nanokrim yang dihasilkan menunjukkan karakteristik organoleptis, pH, homogenitas, daya sebar, dan viskositas yang memenuhi standar yang diperlukan, dengan aktivitas antioksidan tertinggi yang diamati pada FII dan tidak ada potensi tabir surya yang signifikan pada formulasi manapun.

Kata Kunci: antioksidan, karakteristik, nanokrim

1. Introduction

The utilization of plant parts deemed as waste remains at the level of fulfilling everyday needs. The corm of the Kepok banana, for instance, are primarily used for vegetables and animal feed (Apriyanti & Balfas, 2019; Wadhani et al., 2021). Heoretically, Kepok banana corm hold potential as raw materials for pharmaceuticals and cosmetics. Traditionally, the leaves of Kepok banana corm are believed to nourish hair, possess antibacterial properties, function as functional food ingredients, and contain antioxidants (Fawzia N F, 2011; Pongsipulung et al., 2012; Purnamasari,

2013; Wenas et al., 2020). Kepok banana corm extract contains flavonoids (Rahmawati et al., 2021) including quersetin and rutin (Andini, Sari, et al., 2023), and its chromophore groups can absorb UV light, granting the extract UV protective capabilities akin to sunscreen (Agusta et al., 2021). The mesocarp of red watermelon, the white part of the fruit, is abundantly available as watermelons grow independently of seasonal variations (Adnyana et al., 2014).The red watermelon mesocarp is known to contain alkaloids, steroids, and flavonoids (Hanum et al., 2019; Jusnita & Tridharma, 2019). Research on watermelon mesocarp also reveals antioxidant activity, consistent with the findings of Sari (Okzelia & Mardiyyah, 2023), which indicate that the extract of red watermelon mesocarp exhibits antioxidant properties such as vitamin and citrulline.

Nanotechnology represents a rapidly advancing technological field. In medicine and cosmetics, nanotechnology significantly enhances drug delivery systems due to particle sizes in the nano scale of 10-1000 nm(Hanum et al., 2019). The utilization of natural substances as raw materials for pharmaceuticals and cosmetics remains limited, primarily due to issues such as solubility, active ingredient absorption, low bioavailability, and stability. These challenges are addressed by employing nanotechnology methods to formulate preparations. (Jusnita & Syurya, 2019). This study investigates the formulation of a cream using nanoemulsion techniques.

Nanocream, or nanoemulsion, is a topical pharmaceutical preparation applied directly to the skin. It is a drug delivery system composed of oil and water phases combined with surfactants and co-surfactants. Nanocreams have particle sizes ranging from 100-600 nm(Chevalier & Bolzinger, 2019; Hanifah et al., 2019; Rahman & Herdaningsih, 2021). The advantages of nanoemulsions include their ability to encapsulate a high amount of active ingredients, and to prevent issues such as cracking and creaming due to their large surface area and high energy. (Chevalier & Bolzinger, 2019; Sahu et al., 2014).

This research aims to evaluate the potential of a nanocream formulated with a combination of banana corm and red watermelon mesocarp extracts as an antioxidant and sunscreen. Antioxidant activity will be assessed based on IC_{50} values using the DPPH method, while sunscreen activity will be evaluated in vitro based on SPF values using UV-Vis spectrophotometry according to the Mansur equation.

2. Methodology

2.1. Material

The materials utilized in this research include banana corm, red watermelon mesocarp, ethanol p.a. (Onemed), TEA, stearic acid, acetyl alcohol, nipagin, nipasol, glycerin, and aquadest (PT. Brataco). The equipment employed in this study comprises an analytical balance (Ohaus), beakers (Pyrex), weighing bottles, a rotary evaporator (Ika), UV-Vis spectrophotometer (Genesys), volumetric flasks (Pyrex), test tubes (Iwaki), and a grinder (Mierrui).

2.2. Preparation of Banana Corm Extract and Red Watermelon Mesocarp Extract

The banana corm, which have been thoroughly washed, weighed, sliced, and dried, are then macerated using 70% ethanol and evaporated to obtain a concentrated extract of the banana corm. The same procedure is applied to the red watermelon mesocarp.

2.3. Formulation of Nanocream Combining Banana Corm Extract and Red Watermelon Mesocarp Extract

The formulation of nanocream, based on the research by Hanifah and Rahman (Hanifah et al., 2019; Rahman & Herdaningsih, 2021) was modified as follows: the base materials were blended using a mixer according to the formula outlined in Table. 1 for 15 minutes. Active substances were then added and mixed for an additional 20 minutes, followed by sonication for 30 minutes. The nanocream was subsequently packaged and prepared for testing.

Table 1. Formulation of Nanocream Combining Extracts of Kepok Banana Corm and Red Watermelon Mesocarp

	Presentage		
Material	**F1**	**F2**	**F3**

BCE	1	1,5	0,5
RWME	1	0,5	1,5
Stearat Acid	5	5	5
Cetil Alcohol	0,2	0,2	0,2
Gliserol	1	1	1
TEA	0,4	0,4	0,4
Propyl Paraben	0,02	0,02	0,02
Metyl Paraben	0,02	0,02	0,02
Aquadest	Add 100	Add 100	Add 100

BCE: Banana Corm Extract
RWME: Red Watermelon Mesocarp Extract

2.4. Evaluation of the Physical Properties of Nanocreams Combining Extracts of Banana Corm and Red Watermelon Mesocarp

The physicochemical evaluation of the nanocreams includes organoleptic testing, homogeneity testing, pH testing, nanocream type testing, spreadability testing, stability testing, and viscosity testing (Hanifah et al., 2019; Rahman & Herdaningsih, 2021).

2.5. Determination of Antioxidant Activity of a Nanocream Combining Banana Corm Extract and Red Watermelon Mesocarp Extract Using the DPPH Method

The determination of antioxidant activity was performed according to Kartika's study with slight modifications (Rahman et al., 2021). Nano creams FI, FII, and FIII (with three replicates each) were weighed at 1 g each, dissolved in 10 mL of ethanol p.a., filtered, and then 1 mL of the solution was combined with 2 mL of 2,2-diphenyl-1-picrylhydrazyl (DPPH). The mixture was incubated for 30 minutes at 30°C. Absorbance was measured using UV-Vis spectrophotometry at the maximum wavelength of DPPH. The antioxidant activity of the samples, determined by the extent of DPPH radical scavenging, was calculated by measuring the percentage inhibition of DPPH absorption.

2.6. Determination of SPF Value in vitro for the Nanocream Combining Extracts of Banana Corm and Red Semangka Mesocarp

The in vitro SPF evaluation was conducted using UV-Vis spectrophotometry in accordance with previously established research with minor modifications (Andini, Maisa, et al., 2023) . The nanocream formulations FI, FII, and FIII (with 3 replicates) were dissolved in ethanol in 100 mL volumetric flasks. The solution was subjected to ultrasonication for 5 minutes and then filtered. An aliquot of 5 mL of the filtrate was transferred to a 50 mL volumetric flask and subsequently diluted with ethanol. The solution was analyzed at wavelengths ranging from 290 to 320 nm with ethanol as the blank. The absorbance results were used to calculate the SPF value using the Mansur equation (2).

2.7. Data Analysis

Data analysis in this study was conducted using descriptive methods. Antioxidant values and SPF values were measured at each concentration, with three replicates. The determination of antioxidant values was calculated using the formula provided below (1), followed by IC50 calculation, that used to evaluate the potency of an antioxidant, where a lower IC50 value indicates higher antioxidant effectiveness.

$$\%\ Inhibisi = \frac{Abs.blanko - Abs.sampel}{Abs.\ blanko}\ x\ 100\% \qquad \text{..... (1)}$$

The SPF values were analyzed using the Mansur method:

$$SPF\ spectrophotometric = CF\ x \sum_{290}^{320} EE(\lambda)\ x\ I\ (\lambda)\ x\ Abs\ (\lambda) \qquad \text{..... (2)}$$

All data are presented as mean ± standard deviation and statistically analyzed using SPSS software version 17 (Amini et al., 2020).

3. Results and Discussion

3.1. Results

The nanocreams formulated with a combination of active ingredients were tested for physicochemical properties, antioxidant activity, and SPF value. The results of each test for the respective formulations are presented in Table 2.

Table 2. Results of Testing Nanocreams with a Combination of Banana Corm Extract and Red Watermelon Mesocarp.

Test	**Result**			**Description**
	FI	**FII**	**FIII**	
Organoleptic				The organoleptic evaluation of each formulation yielded identical results.
Form	Semi-Solid	Semi-Solid	Semi-Solid	
Color	Off-white	Off-white	Off-white	
Odor	Distinctive	Distinctive	Distinctive	
Homogenity	No undissolved solids	No undissolved solids	No undissolved solids	Homogen
pH	6,37 ± 0,02	6,20 ± 0,01	6,2 ± 0,01	Compliant*
Type	O/W	O/W	O/W	Oil-in-Water
Spreadibility	5,94 ± 0,56	5,72 ± 0,29	5,64 ± 0,43	Compliant**
Stability	Intact	Intact	Intact	Stable
Viscosity	5635 ± 1.52	5339 ± 1.73	5181 ± 1.15	Compliant***
IC50	66,39	24,50	56,45	-
SPF	0,95 ± 0,01	0,87 ± 0,01	1,01 ± 0,01	Lacks protective properties

*****Skin pH requirements 4.5-6.5 (Maulina, 2021), **Spreadibility requirements 5-7 (Noviardi et al., 2019), *******Viscosity requirements 2000-50.000 (Noviardi et al., 2019)

3.2. Discussion

The preparation of nanocream involves several critical stages in the process. Initially, the base materials are mixed using a mixer for 15 minutes, according to the formula outlined in Table 1. This mixture is then combined with the designated active ingredients. Following the addition of the active substances, the mixture is homogenized using the mixer for 20 minutes to ensure even distribution. The final step involves sonication, conducted for 30 minutes, to produce a stable nano dispersion and achieve the desired particle size (Fatmasari, 2022; Jafari & McClements, 2018). This process aims to attain uniform particle distribution and enhance the bioavailability of the active ingredients within the nanocream formulation (Zubaydah et al., 2022) and in accordance with the results of previous research the particle size is in the range of 600-800 nm.

Based on the research findings, the nanocreams for all three formulations exhibited a semi-solid consistency with a yellowish-white color and a characteristic aroma of the extract, as no fragrance was added during preparation. During the homogenization testing, the formulations were found to be homogeneous. Homogeneity is essential to ensure uniform distribution of active ingredients throughout the matrix, which is crucial for maintaining product efficacy. Homogeneity mitigates the risk of particle agglomeration or coalescence, which could compromise the physical and chemical stability of the product. Furthermore, a homogeneous nanoemulsion enhances the penetration of active ingredients into the skin or other biological targets, as nano-sized particles have a larger surface area and interact more readily with biological membranes (Amini et al., 2020; Sari & Susiloningrum, 2022). Therefore, homogeneity in nanocreams not only ensures product stability but also maximizes the efficacy and safety of the product.

The nanocream produced from the research meets the requirements to ensure compatibility and avoid irritation or damage to the skin(Indarto et al., 2022). Nanocream formulations that fall outside this range can disrupt the skin's natural balance, leading to irritation or inflammation (Nurhidayati, 2020). The research findings indicate that the addition of various natural ingredients significantly affects the resulting pH values, with a p-value of 0.017 ($p < 0.05$). The incorporation of natural substances into the nanocream can influence the pH of the formulation, depending on

the chemical properties of the natural ingredients (Jafari & McClements, 2018). Therefore, it is essential to measure and adjust the pH of the nanocream (6.2 – 6.4) after adding natural ingredients to ensure the product remains within the appropriate pH range for skin application

The nanocream developed in this study demonstrates an oil-in-water (O/W) type of nanocream, which is an emulsion system where oil is dispersed in a continuous aqueous phase, using surfactants as emulsifiers (stearic acid) to maintain system stability (Niknam et al., 2020). an O/W formulation, the oil phase is dispersed in the water phase in the form of small droplets, imparting a light and non-greasy texture to the cream. The effects on the skin include effective hydration due to the dominant water phase and the ability to absorb quickly without leaving oily residue. O/W creams are commonly used in cosmetics and dermatology for products requiring a fresh and non-greasy sensation, and for applications that avoid a shiny appearance (Ezeuko et al., 2020; Niknam et al., 2020).

In the formulation of nanocream with varying concentrations of banana plantain pseudostem extract and red watermelon mesocarp extract, the spreadability values still meet the required standards, with a p-value, that is used to determine the statistical significance of spreasability replication test, of 0.024 indicating a significant difference in the extracts used in each formulation. The viscosity values also comply with the requirements, and statistical analysis shows a p-value < 0.05, leading to the same conclusion: that the addition of extracts results in significant differences in the viscosity of each formulation.

The spreadability and viscosity of the nanocream are highly influenced by the variation in the concentration of natural ingredients incorporated into the formulation. Spreadability refers to the nanocream's ability to evenly distribute when applied to a surface, which is often affected by its viscosity. Viscosity, a measure of a liquid's resistance to flow, serves as a crucial parameter in determining how easily the nanocream can be applied and spread (Noviardi et al., 2019). Higher concentrations of natural ingredients can increase the cream viscosity due to the greater concentration of active substances in the formulation, potentially leading to increased flow resistance (Sari & Susiloningrum, 2022), this can reduce the cream spreadability, making it more difficult to apply evenly on the skin. Conversely, lower concentrations of natural ingredients may result in lower viscosity, allowing the nanocream to spread more easily but potentially compromising the stability and efficacy of the active ingredients (Ezeuko et al., 2020; Jafari & McClements, 2018). Therefore, there is a trade-off between spreadability and viscosity that must be considered when designing nanocream. Adjustments in the concentration of natural ingredients should be made cautiously to achieve the desired balance between ease of application and formulation stability (Sari & Susiloningrum, 2022).

Stability testing using centrifugation is a method for evaluating the stability of a formulation, such as nanocreams, by accelerating the phase separation process that typically takes longer under normal conditions (Nurhidayati, 2020). In this test, the sample is placed in a centrifuge machine and spun at high speeds (4500 rpm). This process generates centrifugal force that separates components based on their density. If the test results indicate that the formulation does not exhibit phase separation, such as oil-water separation or aggregation, it can be concluded that the formulation is stable. Stability in this context means that the ingredients within the formulation are well-dispersed and the interactions between components are sufficiently strong to prevent separation or breakdown of the emulsion during centrifugation (Fatmasari, 2022). Therefore, the conclusion drawn is that the nanocream formulation demonstrates good physical stability, which is crucial for the product's quality during storage and use.

The next characteristic assessed is the antioxidant activity of each nanocream formulation. Reagent of this assays is ,2,2-Diphenyl-1-picrylhydrazyl (DPPH) is a stable free radical commonly used in antioxidant assays. It has a deep violet color in solution, which fades to yellow when reduced by antioxidants. DPPH is used to evaluate the antioxidant activity of compounds by measuring their ability to donate electrons or hydrogen atoms, thereby neutralizing free radicals. The degree of discoloration indicates the free radical scavenging capacity of the tested substance, often quantified by IC50 values. The IC50 values obtained varied, with IC50 representing the concentration of an active substance in the nanocream required to inhibit 50% of the target activity, The IC50 values obtained varied, with IC50 representing the concentration of an active substance in the nanocream required to inhibit 50% of the target activity, such as enzymes—including tyrosinase (involved in melanin production), acetylcholinesterase (linked to neurological functions), and cyclooxygenase (COX-1/COX-2) (related to inflammation processes)— or free

radicals, which are unstable molecules with unpaired electrons that can cause oxidative stress and cellular damage, often contributing to aging and various diseases. Examples of free radicals include reactive oxygen species (ROS) like superoxide anion (O_2^-) and hydroxyl radical (•OH) (Fraga & Oteiza, 2011). The IC50 value is often used to evaluate the potential of a compound in neutralizing free radicals. A lower IC50 value indicates a higher antioxidant potential of a compound, as it requires a lower concentration to achieve a 50% inhibition effect (Alibade et al., 2022; Fauziyah et al., 2019; houssemeddine Sellami et al., 2020). The study results show that the compound with an IC50 value of 24.50 in formulation II has higher antioxidant potential compared to the formulation I with an IC50 value of 66.39 and formulation III with an IC50 value of 56.45, as it requires a lower concentration to achieve the same inhibitory effect. This indicates that the active ingredient ratio in formulation II (1.5:0.5) is more effective in counteracting oxidation caused by free radicals, which is important for protecting against cellular damage (Noviardi et al., 2019).

SPF (Sun Protection Factor) is a measure of how well a sunscreen product protects the skin from UVB radiation, which is a primary cause of sunburn and can contribute to skin cancer (Lestari & Prajuwita, 2021; Sari & Fitrianingsih, 2020; Syarifah et al., 2022). However, SPF only measures protection against UVB, not UVA radiation, which can also damage the skin and cause premature aging (Andini, Maisa, et al., 2023; Nadhifah & Sudarti, 2023). T he study results indicate that even the formulation with the highest SPF value (1.01) does not provide adequate protection, as the minimal protection category is SPF 2 (Sari & Fitrianingsih, 2020).

4. Conclusion

The research findings indicate that Organoleptic Properties: All formulations are semi-solid, Colors range from white to yellowish, The type of cream for all formulations is oil-in-water (O/W) and homogeneous. pH Values: FI: 6.37, FII: 6.2, FIII: 6.2 with Statistical significance: *p-value = 0.017*. Spreadability: FI: 5.94 cm, FII: 5.72 cm, FIII: 5.64 cm with Statistical significance: *p-value = 0.024*. Viscosity: FI: 5635 cP, FII: 5339 cP, FIII: 5181 cP with Statistical significance: $p < 0.05$. Antioxidant Activity (IC50): FI: 66.39 µg/mL, FII: 24.50 µg/mL (*highest antioxidant activity*), FIII: 56.45 µg/mL. Sun Protection Factor (SPF) Values: FI: 0.95, FII: 0.87, FIII: 1.01 that indicate in all formulas there is *No significant sunscreen potential in any formulation.* The produced nanocreams meet the required standards in terms of organoleptic properties, pH, homogeneity, spreadability, and viscosity. FII has the highest antioxidant activity, making it the most effective in this aspect and None of the formulations exhibit significant sunscreen potential based on their SPF values.

Acknowledgement

The author expresses gratitude for the financial support provided by the LPPM Poltekkes PIM in the context of the Lecturer Research Program, under reference number 394.5/PLK.4/PN/2024.

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