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Physical Quality Evaluation and Determination of SPF (Sun Protection Factor) Value of Forest Coconut Oil Lotion (*Pandanus Julianettii* Martelli) From Papua

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ABSTRACT

Forest coconut fruit contains double-bonded fat or omega 3-6, tocopherol, or vitamin E. Vitamin E and some compounds such as flavonoids, tannins, and anthraquinone have potential as sunscreens. This study aims to evaluate the physical quality and determine the SPF value in forest coconut oil lotion analyzed in vitro. Physical quality evaluation includes organoleptic tests, homogeneity, spreadability, adhesion, pH, and the determination of SPF values by the UV-Vis spectrophotometry method. The results showed that each formula, namely FI (2%), FII (4%), and FIII (6%), was physically stable. The lotion preparation in each formula, namely FI (2%), FII (4%), and FIII (6%), has SPF values of 1.95, 1.57, and 1.19, respectively.

KEYWORDS: forest coconut fruit, physical quality, lotion, spf, sunscreen

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I. INTRODUCTION

Skin is the primary layer of all residing matters covering all organs. Any damage or alteration in this leads to various conditions/diseases together with the darkness of skin, aging, etc. Consequently, its protection is the highest goal. Persistent exposure to Ultraviolet (UV) radiation may additionally cause pores and skin cancer. There are many ways to protect themselves from ultraviolet radiation, like huge hats or umbrella [1].

Ultraviolet (UV) radiation is the primary purpose of various age-associated skin issues. UVA radiation (320-400 nm), mainly focused on the epidermis, can also affect dermal skin components, including fibroblasts, even as UVB (290-320 nm) has a better unfavorable effect on epidermal keratinocytes. UVA rays penetrating more profound layers of the pores and skin cause oxidative stress by generating intracellular reactive oxygen species (ROS). Overproduction of ROS impacts the activation of the downstream cellular signaling pathways and promotes premature aging of the skin, characterized by the look of wrinkles and lack of elasticity [2,3].

The energy of sunscreen depends on the SPF value. Sun protecting factor, or SPF, is a general indicator that explains the effectiveness of a product or substance that acts as a UV protector [4]. The department degree of sunscreen can be labeled as minimal when the SPF value is around 2-4, medium when the SPF value is between, and extra if the SPF value is between 6-8, maximized if the SPF price is between 8-15 and ultra while SPF value over 15 [5].

Titanium dioxide (TiO2) is the material usually utilized in sunscreens and has been used since 1952 [6]. TiO2 is a physical blocker that reflects UV radiation away from the skin. However, this substance is a carcinogenic that can trigger cancers. Consequently, sunscreen materials from natural elements are currently being developed because they're believed to be more secure and have few side effects [7].

Coconut fruit contains double bonded fat or omega 3-6, tocopherol, or vitamin E, which is relatively high as an antioxidant [8]. Forest coconut fruit oil contains alpha-tocopherol (5.0302 mg/100g), phenol (48.55ppm), carotene (2.75g/g), and an IC50 value of 45.83 mg/ml (potent antioxidant) [9].

It's recommended that one of the active ingredients in sunscreen is phenolic compounds. One of the phenolic compounds believed to play a role as energetic substances of

sunscreen is a derivative of cinnamic acid and flavonoids—the UV protection effect results from a benzene ring capable of absorbing UV wavelengths [10]. Flavonoids, phenols, and β-carotene are a source of natural antioxidants referred to as photoprotective pastime in opposition to UV mild [11].

One of the most familiar sunscreen preparations used is lotion. The lotion is a suspension, emulsion with or without the active element to be used topical whose fluid permits utility calmly and quickly at the skin surface and could leave a thin layer on the skin's surface [12].

Based on the description above, this research aims to formulate, test the physical quality, and determine the SPF value of a lotion made from active forest coconut oil so that it can be a source of information about the use of forest coconut oil in the cosmetic field.

II. METHODES

A. Materials and Equipments

The research was conducted at the pharmacy laboratory and chemistry laboratory, cenderawasih university, jayapura, indonesia.

The equipments in this study were glass tools that are commonly used in the lab, analytical balance, oven, extraction container, rotary vacuum evaporator, mortar and stamper, grinder, hot plate, ph meter, stopwatch, refrigerator, adhesion, and spreadability tester. The materials were forest coconut (obtained from Oksibil District Serambakon, Star Mountain, Papua Province), phenoxyethanol, lanolin, liquid paraffin, cetyl alcohol, propyleneglycol, fragrances, stearic acid, aquades, and methanol p.a.

B. Sample Preparation

Sample preparation was carried out by preparing 2 kg of forest coconut samples (burned), which had been burned at 100oC for ± one to three hours, depending on the size of the coconut body, then split into several parts, then cleaned the outer skin, 750 g of meat was taken and then cut into small pieces small and then mashed using a blender. Sample 715 g of mashed forest coconut fruit is ready to make oil.

Oil making begins with extraction. Coconut pandan fruit oil is extracted using a wet rendering method with an aluminum pan. The endosperm of the fruit, forest coconut pandanus (*Pandanus julianettii* Martelli), which has been separated from the protective layer of the fruit, is then washed under running water. The endosperm was then blended with the addition of 750 g : 750 g water. The coconut milk from the blender is then heated to a temperature between 60°C-70°C until 500 g of oil is obtained. Then, the oil was separated from the dregs using a centrifuge at 10.000 rpm for 10 minutes. As much as 25 ml of oil obtained was stored in a tightly closed bottle and an airtight container [9].

C. Formulation of Forest Coconout Oil (FCO) Lotion

Table 1. Formula forest coconut oil (FCO) lotion

Ingredients	Formula (% b/b)		
	FI	**FII**	**FIII**
Forest Coconut Oil	2	4	6
Stearic acid	2	2	2
Lanolin	2	2	2
Cetyl alcohol	2	2	2
Propylene Glycol	5	5	5
Phenoxyethanol	0,5	0,5	0,5
Liquid Paraffin	3	3	3
Fragrance	0,2	0,2	0,2
Aquadest add	100	100	100

FI : Formula I
FII : Formula II
FIII : Formula III

Making lotion is carried out with three stages of work: the first stage is the manufacture of preparation A (oil phase), the second stage is the manufacture of preparation B (water phase), and the third stage is mixing the two phases as preparation C with the addition of forest coconut oil and fragrance.

Making preparation A (oil phase), namely stearate acid, cetyl alcohol, liquid paraffin, phenoxyethanol, and lanolin is put into a beaker heated using a water bath with a temperature of 700-800 C while stirring continuously until dissolved and homogeneous. Making preparation B (water phase), namely propylene glycol and aquadest, is put into a beaker glass and then heated using a water bath at a temperature of 700-800 C while stirring continuously until homogeneous. Manufacture of phase C by mixing preparation A (oil phase) and preparation B (water phase) into a mortar while stirring using a stamper at a constant speed until it forms a mass of lotion. Then, forest coconut oil is added gradually to the mixture while stirring until it is homogeneous, and add fragrance at the end. Forest coconut oil lotions are put in a container and tightly closed.

D. Forest Coconut Oil Lotion Physical Quality Evaluation

Organoleptic testing was conducted to observe changes in color, aroma, and texture using the five human senses (30 panelists). Homogeneity testing uses glass objects with a certain amount of preparation. If applied to a piece of glass or other suitable transparent material, the preparation must be homogeneous and not look like coarse grains on the preparation [13].

For pH testing carried out by weighing as much as 0.5 g and then diluting with aquades, pH paper is allowed to stand in lotion solution until it changes color. The color that appears matches the standard color on the pH packaging universal indicators (Palevi, 2020). The stable reading is the pH of the lotion, which is expected to be the same as the skin's pH, which is 4.5-7.0 [14].

The Adhesion test is carried out by weighing as much as 0.5 g (lotion) placed on a glass object then covered with other glass objects and given a load weighing 500 g for 1 minute. Then the two glass objects that have been attached to each other are installed on test equipment that is given a load weighing 65 grams. It noted the time it took until the two glass objects could separate [15].

The spreadibility test is carried out by weighing as much as 0.5 g (lotion), which is placed in the center of a glass plate 15 cm in diameter and overwritten with another glass plate as a cover. Then, a load weighing 50 grams is placed on the cover glass and let stand for 1 minute. A ruler makes measurements vertically and horizontally based on the diameter pattern formed. The same treatment was repeated for additional loads of 100 and 150 grams. The calculation of the average value of both is determined as the diameter of the dispersion power [14].

E. Determination of SPF (Sun Protection Factor) value

Forest coconut oil lotion at each concentration (2%, 4%, 6%) was weighed as much as 1 gram and dissolved in 5 ml of methanol p.a. Then filtered with filter paper into a 10 ml measuring flask and added methanol p.a. Then the diluted solution is taken as much as 2 ml and put into a 10 ml measuring flask plus methanol p.a, homogenized. After that, it is put in a vial bottle [16]. After that, a cuvette absorption curve with a length of 1 cm was made at wavelengths between 290 nm and 320 nm, and methanol p.a was used as a blank. A total of 4 ml of samples are inserted into the cuvette. Absorbance readings were carried out in the UVB wavelength range of 290 nm to 320 nm with a wavelength interval of 5 nm, then take the same steps to test the SPF value of sunscreen lotion on the market as a comparison preparation. Rumus penentuan nilai SPF menggunakan persamaan Mansur [17].

$$SPF = CF \times \sum_{295}^{320} EE(\lambda) \times I(\lambda) \times Abs(\lambda)$$

CF = correction factor
EE = erythemal effect spectrum
I = solar intensity spectrum
Abs =absorbance of sunscreen product

F. Data Analysis

The research data was analyzed using the Analysis of Variance (ANOVA) method with a confidence level of 95%. If there is a significant difference, proceed with the Tukey test.

III. RESULT AND DISCUSSION

A. Results of Physical Quality Evaluation of Lotion

Organoleptic Test Results

Organoleptic testing was conducted to determine the quality of lotion preparations in terms of color, aroma, and texture by 30 panelists. Organoleptic testing on each forest coconut oil lotion formula is shown in Table 2.

Table 2. Organoleptic test results

Characteristic	Formula		
	FI	FII	FII
Colour	White	Milky white	Olive
Aroma	Coconut	Coconut	Coconut
Texture	Semi solid	Semi solid	Semi solid

The results of the organoleptic evaluation show the resulting color difference, namely, FI is white, FII is milky white, and FIII is yellow langsat. The difference influences this in the concentration of active substances used in each formula, namely FI (2%), FII (4%), and FIII (6%), where the more active substances used will be different. At the same time, the aroma of lotion is dominated by the distinctive fragrance scent (fragrance ingredients) because the formulation of the lotion uses fragrance ingredients, namely coconut oil. The lotion has a soft, semi-solid texture, indicating that the lotion-forming ingredients' components are well mixed.

Homogeneity Test Results

Homogeneity testing is carried out to determine whether the active substance in the lotion has been mixed evenly with the lotion-forming material so that the active substance contained in the lotion can be spread evenly so that the active substance can cause an appropriate and maximum therapeutic effect. The average results of the evaluation of the homogeneity of the forest coconut oil lotion are shown in Table 3.

Table 3. Results of evaluation of homogeneity of lotion

Formula	Result
FI	Homogenous
FII	Homogenous
FIII	Homogenous

The homogeneity test results showed that all lotions showed the absence of granular or granules on *glass* objects seen directly by the eye and when applied to the skin. The homogeneous preparation arrangement shows the absence of granules in the lotion, so the formula of forest coconut oil lotion can be said already to have good homogeneity properties [18].

Adding emulsifying agents to the preparation, assisted by constant stirring at the appropriate temperature, will accelerate the formation of emulsions. The temperature when mixing lotion ingredients must be maintained stable because it can reduce compaction that is too fast during the lotion-making process; high temperatures will cause water that acts as a carrier substance to evaporate so that the compaction process will occur. The duration of stirring is also a critical factor in making lotion because stirring can affect the smaller particles, so the homogeneity of the lotion obtained is good. Optimal mixing will produce good physical properties of the preparation [19].

pH Test Result

The pH test is performed using pH paper (pH indicator). pH testing of lotion preparations aims to determine whether the preparation is alkaline or acidic to ensure the preparation's safety and that it does not cause irritation to the skin [18]. The pH measurement results of each formulation are shown in Table 4.

Table 4. PH test result

Formula	Result
FI	6.00
FII	6.00
FIII	6.00

Based on Table 4, it is known that the average pH evaluation results in all lotio formulas are FI (6), FII (6), and FIII (6) so that the data results show a constant pH of 6.00. Based on Indonesian National Standard (INS) 16-4399-1996 states that the pH of lotion preparations is in the range of 4.5-8.0 so that the lotion preparations made meet INS quality requirements [20].

Spreadibility Test Result

Dispersion testing aims to determine the ability of lotion to spread when applied to the skin. Lotions of good quality must have sufficient spreadability so that the active substances in the lotion can be distributed evenly and provide maximum therapeutic effects. The average evaluation results of the dispersion power of the three formulas obtained the dispersion power of lotion for a load of 150 grams (FI = 5.5; FII=6.6; FIII=7.0). In this study, it was found that FIII has a greater dispersion power. It happens because extracts in the form of oil decrease the water content in the preparation, and adding the concentration of forest coconut oil increases the lotion's spreadability even more. These results were also shown by previous research [21], which stated that the addition of tamanu oil concentration tends to increase the dispersion power of body lotion because tamanu oil has the form of liquid at room temperature, so its addition increases the liquid effect of the preparation.

Table 5. Spreadibility test result

Weight	Average Spreadibility Test (cm) ± SD			Standard (Grag et al, 2002)
	FI	FII	FIII	
0	5.0±0.00	5.2±0.16	5.8±0.16	5 – 7 cm
50	5.3±0.21	5.3±0.04	6.6±0.10	
100	5.4±0.12	5.7±0.16	6.9±0.04	
150	5.5±0.14	6.6±0.32	7.0±0.00	

The greater the dispersion of the preparation, the faster the release of the desired therapeutic effect on the skin. The difference in dispersion power dramatically affects the diffusion speed of active substances in passing through the membrane. The wider the membrane where the preparation spreads, the greater the diffusion coefficient, increasing the diffusion of active substances in the preparation. The higher the addition of extract concentration, the higher the preparation's viscosity so that the preparation's dispersion decreases [22]. It differs from the results obtained in this study because the material used is a liquid (oil).

The dispersion of semi-solid preparations ranges from 5-7 cm, so each formula's forest coconut oil lotion is good because it is in the range of lotion distribution according to requirements [23]. The longer the stirring, the smaller the particle size of the *lotion,* so the small particle size can cause a wider spread of the lotion on the skin's surface, making absorption easier [19].

Adhesion Test Result

Adhesion testing is done to determine how long the lotion sticks when applied to the skin. A good lotion can guarantee adequate contact time with the skin so that the purpose of its use is achieved but does not leave a sticky impression on the skin [24].

Table 6. Adhesion test result

Formula	Average of Adhesion Test (seconds) ± SD	Standard Betageri and Prabhu, 2002
FI	4.15 ± 0.07	2 – 300 seconds
FII	3.19 ± 0.02	
FIII	2.12 ± 0.02	

The average evaluation results of the dispersion power of the three lotion formulas shown in Table 6 obtained the dispersion power of lotions FI (4.15), FII (3.19), and FIII (2.12). Reasonable adhesion time requirements range from 2-300 seconds [25]. The average result of the removal time of the lotion toward the glass object meets the requirements of a good sticking time because the average result is more than 2 seconds, so it can be concluded that the adhesion test results of each lotion formula FI, FII, and FIII meet the conditions set.

The addition of the concentration of forest coconut oil affects the length of time the lotion sticks *quickly*. These results were also shown in other research [21] that the addition of tamanu *oil* concentration tends to reduce the adhesion of body lotion because tamanu oil has the form of liquid at room temperature, which causes the viscosity of the preparation to drop so that the adhesion is smaller (less sticky).

In Vitro SPF Lotion Value Test Results

Testing lotion preparations as sunscreens aims to see how well forest coconut oil protects the skin from harmful UV exposure by calculating its SPF value. This study's SPF value was tested in vitro by measuring the absorbance value using UV-Vis spectrophotometry. The spectrophotometry method is most commonly used for sunscreen testing because it is

relatively simple and fast, and the chemicals and samples used are few (Puspitasari et al., 2018).

Table 7. SPF value result

Formula	The average of SPF value	Categories
K +	29.18 ± 0.20 [a]	Ultra
FI	1.95 ± 0.20 [b]	Minimal
FII	1.57 ± 0.00 [c]	Minimal
FIII	1.19 ± 0.00 [d]	Minimal

K+ : Commercial product

[a,b,c,d] : notation that shows that significantly in SPF values from each formula.

Based on the results of the SPF value determination test in each lotion formula showed that the SPF value obtained by FI (1.95 ± 0.20), FII (1.57 ± 0.00), and F III (1.19 ± 0.00) is included in the minimum category that has been determined so that the results of this study explain that forest coconut oil (which has been burned) has minimal potential as a sunscreen, In addition, according to [26], several factors affect the determination of SPF values, such as the use of solvents, combinations and concentrations of ingredients, emulsion properties, effects and interactions of carrier components, such as emulgators used in formulations, the addition of active ingredients, and pH. The same thing can also be seen from research conducted by [27], that lime peel essential oil as a sunscreen has an average SPF value ranging from 1.094 to 1.380 with six different concentrations. In addition, another research obtained SPF values of yellow kapok banana extract cream respectively, namely 0.1782, 0.1130, and 0.1067 [28] and in other studies conducted by using moringa seed oil as a cream preparation with SPF values ranging from 17-16 [29].

The positive control (commercial lotion) on the market in this study was used to compare the SPF value of forest coconut oil lotion. The test results show that the SPF value of forest coconut oil is very low compared to sunscreen lotion preparations on the market. Because commercial lotion contains compounds that work to absorb UV rays, such as phenylbenzimidazole sulfonic acid and also titanium dioxide compounds (TiO2), which play a role in blocking or reflecting UV rays, the use of TiO2 in sunscreen preparations aims to increase protection against harmful UV radiation [30].

There is a (total) phenol content in forest coconut oil (which is not burned) of 48.55 ppm [9]. Burned *Pandanus julianettii* has no flavonoid compounds [31]. In addition, another study stated that there were differences in flavonoid content in raw mulberry leaf extract, semi-dried mulberry leaves, and dried leaves [32]; these differences occurred due to flavonoid decomposition that occurred due to the influence of storage treatment and high temperature so that leaf tissue components changed causing flavonoids that were not extracted. High combustion temperatures will result in the oxidation of polyphenol components by adding oxygen molecules [33]. Oxidation of polyphenol components will result in damage to flavonoid compounds. This results in epigallocatechin, and the error will condense to form orthoquinone and then condense with the addition of hydrogen ions, forming bisflavanols. Bisflavanols will then undergo condensation to form theaflavins and thearubigins. These components are components of tannin compounds with relatively small amounts of polyphenols.

Polyphenols help prevent oxidative stress caused by excessive ROS (Reactive Oxygen Species), protect the skin from the adverse effects of UV radiation, and prevent skin cancer [34]. Flavonoids have hydroxyl groups attached to aromatic rings to stabilize ROS. The primary mechanism of action of flavonoids is to play a role in absorbing excess UV rays, thereby reducing their intensity on the skin. This is related to conjugated double bonds in the flavonoid molecule [35]. The content of plant compounds with aromatic rings shows a broad spectrum of absorption of UV light (200 nm - 400 nm) so that it can block both UV A and UV B rays [36].

CONCLUSIONS

It can be concluded from this research that the results of physical quality evaluation in the form of organoleptic tests, homogeneity tests, pH tests, adhesion tests, and dispersion tests on forest coconut oil lotion meet the physical quality requirements of semi-solid preparations, in organoleptic tests produce white, milky white and yellow langsat, with the aroma of *coconut oil*, has a semi-solid texture, evenly mixed (homogeneous), pH 6, and has a dispersion ranging from 5-7 cm with adhesion FI 4.15, FII 3.19 and FIII 2.12 seconds.

Forest coconut oil lotion with a concentration of FI (2%), FII (4%), and FII (6%) has minimal potential as a sunscreen; this is due to the results of the average SPF value of the three formulas, namely FI (1.95), FII (1.57), and FIII (1.19).

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