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Original Research Article

Formulation and Activity Test of *Sunscreen Cream Preparations* Balangkasua Leaf Extract (*Lepisanthes alata* (Blume) Lennh)

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Abstract

Balangkasua leaves (Lepisanthes alata (Blume) Leenh.) are known to contain secondary metabolites, particularlyphenolics and flavonoids, which have the potential to be used as active ingredients in natural sunscreens. This study aims to determine the content of secondary metabolites inbalangkasua leaf extract. To determine the physical characteristics and stability of the balangkasua leaf extract sunscreen cream formulation. To determine the SPF value of balangkasua leavesand balangkasua leaf extract sunscreen cream. To determine whether thebalangkasua leaf extract sunscreen formulation is safe and acceptable tousers based on the results of irritation and hedonic tests. In the phytochemical screening test, balangkasua leaf extract contained alkaloids, tannins, flavonoids, saponins, and steroids. The formulated sunscreen good physical stability, although in the fourth cycle there was a slightphase separation. The SPF values of balangkasua leaf extract at concentrations of 400 ppm, 600 ppm, and 800 ppm showed ultra protection of 20.21,24.13, and 28.22, respectively. The SPF obtained from the three formulations of balangkasua leaf extract creamwere F1 15.37, F2 23.16, and F3 32.35, all of which fall into the "ultra" protection category. Based on the results of irritation, cream formulations demonstrated safe properties and were well-tolerated users.

Keywords: Flavonoids, Cream, Lepisanthes alata, SPF, sunscreen.

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1 Introduction

Reactive Oxygen Reactive Oxygen Species (ROS) are compounds that have one or more unpaired electrons in their outer orbit. This reactive state causes electrons to seek out partners to bond with surrounding molecular electrons. Electrons bound to free radicals are detrimental because increased ROS also increases damage to proteins, lipids, and cellular DNA. The resulting DNA damage leads to the destruction of elastic fibers due to the presence of proteases and reactive oxygen species. The resulting skin appears dark [15].

The skin is the outermost layer of the human body, protecting the body's interior from the external environment. It primarily protects the body from ultraviolet rays by using melanin, regulating body temperature, and reducing external stimuli. Excessive exposure to UVA and UVB rays can compromise skin health and function. Environmental changes and aging also contribute to the decline in skin function in humans [15]

Indonesia is a tropical country with quite hot weather and intense sunlight. Indonesia is also said to experience high levels of sunlight intensity. Ultraviolet A rays, with a wavelength of 320-400 nm, can cause skin hyperpigmentation. Ultraviolet B rays, with a wavelength of 290-320 nm, cause *photodamage* to the skin, including inflammation. 76% of Indonesian women are aware of the signs of premature aging by the age of 30 [26].

Antioxidants are essential compounds and a last resort for counteracting free radicals. Antioxidants are highly oxidizable, rendering free radicals unreactive. Antioxidants are commonly used as active ingredients in sunscreens . Their ability to protect against photoprotective activity and prevent the harmful effects of free radicals is crucial. The function of antioxidants is clearly the opposite of that of free radicals. Exogenous antioxidants are typically obtained from external sources, such as food or supplements. Endogenous antioxidants are naturally produced within the human body, for example, superoxide dismutase (SOD), glutathione peroxidase (GSHPx), catalase, and nonenzymes (small glutathione proteins) [19]

One of the plants that has the ability as an antioxidant found in nature is the Balangkasua plant *(Lepisanthes alata* (Blume) Leenh.) [12]. Balangkasua fruit is used by some indigenous people for consumption and is also used in traditional medicine, such as in East Kalimantan where *L. alata leaves are used* to reduce itching on the skin caused by scabies [27]. The use of balangkasua fruit by the Dayak tribe as a traditional medicine, namely the roots as a medicine for vaginal discharge, internal wounds and stomach pain [25].

Research has been conducted and it is known that the vitamin C content of balangkasua fruit is (41.50 mg/100 g) while in the skin it is (38.0 mg/100 g) . Research has been conducted (Anaggraini et al., 2019) total anthocyanin of fruit skin (1462.82 mg/100 g), whole fruit (1017.85 mg/100 g), seeds (939.22 mg/100 g) and fruit flesh (672.27 mg/100 g). In addition, leaf extract contains catechin 10.60±1.1 g/ml, epicatechin 15.60±3.3 g/ml, and epigallocatechin gallate (15.60±3.3 g/mL). Research has shown that the ethanol extract of seeds contains phenolics (1.00 mg GAE/100 g), fruit skin (0.92 mg GAE/100 g) and flesh 0.32 mg GAE/100 g). Total flavonoids ($p<0.05$) where the seeds contain (2.5 mg QE/100 g), fruit skin (1.77 mg QE/100 g), and flesh (0.46 mg QE/100 g). Dark colored fruit skin contains a total of 82 to 297 mg anthocyanins/100 g while light colored fruit skin has a total of 2 to 41 mg anthocyanins/100 g [12]

Sunscreen cream is a cream preparation containing active ingredients in the form of antioxidants. Sunscreen preparations are used to reduce signs of aging on the skin, which are caused by UVA and UVB rays [11]. Compared to ointments, cream preparations are less heavy and thick. The advantages of cream preparations themselves are an attractive appearance, comfortable application, easy absorption into the skin, non-sticky, and easy to wash off with water. Form stock *sunscreen* can made in stock ointment, gel, cream, lotion, or spray [2].

In the research previously, has done formulation *essence* of extract skin fruit balangkasua , however Still Not yet There is formulation stock cream *sunscreen* from extract leaf balangkasua , as well as Not yet

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Once done determination SPF value against part plant Balangkasua. Meanwhile, many antioxidant tests have been conducted on all parts of the balangkasua plant.

2 Method

3.1 Determination Yield

Determination yield done with use powder dried and weighed simplicia . The extract results obtained weighed Then heavy extract shared with heavy simple ingredients beginning Then multiplied by 100%.

2.2 Testing Screening Phytochemicals

Phytochemical screening testing is carried out by adding several reactions to a test tube containing the extract to see the reaction by observing color changes [18]

a. Alkaloid

The alkaloid phytochemical screening test was carried out by adding 2 mL of extract into each of 3 test tubes, adding 1 mL HCl 2 N. Add 3 drops of Mayer's reagent to tube 1, 3 drops of Wagner's reagent to tube 2, and 3 drops of Dragendorff's reagent to tube 3. A positive result will produce an orange-brown precipitate in Dragendorff's reagent, a yellow or white precipitate in Mayer's reagent, and a brown precipitate in Wagner's reagent.

b. Tannin

Testing screening phytochemicals tannin done with enter solution 2 mL of test extract into tube reaction Then 3 drops of $FeCl_3$ solution were added. A positive result is indicated by a color change to blackish green or blackish blue.

c. Flavonoid

The flavonoid phytochemical screening test was performed by dissolving 2 mL of the extract in 96% ethanol and heating it for approximately 2 minutes. Then, 4-5 drops of concentrated HCl and 0.1 gram of Mg powder were added, shaken, and allowed to separate. A positive result was indicated by a color change to red, yellow, or orange.

d. Steroids/Triterpenoids

Testing screening steroid/triterpenoid phytochemicals were carried out with entered extract to in tube reaction and dissolved in 0.5 mL chloroform, add 0.5 mL acid acetate anhydrous, 1-2 mL acid sulfate concentrated. Positive steroid results are characterized by with formation color blue, while triterpenoids are marked with formation color red, orange or purple.

e. Saponin

Testing screening phytochemical analysis of saponins was carried out with dissolved extract and take as much as 5 mL, put in to in tube reaction, then shaken with strong. If formed foam, added 1 N HCl. Positive result marked with emergence stable foam.

2.3 Formulation and Manufacturing Cream

Table 1. *Sunscreen* cream preparation formulation Balangkasua leaf extract

Material	Function	F0	F1	F2	F3	Usage range (%)
		(%)				
Balangkasua leaf extract	Active ingredient	-	0.5%	1%	1.5%	-
Sour Stearate	Emulsifying agent	8%	8%	8%	8%	1-20%
Cetyl alcohol	*Stiffening agent*	2%	2%	2%	2%	2-5%
Lanolin	Emollient	2%	2%	2%	2%	2%

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TEA	Emulsifying agent	1%	1%	1%	1%	2–4%
Glycerin	Humectant	10%	10%	10%	10%	<30%
Methyl paraben	Preservative	0.18%	0.18%	0.18%	0.18%	0.8%
Propyl paraben	Preservative	0.02%	0.02%	0.02%	0.02%	0.8%
α-tocopherol	Antioxidants	0.001%	0.001%	0.001%	0.001%	0.001– 0.05%
Aquades	Solvent	qs	qs	qs	qs	qs

Prepared phase oil (acid stearate, lanolin, propyl paraben, and cetyl alcohol), inserted to in glass chemical and melted on top *hot plate* with temperature 70°C to melted perfect. Prepared water phase (TEA, glycerin, and methyl paraben) then heated above *hot plate* with temperature 70°C. Entered water phase in slowly to in container containing phase oil. Mixture phase oil and water phases are stirred use homogenizer 6,000 rpm for 15 minutes until Homogeneous. Added concentrations of Balangkasua leaf extract (0.5%, 1%, and 1.5%).

2.4 SPF test extract and cream *Sunscreen*

Testing SPF value of the extract done with extract ethanol leaf balangkasua made concentrations of 400 ppm, 600 ppm, and 800 ppm using ethanol extract read absorption with long wave between 290-320 nm with 5 nm intervals and carried out three replications. Blanks used is ethanol pa Absorbance results used for count SPF value with equality Mansur's formula (1986). Testing SPF value of the cream *sunscreen* done with dissolve 0.5 grams stock creams F0, F1, F2, and F3 use ethanol Dad until add 10 mL. Its absorption read with long wave between 290-320 nm with 5 nm intervals and carried out three replications. Blanks used is ethanol pa Absorbance results used For count SPF value with equality Mansur's formula (1986).

2.5 Activity Test Preparation Cream

a. *Cycling* Test

Cycling test done with stock stored at a temperature of ± 4°C for 24 hours then transferred at a temperature of ± 40°C for 24 hours (1 cycle) and carried out as many as 6 cycles.
Evaluation tests were carried out physique supplies at each cycle. Stable *cycling test* results that is No experience change color, smell, and shape, as well own constant viscosity and pH.

b. Organoleptic Test

Organoleptic testing is carried out by directly observing the color, aroma, and texture of the cream preparation.

c. Homogeneity Test

The homogeneity test is performed by placing 0.5 g of cream between two glass slides and observing the particle composition of the preparation for the presence of lumps or coarse grains. The preparation must exhibit a homogeneous composition and must not contain any coarse grains.

d. Viscosity Test

The viscosity test was conducted using a *Brookfield viscometer* with spindle number 4 selected and mounted on the viscometer at 50 rpm. The viscosity of the *sunscreen cream preparation was then measured* in three replicates.

e. Power Test Spread

The spreadability test was conducted by taking 0.5 grams of the cream preparation and placing it on a 20x20 cm glass, covering it with another glass, and leaving it for 1 minute. Next, a 250-gram load was applied to the top and left for 5 minutes, and the spreadability of the *sunscreen cream preparation was measured*. The dispersion power was measured in three replications using millimeter blocks and rulers.

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f. Power Test Sticky

The adhesion test was performed by taking 0.5 grams of the cream preparation, placing it on a glass slide, covering it with another glass slide, and leaving it for 1 minute. Next, a 250-gram load was applied to the slide , leaving it for 5 minutes, and waiting for the glass slide to detach.

g. pH test

pH value of the preparation measured using a pH meter. Testing This started with a calibrated pH meter use solution buffer standard with neutral pH namely pH 7 and acidic pH namely pH 4. After the pH meter shows appropriate pH value , electrode washed with distilled water and dried use tissue. Next, the electrode dipped to in stock cream until obtained pH value of the preparation.

2.6 Irritation Test

The irritation test was conducted by applying 0.5 grams of cream to a cover consisting of a round filter paper with a diameter of 2.5 cm, aluminum foil , and plaster, then attached to the upper arm of thirty panelists for 4 hours. Observations were made at 0, 24, 48, and 72 hours after application, with assessment based on scoring 0 to 4. The edema score was assessed with the following criteria: 0 = no edema, 1 = very mild edema (skin increased ± 1 mm), 2 = mild edema (skin increased ± 2 mm), 3 = moderate edema (skin increased ± 3 mm), and 4 = severe edema (skin increased ± 4 mm). Meanwhile, the erythema score was determined using the following criteria: 0 = no erythema, 1 = very mild erythema (almost invisible), 2 = very visible erythema (diameter 25.1–30 mm), 3 = moderate to severe erythema (skin increased ± 3 mm), and 4 = severe erythema (dark red with eschar formation , diameter >35 mm).

2.7 Data Analysis

Data analysis from this test included the yield of ethanol extract of balangkasua leaves and phytochemical screening. Data from the physical activity tests (organoleptic test , pH test , homogeneity test, spreadability test, adhesiveness test, and viscosity test) and physical stability using the *cycling method were also obtained. test* analyzed with *one way anova* . Determination of the SPF value is carried out using a UV- Vis Spectrophotometer to determine the absorbance value , the erythmogenic effect of radiation at wavelength (λ), and then calculating the SPF value following the Mansur (1986) equation listed below.

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

Information:

CF : Correction factor is 10

EE : Erythmogenic effect of radiation at wavelength (λ)

I : Simulated spectrum of solar radiation (λ)

A : Absorbance value at wavelength (λ) (290–320 nm , every 5 nm)

3 Result and Discussion

3.1 Yield and screening phytochemicals

3.1.1Results of Balangkasua Leaf Extract Yield

The yield value obtained from the balangkasua leaf extract can be seen as follows.

$$\% \text{ Yield} = \frac{\text{Weight of Balangkasua leaf extract}}{\text{Initial weight of dry simples}} \times 100\%$$

$$= \frac{34{,}82 \text{ gram}}{500 \text{ gram}} \times 100\%$$

$$= 24.81\%$$

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3.1.2 Phytochemical Screening Results of Balangkasua Leaf Extract

The results of phytochemical screening of ethanol extract of balangkasua leaves are as follows.

Table 2. Screening Result Data Phytochemicals Extract Leaf Balangkasua

Metabolites secondary	Reagent	Parameter	Results
Alkaloid	Dragendorff	Sediment orange	+
	Mayer	Sediment white	-
	Wagner	Sediment chocolate	+
Tannin	$FeCl_3$ 1%	Blackish green	+
Flavonoid	HCl+Mg NaOH 2N	Solution orange	+
Saponin		Formed foam	+
Steroids/Triterpenoids	Libermen Bouchard	Steroid = color solution blue Triterpenoid = color red , orange , or purple	+ -

Extract yield is the percentage of the extract obtained from the base material after the extraction process, compared to the initial weight of the material. This yield is usually used to determine the amount of compounds successfully extracted from balangkasua leaves. Determining the yield value is carried out to determine the amount of extract obtained during the extraction process. The yield results are related to the active compounds contained in balangkasua leaves. The higher the yield, the more active compounds in the sample (Anggestia et al., 2023).

Based on the results obtained, the yield value of the ethanol extract of balangkasua leaves was obtained. 24.81%. The requirement for a good extract yield is above 10% (Ministry of Health, 2017). Factors affecting the yield value are the type of raw material, the size of the simplicia, the ratio of the simplicia to the solvent, temperature, stirring, equipment, equipment used, and accuracy. The yield obtained from the balangkasua leaf ethanol extract, which was 24.81%, met the requirements because it exceeded 10%.

Phytochemical screening is a method used to identify the secondary metabolite content of a natural product. Phytochemical screening tests are conducted to determine the secondary metabolite content of balangkasua leaf extract. Phytochemical screening shows the presence of various secondary metabolite compounds that play an important role in the biological activity of plants. Phytochemical screening methods can be carried out by observing the color reaction using a specific reagent. The choice of solvent and extraction method is crucial and greatly affects the phytochemical screening process. Inappropriate solvents may prevent the desired active compounds from being properly and completely attracted [29].

Based on the results of research data in Table 1.2, the ethanol extract of balangkasua leaves is positive for containing alkaloids, flavonoids, tannins, steroids, and saponins. Negative for triterpenoid secondary metabolites. In the identification of alkaloids using Wagner, Mayer , and Dragendorff reagents, positive results are indicated if 2 of the 3 reagents give a precipitate in accordance with the literature listed in Table 1.2, namely Wagner and Dragendorff reagents are positive for containing alkaloids. The principle used in the alkaloid test is a precipitation reaction, this occurs due to the replacement of ligands [8].

Wagner reagent contains iodidum and iodide. The precipitate formed is a potassium-alkaloid precipitate. This occurs when the iodine atom reacts with the I ion from potassium and iodide which produces a brown I_3^- ion while the K^+ metal will form a coordinate covalent bond with the nitrogen present in the precipitated potassium-alkaloid complex alkaloid. The Dragendorff reagent contains bismuth nitrate and potassium iodide (KI) which are made in a glacial acetic acid solution (potassium tetraiodide bismuthate (III)). Bismuth nitrate is dissolved first in HCl so that the hydrolysis reaction does not occur because bismuth ions (BiO^+) will form from bismuth salts which are easily hydrolyzed. When the solution is

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added to the acid, the bismuth ions (Bi^{3+}) will remain in the solution so that when potassium iodide is added it will react with the bismuth ions (Bi^{3+}) from bismuth nitrate and form a precipitate. When bismuth (III) iodide dissolves in excess potassium iodide, it forms potassium tetraiodobismuthate . The K^{+} ion from potassium tetraiodobismuthate forms a coordinate covalent bond with the nitrogen from the complex alkaloid, forming a volatile potassium alkaloid complex [10].

Testing of flavonoid compounds in ethanol extract of balangkasua leaves using Mg powder and concentrated HCl reagents. Based on the results shown in Table 1.2 , the ethanol extract of balangkasua leaves contains flavonoid compounds. The addition of HCl aims to hydrolyze flavonoids into their aglycones by hydrolyzing O- glyconyl which will then reduce the flavonoids with the addition of metallic magnesium. Mg will reduce the benzopyrone core in the flavonoid structure so that a red, yellow, or orange flavilium salt will be formed [24]

Identification of tannins is done by adding $FeCl_3$ and will give a positive result in the form of a color change to blackish green. The color change is because tannins are polyphenol compounds. Polyphenol compounds will form complex compounds with Fe ions as the central atom which will bind polyphenol compounds that have O atoms which also have lone electron pairs that can coordinate to the central atom as their ligands [22].

The saponin test was carried out by adding water to the balangkasua leaf extract , boiling it and shaking it, showing a positive result as can be seen in table 1. 2 due to the formation of foam. The foam persisted for a long time after being left for 2 minutes. The foam formed indicated the presence of glycosides in the balangkasua leaf extract. Glycosyl contained in saponins is a polar group part of triterpenoids or steroids, so this nonpolar group will have active properties on the surface and when shaken with water, micelles are formed. The polar groups of the micelle structure will point outward while the nonpolar groups point inward and this condition will appear like foam [24]

Out using Lieberman-Burchard, the principle of which is to identify cholesterol by adding $H2SO4_{to}$ the mixture. In this test, a positive result was obtained for the balangkasua leaf extract containing $_{steroids}$. The triterpenoid test was carried out with the Lieberman-Burchard reagent ($_{concentrated\ H2SO4}$ acetic anhydride) which can be seen in table 1. 2 negative results, this is likely due to the extraction using solvents that have semipolar and polar properties. Triterpenoids are compounds that have nonpolar properties , causing the compounds to be tested not to be extracted immediately homogeneously by the solvent used. The reagents used generally have polar properties so that interactions occur in the sample, the principle of which is " *like*" *dissolve like* ", states that only compounds that are polar in nature will bind in the solvent, such as alkaloids, tannins, and flavonoids [11].

3.2 Extract SPF Value Leaf Balangkasua

Table 3. SPF Value Data of Balangkasua Leaf Ethanol Extract

Concentration	SPF value	Category
400 ppm	20,21	Ultra protection
600 ppm	24.13	Ultra protection
800 ppm	28.22	Ultra protection

Table 4. SPF Value of Cream *sunscreen* extract leaf balangkasua

Formulation	Concentration	SPF value	Category
F0	-	0.33	No There is protection
F1	0.5%	15.37	Ultra protection
F2	1%	23.16	Ultra protection
F3	1.5%	32.35	Ultra protection

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Ethanol extract of balangkasua leaves contains secondary metabolites, namely flavonoids, which are the largest group of phenolic compounds that play a role in absorbing UV rays and acting as antioxidants. These compounds can act as natural filters that inhibit the penetration of UV rays into the skin, thereby preventing skin cell damage due to excessive UV radiation [13]. Flavonoid compounds can protect the skin from UV exposure due to the presence of chromophore groups (conjugated single double bonds) that can absorb UV-B rays, thereby reducing the intensity of radiation in the skin layer. Sunscreen is a product used to protect the skin from sunlight by effectively reflecting or absorbing sunlight [21].

Based on the research results in table 1.3 , the SPF value of balangkasua leaf extract at concentrations of 400 ppm, 600 ppm, and 800 ppm showed a protection potential of 20.21 (ultra protection), 24.13 (ultra protection), and 28.22 (ultra protection). This shows that balangkasua leaf extract can be an alternative natural ingredient for sunscreen formulation. The sunscreen potential of balangkasua leaf extract is due to the presence of secondary metabolite compounds contained in balangkasua leaf extract , namely flavonoids and tannins , which are groups of Phenolics , which are thought to have a significant effect in providing protection against UV rays. Repeated exposure to UV radiation can activate melanin synthesis, thereby increasing melanin content in the skin (Prasetyo, 2021).

Continuous exposure to UV (Ultra Violet) rays is one of the causes of structural and compositional changes and oxidative stress reactions in the skin. Oxidative stress reactions resulting from direct UV exposure can damage DNA and cause keratinocytes to undergo apoptosis, a process known as sunburn. UV rays are able to induce one of the ROS (*Reactive Oxygen Species*) namely 8-OHdG (8- *hydrusy-douxyguanosine*) which can cause oxidative stress , cell damage and if continued can stimulate the activation of p53. When p53 activation occurs , POMC (*pro- opiomelanocortin)* which is located in the pituitary gland will produce a-MSH (*alpha-melanocyte stimulating The hormone* e-MSH binds to its receptor, MCIR (*melanocortin-1 receptors*), in melanocytes . After binding, tyrosin levels and melanin biosynthesis enzymes increase . Melanogenesis then occurs , leading to the accumulation of melanin in keratinocytes , leading to pigmentation. Tyrosinase is involved in melanin biosynthesis in melanocytes , where melanin pigment is produced through melanogenesis [24].

Phenolic compounds , namely flavonoids and tannins, have the capacity to protect the skin from UV-induced cell damage in keratinocytes , or can be called photoprotectors . Photoprotectors are compounds that compete with compounds that can be damaged by solar compounds. The photoprotective mechanism of phenolic compounds is by absorbing UV rays that penetrate the skin. Flavonoids have conjugated double bonds. Flavonoids will absorb UV rays and cause electron excitation from the ground state. The UVB state transitions to a higher-energy orbital. The absorbed UVB rays are then emitted , but with much lower energy. Most of the UVB energy is converted into heat energy, which is harmless to the skin. This mechanism subsequently inhibits or minimizes the appearance of erythema and pigmentation caused by sunlight [3]

Flavonoids can act as tyrosinase inhibitors in enzymatic reactions because the structure of flavonoids is similar to that of the substrate, therefore there is competition between the inhibitor (flavonoid) and the substrate to enter the active site of the enzyme. Flavonoids that bind to the active site of the enzyme can prevent the formation of dopachrome . If dopachrome is not formed, the prosinase enzyme can be maximally inhibited [3]. Condensed tannins have activity as tyrosinase inhibitors. This tyrosinase inhibitory activity occurs due to the structural similarity between the condensed tannin subunit and the substrate (tyrosine and L-DOPA). The mechanism of action is because condensed tannins will compete in the process of forming L-DOPA and DOPA quinones [16].

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3.3 Sunscreen Cream Extract Leaf Balangkasua

3.3.1 Organoleptic Test

Table 5. Organoleptic Test Table

Information	Formulation			
	F0	F1	F2	F3
Color	White	Light green	Light green	Light green
Aroma	Typical base	Distinctive aroma extract leaf balangkasua	Distinctive aroma extract leaf balangkasua	Distinctive aroma extract leaf balangkasua
Texture	L, LM, TL	L, LM, TL	L, LM, TL	L, LM, TL
				

Information :
L: Soft
LM: Instantly Even
TL: Not Sticky

3.3.2 Homogeneity Test

Table 6. Homogeneity Test Results

Cycle	Measurement Homogeneity				Standard Parameters
	F0	F1	F2	F3	
0	Homogeneous	Homogeneous	Homogeneous	Homogeneous	No there is grains rough , lumpy , and even color
1	Homogeneous	Homogeneous	Homogeneous	Homogeneous	
2	Homogeneous	Homogeneous	Homogeneous	Homogeneous	
3	Homogeneous	Homogeneous	Homogeneous	Homogeneous	
4	Homogeneous	Homogeneous	Non-homogeneous	Non-homogeneous	
5	Homogeneous	Non-homogeneous	Non-homogeneous	Non-homogeneous	
6	Homogeneous	Non-homogeneous	Non-homogeneous	Non-homogeneous	

3.3.3 pH test

Table 7. pH Test Results

Cycle	pH measurement				Standard Parameters
	F0	F1	F2	F3	
0	6.15 ±0.02	5.32 ±0.02	5.13 ±0.021	5.09 ±0.01	Skin pH 4.5-6.5 Cream pH 4.5-8 SNI 16-4399-1996
1	6.15 ± 0.02	5.32 ± 0.03	5.11 ± 0.014	5.09 ± 0.01	
2	6.17 ± 0.036	5.36 ± 0.017	5.13 ± 0.01	5.1 ± 0.02	
3	6.15 ± 0.01	5.33 ± 0.028	5.15 ± 0.02	5.10 ± 0.015	
4	6.2 ±0.026	5.35 ± 0.0265	5.12 ±0.021	5.07 ±0.02	

5	6.16 ±0.026	5.36 ±0.04	5.14 ±0.026	5.09 ±0.01
6	6.15 ±0.02	5.32 ±0.03	5.13 ±0.021	5.09 ±0.01
Average	6.161 ±0.023	5.337 ±0.027	5.131 ±0.019	5.09 ±0.014

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3.3.4 Viscosity Test

Table 8. Viscosity Test Results

Cycle	Measurement Viscosity				Standard Parameters
	F0	F1	F2	F3	
0	23,902 ± 2,863	25,564 ± 3,419	26,801 ±3,838	29,997 ± 2,060	2,000-50,000 cP
1	22,936 ±1,856	23,632 ±2,586	26,357 ±3,745	29,559 ±1,470	
2	22,682 ±1,309	23,518 ±2,414	26,023 ±3,310	28,732 ±1,186	
3	20,848 ± 1,634	22,195 ± 2,996	24,958 ±2,923	28,023 ± 2,203	
4	21,848 ± 2,167	22,262 ± 2,033	24,293 ± 2,437	25,521 ± 3,010	
5	21,006 ± 1,926	22,262 ± 2,033	23,073 ± 2,126	23,216 ± 2,432	
6	21,006 ± 1,926	22,028 ± 1,693	22,801 ± 1,015	23,117 ± 1,129	
Average	22,033 ± 1,954	23,066 ± 2,453	24,901 ±2,467	26,881 ±1,927	

3.3.5 Power Test Spread

Table 9. Power Test Results Spread

Cycle	Measurement Power Spread				Standard Parameters
	F0	F1	F2	F3	
0	6.00 ±0.01	5.41 ±0.01	5.21 ±0.01	5.01 ±0.01	5-7 cm
1	6.07 ±0.12	5.53 ±0.12	5.33 ±0.12	5.13 ±0.12	
2	6.07 ±0.12	5.53 ± 0.12	5.33 ±0.12	5.13 ±0.12	
3	6.27 ±0.12	6.20 ±0.00	6.00 ±0.00	5.27 ±0.12	
4	6.27 ±0.12	6.20 ±0.00	6.07 ±0.12	5.60 ±0.00	
5	6.00 ±0.00	6.07 ±0.12	6.13 ±0.12	5.53 ±0.12	
6	5.73 ±0.12	5.67 ±0.12	5.53 ±0.12	5.40 ±0.00	
Average	6.059 ±0.087	5.801 ±0.07	5.657 ±0.12	5.296 ±0.08	

3.3.6 Power Test Sticky

Table 10. Power Test Results Sticky

Cycle	Measurement Power Sticky				Standard Parameters
	F0	F1	F2	F3	
0	12.37 ±0.01	12.59 ±0.01	12.81±0.01	13.15 ±0.01	> 4 seconds
1	12.27 ±0.01	12.39 ±0.01	12.62±0.01	12.84 ±0.01	
2	11.85 ±0.01	12.13 ±0.02	12.33±0.01	12.55 ±0.02	
3	11.56 ±0.01	11.86 ±0.01	12.19±0.01	12.33 ±0.01	

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4	10.96 ±0.01	11.32 ±0.01	11.50±0.01	11.83 ±0.01
5	9.92 ±0.02	10.02 ±0.01	10.34±0.01	10.66 ±0.02
6	8.54 ±0.01	8.84 ±0.01	9.11 ±0.01	9.33 ±0.01
Average	11.07±0.011	11.31 ±0.01	11.56±0.01	11.81±0.013

Sunscreen cream preparation formulation This study was conducted to determine the physical evaluation and physical stability of the cream from the ethanol extract of balangkasua leaves . The extract concentrations used were 0.5%, 1%, and 1.5%. The concentration of each extract was mixed into the *sunscreen cream base ,* namely stearic acid, TEA, cetyl alcohol , and ethanol extract. alcohol , lanolin, glycerin propyl paraben , methyl paraben , distilled water , and α-tocopherol. *Sunscreen cream* that has been made will undergo physical evaluation and physical stability testing.

Physical evaluation conducted on *sunscreen cream preparations The results of* the balangkasua leaf extract test include organoleptic tests , homogeneity tests, pH tests , viscosity tests, and spreadability tests. The organoleptic test was carried out to determine the texture, color, and aroma of the cream preparation, where a good cream texture is soft, easy to spread, and not sticky. The organoleptic results in Formula 0 were white, Formula 1 was light green, Formula 2 was light green, and Formula 3 was green. The aroma of Formula 0 is typical of lanolin, while Formula 1, Formula 2, and Formula 3 have the typical aroma of balangkasua leaves and will become stronger as the concentration of extract added to the preparation increases. The homogeneity of Formula 0, 1, 2, and 3 is homogeneous, there are no coarse grains [5].

Homogeneity test conducted on *sunscreen cream preparations* F0, F1, F2, and F3 do not contain any grains, indicating that all excipients and active ingredients are mixed homogeneously. The homogeneity test is conducted to determine if there is a mixture of ingredients in the cream preparation, where a homogeneous cream preparation indicates that the ingredients used in making the cream have been mixed evenly [6].

Sunscreen cream preparations show varying pH values at each extract concentration, as seen in the table. The higher the concentration of the added extract, the lower the pH of the formula. This can occur due to the addition of the extract [25]. Balangkasua leaf extract is acidic, having a pH of 4.33 and is not compatible with skin pH. According to (Denansyah and Pujiastuti, 2022), the concentration of stearic acid and triethanolamine can affect the pH of the preparation. The higher the concentration of stearic acid added, the lower the pH of the preparation. The higher the concentration of TEA added , the higher the pH of the preparation. However, all preparations have good pH values, which meet the requirements for human skin pH. Formula pH 0, 1, 2, and 3 still meet the requirements according to SNI 16-4399-1996, which is 4.5-8 [28]. Cream preparations that have a pH A pH below 4.5 can cause irritation, while a pH above 8 can cause dryness. A pH value for a preparation that meets the skin's pH criteria and is non-irritating is in the pH range of 4.5-6.5.

sunscreen cream preparation The higher the concentration of extract added, the viscosity test results can be seen in the table. The viscosity requirement for topical preparations is 2,000-50,000 cP (Budianor et al., 2022). The viscosity of a cream preparation is influenced by the ingredients used in the formula, especially those in the oil phase, namely stearic acid and triethanolamine . The concentration of the added emulsifier also plays a significant role in the consistency of the cream; the more emulsifier added, the greater the viscosity and consistency of the cream [8]. The viscosity of the preparation will be directly proportional to the ability of the cream to adhere to the skin and will be inversely proportional to its spreading power. This is because the higher the viscosity, the greater the adhesion power, but as the viscosity value of the cream increases, the spreading power of the cream will decrease [10]

Spreadability test on *sunscreen cream preparations* Formulas 0, 1, 2, and 3, in descending order, can be seen in the table . This corresponds to viscosity, where the higher the viscosity, the lower the spreadability. The concentration of the emulsifier also affects the spreadability of the cream preparation because the higher the concentration of the emulsifier used, the lower the spreadability of the cream preparation (Deniansyah and Pujiastuti, 2022). The spreadability test was conducted to determine the

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speed of the cream's spreadability when applied to the skin. The results of the spreadability test met the standard requirements for good spreadability, which is around 5-7 cm.

The adhesion test on *sunscreen cream* formulas 0, 1, 2, and 3 sequentially showed increasing values, as can be seen in. This occurs because the higher the viscosity of the preparation, the greater the cream's adhesion. The adhesion value between formulas is influenced by the concentration of TEA and stearic acid [14]. The adhesion test was conducted to determine the cream's ability to maintain adhesion or stick to the skin surface for a certain period of time. The longer the cream's adhesion, the better. Good adhesion will help the cream remain on the skin and not be easily removed by light friction. The results of the adhesion test showed that all formulas met the standard for good adhesion, which is within the time range of seconds ≥ 4 seconds .

Physical stability test using *cycling method test* was carried out to determine the physical changes in the cream preparation using several cycle at a predetermined temperature, namely at 4 ℃ for 24 hours and at 40 ℃ for 24 hours. In the table of physical evaluation results and physical stability, it is known that there is no significant difference between before and after the physical stability test on F0 *sunscreen cream.* showed stability during the storage period, however, in F1 cycle 5 and 6 *sunscreen creams* Balangkasua leaf extract shows the separation of the oil phase from the water phase, it is known that F2 and F3 *sunscreen creams* showed instability in phases 4, 5, and 6 indicating the separation of the water phase and the oil phase so that the cream was not homogeneous, the F0, F1, F2, and F3 formulations in cycles 1-6 showed changes in pH , viscosity, spreadability, and adhesiveness. Changes can occur as the number of cycles increases, where the formula becomes more alkaline or there is an increase and decrease in pH . Changes in pH are caused by the destruction of the components in the preparation. The decrease in pH in the preparation is caused by oxidation in the presence of oxygen and the atmosphere or the presence of photooxidation, as well as the activity of organisms. Meanwhile, the increase in pH can be caused by the slow release of hydroxyl ions from the container (Rizal and Ariyani, 2023). However, the increase and decrease in pH are only slight and still meet the requirements of a good pH , namely in the range of 4.5-6.5. The viscosity of the cream preparation shows that it decreases over time because viscosity can be affected by temperature, the higher the temperature, the distance between particles will decrease. The spreadability of the cream increases with increasing cycles because spreadability is also related to temperature and viscosity. Lower temperatures increase particle density and reduce spreadability. Cream viscosity decreases, so lower viscosity results in a larger spread area. However, lower viscosity results in lower adhesive strength [5].

Based on the results of the physical stability test obtained, the *sunscreen cream* Ethanol extract of balangkasua leaves, separation occurs between the oil phase and the water phase. Phase separation is characterized by a difference in color at the base of the preparation. Phase separation can be affected by storage at high temperatures because it is in accordance with the Arrhenius chemical kinetics equation which states that the higher the temperature, the higher the ability to move a molecule from the liquid so that the water phase globule and the oil phase will try to join the same phase (*coalescence*). In addition, the mixing temperature also affects the separation between the oil and water phases, because the smaller the particle size, the less separation will occur in the cream preparation. Small particle sizes can maintain the emulsion to remain stable so that there is no separation of the cream. While larger particle sizes in cream preparations will not be able to stabilize the emulsion, resulting in *creaming* in the cream preparation [4]. *Sunscreen* cream preparations The ethanol extract of balangkasua leaves did not change color and did not smell rancid because α-tocopherol was added as an antioxidant agent to prevent oxidation in the cream preparation.

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3.4 Irritation Test and Hedonic Test

Table 11. *Sunscreen* Cream Irritation Test Results

Formulation	Number of panelists	Criteria	Time (Hour)			
			0	24	48	72
F0	30	Edema And Erythema	0	0	0	0
F1			0	0	0	0
F2			0	0	0	0
F3			0	0	0	0

Information score edema:
0: No there is edema
1: Very mild edema (skin increased ± 1 mm)
2: Mild edema (skin increased ± 2 mm)
3: Moderate edema (skin increased ± 3 mm)
4: Severe edema (skin increased ± 4 mm)

Information score erythema:
0: No there is erythema
1: Very mild erythema (almost No seen)
2: Erythema is very visible clear (diameter 25.1- 30 mm)
3: Erythema currently until severe (skin increased ± 3 mm)
4: Erythema severe (dark) red with form eschar, diameter >35 mm)

The irritation test is a test conducted to determine the risk of irritation and edema in cream preparations used on the human body. Patch test method Patch test involves attaching the preparation to the skin of the back or arm, which is covered with a plaster for a certain period . Observations of the effects of irritation and edema are carried out at 0 hours before the test material is attached and observations after 24, 48, and 72 hours of the test material being removed. The panelist criteria required in the irritation test and hedonic test are, willing to provide information regarding age, gender and willing to sign the consent form consciously without coercion from any party . The irritation test is a test conducted to determine the risk of irritation and edema of the cream preparation used on the human body [6]. Observations of the effects of irritation and edema are carried out at 0 hours before the test material is attached and observations after 24, 48, and 72 hours of the test material being removed. The panelist criteria required in the irritation test and hedonic test are, willing to provide information regarding age, gender and willing to sign the consent form consciously without coercion from any party . Willing to participate in the entire series of tests by providing documentation Meet the criteria of being male and female with an age range of 20-35 years. Are in good health and have no wounds or scars, allergies, irritations or active skin diseases at the test site (upper arm). Have no allergies to the ingredients used (Stearic acid, Cetyl alcohol, Glycerin , Alpha Tocopherol, Lanolin, Triethanolamine, Methyl paraben , Propyl Parabens). Willing to not consume foods (nuts, eggs, chocolate, and seafood) and drinks (milk and alcohol) that can cause allergies [7].

Skin irritation reactions are characterized by redness (erythema) and swelling (edema) while normal skin is the opposite [27]. Irritation tests conducted on formulas F0, F1, F2, and F3 on 30 panelists did not show erythema and edema, this is in accordance with the pH of the F0, F1, F2, and F3 cream preparations which meet the requirements, namely around 4.5-6.5 [24]. Panelists will experience irritation or erythema if the pH of the preparation is below 4.5 and will cause a dry feeling on the skin if the pH of the preparation is more than 8 [28]. Erythema will be seen if there is a change in color to reddish on the skin. Edema is seen in the height of the skin surface that is raised/swollen compared to normal skin [29].

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4. Conclusion

Based on the results of the research that has been carried out, it can be concluded that the ethanol extract of balangkasua leaves (*Lepisanthes alata* (Blume) Leenh.) contains secondary metabolite compounds in the form of alkaloids, flavonoids, tannins, saponins, and steroids that have the potential as natural photoprotective agents. Balangkasua leaf extract showed excellent sunscreen activity with SPF values at concentrations of 400 ppm, 600 ppm, and 800 ppm of 20.21; 24.13; and 28.22, respectively, which are included in the ultra protection category.

Sunscreen cream preparations of balangkasua leaf extract at various concentrations produced good physical characteristics, including organoleptic tests, homogeneity, pH, viscosity, spreadability, and adhesiveness that met the requirements of topical preparations. The SPF alue of sunscreen cream preparations in formulas F1, F2, and F3 also showed the ultra protection category, thus proving that balangkasua leaf extract remained effective after being formulated into a cream preparation.

The irritation test results showed that the balangkasua leaf extract sunscreen cream preparation was safe to use because it did not cause skin irritation, while the hedonic test showed a good level of acceptance by the panelists. Although the physical stability test using the cycling method Tests of several formulas showed instability in certain cycles, in general, balangkasua leaf extract has great potential to be developed as a natural active ingredient in sunscreen cream formulations with high protective effectiveness and physical properties that meet standards.

5. Declarations

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5.2 Author contributions

Sucitha contributed to the conceptualization, methodology, experimental work, data collection, data analysis, and manuscript preparation. Abdul Rahim contributed to research supervision, study design, data interpretation, critical revision of the manuscript, and final approval of the version to be published. All authors have read and approved the final manuscript.

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