Test The Potential Of Macadamia Nut Oil (*Macadamia F.Muell*) As Sunscreen In Cream Preparations In Vitro

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Abstract.
Background: Sunlight has a beneficial effect by activating provitamin D3 found in the epidermis of the skin to become vitamin D3. However, excessive sun exposure can also have detrimental effects, especially on the skin. Macadamia nut oil contains vitamin E (tocotrienols and tocopherols) which are natural antioxidants. Macadamia nut oil also contains linoleic acid which is great for softening the skin, regenerating skin cells, moisturizing the skin, and is a natural anti-inflammatory. and helps restore skin barrier function and reduce transepidermal water loss (TEWL). Objectives: To determine whether there is a sunscreen potential from macadamia nut oil, the difference in the SPF value is significant between cream preparations with the addition of macadamia nut oil in various concentrations and to determine the sunscreen category of each macadamia nut oil formulation. Methods: This research was carried out experimentally, including the preparation of macadamia nut oil lotion, pH test, irritation test, and in vitro determination of the SPF (sun protection factor) number using a UV-Vis spectrophotometer. Results: The addition of macadamia nut oil combined with oxybenzone and octylmetoxycinamate in cream preparations has an average SPF value of F1 (blank) of 9.97; F2 (blank + 2% oxybenzone + 5% octyl methoxycinamate) of 23.14; F3 (1% macadamia nut oil) of 29.39; F4 (5% macadamia nut oil) of 32.99; and F5 (10% macadamia nut oil) of 37.59. The addition of macadamia nut oil in various concentrations gave a significant difference in increasing the SPF value between each formula combined with oxybenzone and octylmetoxycinamate. Conclusion: The addition of macadamia nut oil can increase the effectiveness of the combination oxybenzone and octylmetoxycinamate sunscreen in cream preparations.

Keyword: *Potensial of Macadamia Nut Oil (Macadamia F. Muell), Sunscreen, Cream and Invitro.*

I. INTRODUCTION

Sunlight has a beneficial effect, which can prevent or treat bone disorders by activating provitamin D3 found in the epidermis of the skin into vitamin D3. However, excessive sun exposure can also cause adverse effects, especially on the skin [1]. Ultraviolet light can cause erythema (redness) of the skin, excessive pigmentation, thickening of horn cells, and aging (aging of the skin). Excessive sunburn can also cause skin disorders ranging from mild dermatitis (usually marked by mild symptoms in the form of a slightly dry, scaly redness, may or may not cause itching), to skin cancer. One effort to prevent the occurrence of various skin disorders due to exposure to light (UV) is to use sunscreen to filter out harmful UV rays before they penetrate the skin [1].Sunscreen is a compound that is used to protect the skin from sun exposure, especially ultra violet (UV). Sunscreen is divided into two based on the type of active ingredient, namely as a physical light blocker and a chemical absorber. Chemical sunscreens such as benzophenone, oxybenzone, octyl methoxycinnamate, and antarnylate that can absorb radiation energy. Physical sunscreens such as titanium dioxide, zinc oxide which can reflect light [2][26].Currently the cosmetic industry is intensively developing products that are oriented towards the use of natural ingredients due to the large positive response from the community. This is due to the assumption that the preparation of natural ingredients is considered safer to use and has fewer negative impacts than the use of chemicals [3]. Supported by Indonesia's natural wealth, the country's cosmetic industry can utilize phytoconstituents from various plants for active ingredients in cosmetic preparations. Therefore, the use of natural ingredients that can reduce solar radiation and increase protection against the negative effects of solar radiation on the skin has become the focus of several studies [4].

According to research, macadamia nut oil contains vitamin E (tocotrienols and tocopherols) which are natural antioxidants. These antioxidants can reduce inflammation and oxidative stress on the skin, in addition this oil exhibits palmitic acid and unsaturated fatty acids similar to the content in the skin [5]. Macadamia nut oil also contains oleic acid which is good for softening the skin, regenerating skin cells, moisturizing the skin, and is a natural anti-inflammatory [6].The content of linoleic acid helps restore the skin's barrier function and reduces transepidermal water loss (TEWL). Macadamia nut oil also contains

squalene which benefits cell regeneration and acts as an antioxidant by protecting the skin from UV-induced lipid peroxidation [7]. Macadamia nut oil also exhibits high emollient properties and fast penetration thereby helping to maintain the physiological function of the skin [8].Based on this description, macadamia nut oil has potential as a sunscreen. However, there has been no scientific research that has tested the activity of this potential. Therefore, it is necessary to conduct research to determine the activity of potential as a sunscreen and calculate the value of SPF (Sun Protecting Factor).

II. LITERATURE REVIEW

Skin Anatomy and Physiology

The skin is a "blanket" that covers the surface of the body and has the main function as a protector from various kinds of disturbances and external stimuli. This protective function occurs through a number of biological mechanisms, such as keratinization, respiration and regulation of body temperature, production of sebum and sweat, and the formation of the pigment melanin to protect the skin from the harmful ultraviolet rays of the sun, as a touch and taste, as well as defense against external pressures and infections. 9].

Skin Structure

The skin is also called the integument or cutis which grows from two kinds of tissue, namely epithelial tissue that grows the epidermis layer and connective tissue (support) that grows the dermis layer (deep skin). The skin has a finely woven arrangement of nerve fibers that is useful for feeling touch or as a tool of touch and is an indicator for obtaining general impressions by looking at changes in the skin [10]. The skin is an organ composed of 4 basic tissues: First, the skin has various types of epithelium, especially stratified squamous epithelium with a horny layer. The blood vessels in the dermis are lined with endothelium. The skin glands are epithelial glands. Second, there are several types of connective tissue, such as collagen and elastin fibers, and fat cells in the dermis. Third, muscle tissue can be found in the dermis. For example, smooth muscle tissue, namely hair-bearing muscles (m. arrector pili) and in the walls of blood vessels, while patterned muscle tissue is found in the muscles of facial expression. And Fourth, Nervous tissue as sensory receptors that can be found on the skin in the form of free nerve endings and various nerve ending bodies. Microscopically, the skin layer is divided into three (epidermis, dermis and hypodermis).

Epidermis

The epidermis is the outermost layer of the skin that is in direct contact with the environment [11]. The epidermis is divided into five layers, namely: Stratum corneum (horn layer), Stratum lucidum, Stratum granulosum, Stratum spinosum (malpighian layer) and Stratum germinativum (basal layer or basement membrane).Stratum corneum layer (horn layer); This layer is mostly composed of keratin (a protein that is not soluble in water). Naturally, the dead cells on the surface of the skin will release themselves to regenerate. The surface of this layer is covered by a protective layer that is moist, thin, and acidic called the skin's acid mantle [9]. Generally, the physiological pH of the skin's acid mantle ranges from 4.5 to 6.5. The skin's acid coat has a function that is quite important for skin protection, so it is called "the first line barrier of the skin". The skin's acid mantle has three main functions, first as a buffer to neutralize chemicals that are too acidic or too alkaline that enter the skin. Second, the skin with its acidic nature can kill or suppress the growth of microorganisms that are harmful to the skin. And third, the skin with its moist properties, can prevent skin dryness [9].Stratum lucidum layer; This layer is located just below the stratum corneum. This layer contains eleidin, and is clearly visible on the palms of the hands and soles of the feet [9].

Stratum granulosum layer; This layer is composed of polygonal, coarse-grained keratinocytes. These coarse grains consist of keratohyalin. This layer is also evident on the palms and soles [9][12]. Stratum spinosum layer (malpighian layer); This layer has cuboidal and spike-like cells, and is oval in shape. These cells are closer to the surface of the skin the more flattened they become. Each cell contains small filaments consisting of protein fibers. Among the cells of the stratum spinosum are Langerhans cells which have an important role in the body's immune system [9][12]). And finally, the stratum germinativum (basal layer or basement membrane); This layer is the lowest layer of the epidermis. It contains melanocyte cells, which are cells that do not undergo keratinization and whose function is only to form the pigment melanin and are

given through dendrites to keratinocyte cells. One melanin cell for about 36 keratinocyte cells is called an epidermal melanin unit [9].

Dermis

Dermis adalah lapisan di bawah epidermis yang merupakan struktur dari kulit dan dasar dari organ tubuh [11]. Lapisan dermis termasuk bagian terpenting pada tubuh, bukan hanya menyediakan gizi, memberi kekebalan dan menyangga epidermis, tetapi juga berperan dalam mengatur suhu, tekanan dan rasa sakit. Lapisan dermis memiliki tebal 0,5-1,0 cm dan terdiri dari serat-serat kolagen (70%) yang memberikan elastisitas dan menjadi bantalan di dalam matriks semigel dari mukopolisakarida. Sel utama dalam lapisan dermis adalah fibroblast, yang menghasilkan kolagen, laminin, fibronectin dan vitronectin, sel mast yang terlibat dalam reaksi imun dan inflamasi, dan melanosit yang terlibat dalam produksi pigmen melanin [13].

Hipodermis

The hypodermis is the layer below the dermis, composed of a layer of adipose cells and as a symbol of the "cushion" of fat between the skin and the organs under it [11]. Commonly called the subcutis layer, acts as a heat insulator, absorbs vibrations and is used for energy storage. This layer is a network of fat cells that are directly connected to the dermis through the connection of collagen and elastin fibers. Apart from fat cells, this layer consists of fibroblasts and macrophages. The main role of the hypodermis is to support blood vessels and the nervous system.

Skin Function

According to Wasitaatmadja (1997), the skin has various functions [12]. Protection function; The skin protects the inside of the human body against physical and mechanical disturbances, such as pressure, friction, pulling, chemical disturbances, such as irritants (lysol, carbolic acid or other strong bases), heat or cold disturbances. interference with radiation or ultraviolet rays, interference with germs, fungi, bacteria or viruses. absorption function; Healthy skin doesn't readily absorb water, solutions, or solids, but volatile liquids are more likely to be absorbed by the skin, as are oil-soluble substances. The absorption ability of the skin depends on the thickness of the skin, hydration, humidity, metabolism and the type of vehicle attached to the skin. Absorption through intercellular gaps, gland ducts or hair outlets.Sensory function (sensory); The skin contains sensory nerve endings in the dermis and subcutis. The ruffini body, which is located in the dermis, receives cold stimulation and hot stimulation is acted by Krause's body. Meissner tactile bodies located in the papillary dermis receive tactile stimulation, as well as Merkel-renvier bodies located in the epidermis.Body temperature regulation function (thermoregulation); The skin performs this role by sweating and contracting the muscles of the skin's blood vessel walls. When the body temperature increases, the sweat glands secrete a lot of sweat to the surface of the skin and by evaporating the sweat, body heat is wasted. Vasoconstriction of the capillaries of the skin causes the skin to protect itself from heat loss in the cold.

Skin as Excretion (excretion); Glands in the skin secrete substances that are not useful metabolic waste in the body such as NaCl, urea and other substances such as uric acid, ammonia and a little fat.Pigment formation function (melanogenesis); The number of melanocytes and the amount and amount of melanin formed determines skin color. Melanin is made from a type of protein, tyrosine, with the help of the enzyme tyrosinase, Cu ions and oxygen, produced by melanocyte cells in melanosomes. Sun exposure can affect melanin production. Keratinization function; Keratinization starts from basal cells that are cuboidal, mitotic upwards, changing to a more polygonal shape, namely spinosum cells, rising upwards to become more flattened, and granulating into granulosum cells. Then the cells are raised upwards and become more flattened and the granules and nuclei disappear into spinosum cells and finally until the surface of the skin becomes dead cells, the protoplasm dries to become hard, flat, without a nucleus called horn cells. These horn cells will be continuously separated from the surface of the skin and replaced by cells located below it. Skin as a site for vitamin D synthesis; The skin can form Vitamin D from the raw material 7-dehydroxy cholesterol with the help of sunlight. However, this production is still lower than the body's needs, so additional vitamin D is needed from the outside through food. Vitamin D can be obtained from milk, cheese, eggs, tofu, soybeans, cod liver oil, salmon and mushrooms.

The Mechanism of Pigmentation in the Skin

The process of formation of the melanin pigment occurs in melanosome grains produced by melanocyte cells located between the basal cells of the keratinocytes in the basal layer (stratum germinativum). Through outstretched arms called dendrites, melanocytes provide melanosomes to a number of surrounding keratinocyte cells. Melanosomes contained in keratinocytes are in the form of solid particles or are a combination of 3-4 smaller particles having a membrane [9].

Effects of Sunlight on Skin

The skin is the body's protector from external influences, especially from sunburn. Sunlight has 2 effects, both detrimental and beneficial, depending on the frequency and duration of light on the skin, the intensity of sunlight, and a person's sensitivity. Although it is needed for the formation of vitamin D which is very useful for the body, sunlight is a major factor in various skin problems, ranging from sunburn, skin pigmentation, skin aging, to skin cancer. Skin that is exposed to UV radiation will be darker in color, wrinkled, dull, dry, blackish brown (melasma) appears, and skin cancer.Excessive sun exposure over a long period of time can have detrimental effects on the top layer of skin (epidermis) and deeper layer of skin (dermis). In the epidermis layer of skin damage leads to skin wrinkling and the formation of spots on the skin due to excessive melanin distribution. Damage to elastin and collagen fibers is seen in the dermis layer which resulting in a decrease in skin elasticity [14].Solar radiation consists of various spectrums with different wavelengths, from infrared to ultraviolet spectrum. Based on the wavelength and its physiological effects, ultraviolet light can be divided into 3 parts, namely: Ultraviolet A is light with a wavelength between 400-315 nm with the highest effectiveness at 340 nm, can cause a brown color on the skin without causing redness, so it is called a pigmentation area. Ultraviolet B is light with a wavelength between 315-280 nm with the highest effectiveness at 297.6 nm, is an erythematous area, can cause sunburn pain and an initial melanin formation reaction occurs. Ultraviolet C is light with a wavelength below 280 nm, can damage skin tissue, but is mostly filtered by the ozone layer in the atmosphere [15].

Sunscreen

Sunscreen preparations are cosmetic preparations that are used for the purpose of reflecting or effectively absorbing sunlight, especially the emission areas of ultraviolet and infrared waves, so as to prevent skin disorders due to sunlight [15].

Table 2. Components of sunscreen that are permitted to be used [15]

Sunscreen Active Ingredients	Maximum Concentration (%)	
	USA	EU
Asam aminobenzoat	15	5
Avobenzone	3	5
Sinosat	3	10
Dioksibenzon	3	10
Homosalat	15	10
Maradimat (Mentil antranilat)	5	-
Oktotrilen (2-etilheksil 2-siano-3,3-difenilakrilat)	10	10
Oktinosat (Oktil metoksisinamat)	7,5	10
Oktisalat (Oktil salisilat)	5	5
Oksibenzon	6	10
Padamit O	8	8
Ensulizol (Asam sulfonat fenilbenzimidazol)	4	8
Sulisobenzon	10	-
Titanium dioksida	25	-
Trolamin salisilat (Trietanolamin salisilat)	12	-
Zink oksida	25	-

There are 2 types of sunscreens, namely: Chemical sunscreens, including PABA, PABA esters, benzophenone, salicylates, anthranilates, which can absorb almost 95% of UVB radiation which can cause sunburn (erythema) and block UVA which causes direct tanning, damage to elastin cells. , actinitic skin damage, and the onset of skin cancer. And physical sunscreens, such as titanium dioxide, magnesium silicate, zinc oxide, and kaolin that can block, block and reflect sunlight. Physical sunscreens can withstand

both UV-A and UV-B [12].A good sunscreen is a sunscreen with a broad spectrum, has protection against UV-A and UV-B to prevent skin damage including erythema, sunburn, premature aging to skin cancer [16]. To optimize the ability of sunscreens, chemical sunscreens and physical sunscreens are often combined, some even use several kinds of sunscreens in one cosmetic preparation [12].

Sun Protecting Factor (SPF)

Sun Protection Factor (SPF) is the ratio between the amount of UV light needed to produce sunburn on skin protected by sunscreen preparations and the amount of UV light needed to produce sunburn on skin that is not protected by sunscreen preparations (FDA, 2015). Sun Protection Factor (SPF) is a universal indicator that describes the effectiveness of a product or substance that is UV protector, the higher the SPF value of a sunscreen product or active substance, the more effective it is to protect the skin from the adverse effects of UV rays [17].Measurement of the SPF value of a sunscreen preparation can be done in vitro and in vivo. The method of measuring the SPF value in vitro is generally divided into two types. The first type is by measuring the absorption or transmission of UV radiation through a layer of sunscreen products on a quartz plate or biomembrane. The second type is to use the Mansur method by determining the absorption characteristics of the sunscreen using spectrophotometric analysis of the diluted solution of the tested sunscreen [18].Whereas in vivo, the method for obtaining the SPF value is where SPF means the ratio between the amount of ultraviolet energy required to produce erythema (Minimum Erythemal Dose) on skin protected by sunscreen and with skin that is not protected by sunscreen. The SPF assessment refers to the FDA's provisions which classify the effectiveness of sunscreen preparations based on SPF [19].

1. Sunscreen with an SPF value of 2-4, provides minimal protection
2. Sunscreen with an SPF value of 4-6, provides moderate protection
3. Sunscreen with an SPF value of 6-8, provides extra protection
4. Sunscreen with an SPF value of 8-15, providing maximum protection
5. Sunscreen with SPF value 15, provides ultra protection

Oksibenzon

Oxybenzone absorbs UV B efficiently, but absorbs well at UV A (320-340 nm), so it is more often used to absorb UV A. Oxybenzone can increase SPF when combined with materials that absorb UV B. Oxybenzone is solid and poorly soluble. [21] [22]

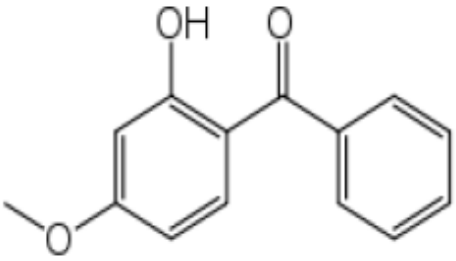

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Fig 2.1. The formula for building oxybenzone

Chemical name : 2-hydroxy-4-methoxyphenyl-phenylmethanone
Trade name : oxybenzone, benzophenone-3, 2-hydroxy-4-methoxybenzophenone
Molecular Weight : 228.25 g/mol
Build formula : $C_{14}H_{12}O_3$
Description : yellow crystalline powder and weak aromatic odor

Oktil Metoksisinamat

Octyl methoxycinnamate is a good UV B absorber, which has a maximum wavelength of 311 nm. It is the most widely used ingredient in sunscreen preparations worldwide. Octyl methoxycinnamate belongs to the cinnamic derivative, which is currently a substitute for the p-aminobenzoic acid group. Octyl methoxycinnamate has good oil solubility and is most effective in increasing SPF when combined with other ingredients [22]

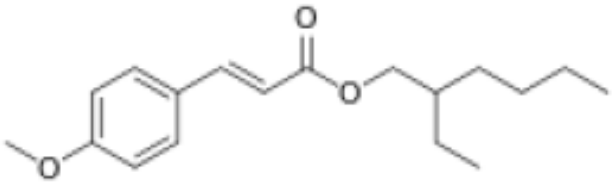

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Fig 2.2. Constructing Formula of Octyl Methoxycinnamate

Chemical name : 2-ethylhexyl-3-(4-methoxyphenyl)-2-propenoate
Trade names : Eusolex 2292, Escalol 557, NeoHolipan, Parsol MCX
Build formula : $C_{18}H_{26}O_3$
Molecular Weight : 290.40 g/mol
Description : clear color in the form of liquid

Spektrofotometer UV-Vis

UV-Vis spectrophotometry is a science that studies the technique of measuring the interaction of matter in the form of molecules with energy or light in the form of visible or ultraviolet light that can cause the excitation of electrons in the molecular orbitals from the basic energy level to a higher energy level as a function of wavelength. Ultraviolet light has a wavelength between 200-400 nm, while visible light (Visible) has a wavelength of 400-800 nm. As the name implies, UV-Vis spectrophotometer is a combination of UV and Visible spectrophotometer. The UV-Vis spectrophotometer uses two different light sources, namely a UV light source and a Visible light source. The UV-Vis spectrophotometer is a double-beam spectrophotometer while the Visible or UV spectrophotometer is a single-beam spectrophotometer.

In a double beam spectrophotometer, the blank and the sample are inserted or irradiated simultaneously, while the single beam spectrophotometer is inserted or irradiated separately [23].When light hits the sample, some will be absorbed, some will be scattered and some will be transmitted. In spectrophotometry, incident light or incoming light or light hitting the surface of a substance and light after passing through the substance cannot be measured, what can be measured is It/I0 or I0/It (the ratio of incident light to light after passing through the material (sample). Where I0 is incident light intensity and it or I1 is the light intensity after passing through the sample [24].The spectrum emitted by a UV-Vis spectrophotometer is a wide band and usually shows only a few peaks. The peak is reported as the wavelength at which the maximum occurs. The widening band of UV-Vis is caused by the energy possessed, besides causing electronic transitions, there are also rotations and vibrations of electrons in molecules [23].

Macadamia Nut Oil

Macadamia nut oil is a unique vegetable oil because it is high in monounsaturated fatty acids, and contains vitamin E (tocotrienols and tocopherols) which are natural antioxidants. These antioxidants can reduce inflammation and skin oxidative stress. This vegetable oil can penetrate the skin because the components in it are very similar to the skin's natural oil and function to retain moisture and nourish the skin [6]. The composition of macadamia oil has a high content of unsaturated fatty acids so it is often used as skin care products and also anti-aging. Macadamia oil in addition to having good value for benefits, and is safe to be made as a cosmetic product [25].Vitamin E functions as an antioxidant, especially for unsaturated fatty acids in phospholipids in cell membranes. Vitamin E has the ability to protect cell membranes from free radicals. In cell membranes vitamin E collects free radicals thereby protecting unsaturated fatty acids, proteins and skin oxidative damage [27]. Macadamia oil contains palmitic acid and oleic acid which are great for softening the skin, regenerating skin cells, moisturizing the skin, and is a natural anti-inflammatory.

The content of linoleic acid helps restore skin barrier function and reduces transepidermal water loss (TEWL) [6].Phytosterols are also found in effective amounts, mostly consisting of B-sitosterol, campesterol and stigmasterol. This phytosterol has a function similar to cortisone which can reduce itching, redness, and relieve irritated skin. Macadamia oil also contains squalene which benefits cell regeneration and acts as an antioxidant by protecting the skin from UV-induced lipid peroxidation [7]. The fatty acid that is often used in cosmetics is palmitic acid which is part of human skin sebum. The content of palmitic acid contained in macadamia oil is widely formulated for skin care products [8]. Macadamia oil has good value for benefits;

besides that, it is safe to be made as a cosmetic product [25].

III. METHODS

This research method was carried out experimentally. The research includes the manufacture of macadamia nut oil lotion preparations, pH test, irritation test, and determination of the SPF (Sun Protection Factor) number in vitro using a UV-Vis spectrophotometer. Independent variables: macadamia nut oil concentration 1%, 5% and 10%, combination with oxybenzone and octyl methoxycinnamate. Bound variable: SPF. Parameters: SPF value, pH value, Homogeneity, Irritation. This research was conducted from July 2019 to August 2019 at the Cosmetology Laboratory and Physical Pharmacy Laboratory, Faculty of Pharmacy, University of North Sumatra. The tools used are laboratory glassware, UV-Vis spectrophotometer (Shimadzu UV 1800), analytical balance (Boeco Germany), pH meter (Hanna Instruments), dropper pipette, conductimeter, aluminum foil, parchment paper, tissue, mortar., stamper, spatula and water bath. 1,3-butylene glycol, Distilled water, Alcohol 96%, Stearic acid, Disodium Edetate, Triethanolamine, Oxybenzone, Octyl methoxycinnamate, Petrolatum, Cetyl alcohol, Glyceryl monostearate, Sodium metabisulfite, Nipagin, and Macadamia nut oil.

Work procedures Formula

Lotion preparation formulations; Cream base preparation based on a modified standard formula.

The Standard Formula [16] is as follows:

R/ 1,3-butilen glikol	7%
Titanium Dioksida	5%
Disodium Edetat	0,05%
Trietanolamin	1%
Oktil metoksisinamat	5%
Oksibenzon	2%
Squalane	10%
Petrolatum	5%
Stearil alkohol	3%
Asam stearat	3%
Gliseril monostearat	3%
Etil poliakrilat	1%
Antioksidan	q.s
Pengawet	q.s
Parfum	q.s
Air suling ad	100%

Modified Formula

R/ 1,3-butilen glikol	7%
Disodium edetat	0,05%
Trietanolamin	1%
Oktilmetoksisinamat	5%
Oksibenzon	2%
Petrolatum	5%
Setil alkohol	3%
Asam stearat	3%
Gliseril monostearat	3%
Natrium metabisulfit	0,1%
Nipagin	0,1%
Air suling ad	100%

Modified Formula with Modified Oil Concentration

Tabel 3.1 1 to 5. composition formula

Substance	Concentration (%)				
	F1	F2	F3	F4	F5
Macadamia nut oil	-	-	1	5	10
Oksibenzon	-	2	2	2	2
Oktil metoksisinamat	-	5	5	5	5
Cream base	100	93	92	88	83

Note:

F1 : Blanko (creame base)

F2 : Creame base + Oksibenzon 2% + Oktil metoksisinamat 5%

F3 : Oksibenzon 2% + Oktil metoksisinamat 5% + Macadamia nut oil 1%

F4 : Oksibenzon 2% + Oktil metoksisinamat 5% + Macadamia nut oil 5%

F5 : Oksibenzon 2% + Oktil metoksisinamat 5% + Macadamia nut oil 10%

Making Sunscreen Cream Preparations

The cream base that will be made is an oil-in-water (o/o) emulsion type. The materials needed include the water phase and the oil phase. The aqueous phase consisted of 1,3-butylene glycol, disodium edetate, nipagin, sodium metabisulfite, triethanolamine, distilled water. While the oil phase consists of stearic acid, glyceryl monostearate, cetyl alcohol, oxybenzone and petrolatum. The material is weighed first, then the oil phase is melted on a water bath using an evaporating dish at a temperature of ± 70-75^{o}C (mass I). The aqueous phase is dissolved in distilled water which has been heated (mass II). Mass II was put into a preheated mortar and then slowly added mass I into it while being crushed constantly at a temperature of ± 70^{o}C until a cream mass was obtained and octylmethoxycinnamate was added, ground until homogeneous, then added soybean oil and crushed cream until homogeneous [16].

Evaluation of Preparation Quality

Homogeneity Check; A certain amount of the preparation is smeared on a piece of glass or other transparent material; it must show a homogeneous arrangement and no coarse grains are seen [15].

pH measurement

Determination of the pH of the preparation is done using a pH meter. The instrument was first calibrated using a neutral standard buffer solution (pH 7.01) and an acidic pH buffer solution (pH 4.01) until the instrument showed the pH value. The electrodes were washed with distilled water, then dried with a tissue. The sample was made in a concentration of 1%, that is, 1 gram of the preparation was weighed and dissolved in 100 ml of distilled water and then the electrode was immersed in the solution. Let the tool show the pH value until it is constant. The number shown by the pH meter is the pH of the preparation.

Irritation Test volunteers

Irritation test is carried out by applying the test preparation to normal human skin to determine whether or not irritation occurs on the skin. The technique used in this irritation test is an open patch test on 12 volunteers with the following criteria [15]:

1. Healthy women
2. Age between 20-30 years old
3. There is no history of disease related to allergies
4. Willing to volunteer

This experiment was conducted using the highest concentration of soybean oil, namely 10%. The open patch test was carried out by applying the test preparation to a circle with a diameter of 3 cm, carried out on the elbow crease area and left open for approximately 24 hours, observing the skin reaction that occurred. The reaction observed was the occurrence of erythema, papules, vesicles or edema. The signs for noting patch test reactions [15] are as follows:

1. No reaction 0
2. Erythema +
3. Erythema and papules ++

4. Erythema, papules and bubbles (vesicles) +++
5. Edema and bubbles (vesicles) ++++.

Determination of SPF value

Measurement of the SPF value of a sunscreen preparation can be done in vitro. The method of measuring the SPF value in vitro is generally divided into two types. The first type is to measure the absorption or transmission of UV radiation through a layer of sunscreen product on a quartz plate or biomembrane. The second type is to determine the absorption characteristics of the sunscreen using spectrophotometric analysis of the diluted sunscreen solution tested with a spectrophotometer.The SPF value is calculated using the Mansur equation because it specifically calculates absorbance at UVB wavelengths, as we know that SPF only shows protection against UVB rays, but when measurements are made up to 400 nm wavelengths as additional information about sample absorption up to that wavelength.The absorption spectrum of the sample was obtained using a UV-Vis spectrophotometer at a wavelength of 290-400 nm with 96% alcohol as a blank, the absorption value was recorded every 5 nm interval at a wavelength of 290-320 nm and an interval of 10 nm at a wavelength of 320-400 nm. The absorption value obtained is multiplied by EE x I for each interval. The value of EE x I for each interval can be seen in Table 3.2. The number of EE x I obtained is multiplied by the correction factor and finally the SPF value of the tested sample is obtained.

Information:

CF = Correction factor

EE = Erytemal Effect Spectrum

I = Intensity Spectrum from the Sun

Abs = Absorbance of the sample

Table 3.2. Values of EE x I (Erythmic effect spectrum x intensity spectrum from the sun)

Wavelength (nm)	EE x I
290	0,0150
295	0,0817
300	0,2874
305	0,3278
310	0,1864
315	0,0839
320	0,0180
Total	1

The value of EE x I and the correction factor is a constant where the value of EE x I from a wavelength of 290-320 nm and every difference of 5 nm and a correction factor of 10 has been determined by Sayre et al (1979), as in Table 3.2 above.

Data analysis

Measurements were carried out with the same treatment 6 times for each formula. To find out the significant difference in SPF values between formulas, a statistical test was performed using the ANOVA (Analysis of Variance) method with the SPSS (Statistical Package for the Social Sciences) program with a 95% confidence level.

IV. RESULT AND DISCUSSION

Sunscreen Cream Making

Sunscreen cream preparations were made using a standard sunscreen cream formula [16], the formula was modified with the addition of macadamia nut oil as an active ingredient and without the use of titanium dioxide. The concentrations of macadamia nut oil used were 1%, 5%, and 10%. The color of the sunscreen cream produced in Formula 1 is white, while Formula 2 to Formula 5 (with the addition of oxybenzone and octyl methoxycinnamate and various concentrations of macadamia nut oil) is white.

Determination of Physical Quality of Preparations

The homogeneity test is carried out by applying the preparation to a piece of glass or other transparent material, the preparation must show a homogeneous arrangement and no coarse grains are seen

[15]. From the experiments conducted on all the formulas of this sunscreen cream, no coarse grains were obtained on the glass chips.

pH Value Measurement

The stability of the cream can also be seen from the pH value obtained by the preparation during storage. The results of the average pH measurement of the cream preparations made can be seen in Table 4.1 as follows:

Table 4.1. Initial pH results of sunscreen cream preparations when finished

Formula	pH			
	I	II	III	Average
F1	6,9	6,9	6,9	6,90
F2	7	7	6,9	6,97
F3	6,9	7	6,8	6,9
F4	7	6,9	6,9	6,93
F5	6,9	6,8	6,9	6,87

Information:

F1 : blank (cream base)

F2 : Cream base + Oxybenzone 2% + Octyl methoxycinnamate 5%

F3 : Oxybenzone 2% + Octyl methoxycinnamate 5% + Macadamia nut oil 1%

F4 : Oxybenzone 2% + Octyl methoxycinnamate 5% + Macadamia nut oil 5%

F5 : Oxybenzone 2% + Octyl methoxycinnamate 5% + Macadamia nut oil 10%

From Table 4.1 it can be seen that macadamia nut oil shows a pH range that corresponds to the physiological pH of the "acid coat" of the skin, which is 4.5-7.0 so there is no risk of causing negative reactions on the skin.

Irritation Test results

This test is carried out to determine the presence or absence of an irritation reaction, so a skin irritation test is carried out, namely a patch test. Patch test is an irritation test carried out for the purpose of knowing whether the test preparation causes irritation or not [15]. The patch test was carried out for ± 24 hours and then the reaction was observed.

Table 4.2. Volunteer skin irritation test data

Volunteer	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Response	0	0	0	0	0	0	0	0	0	0	0	0

Remarks:

No reaction	0
Erythema	+
Erythema and papules	++
Erythema, papules and bubbles (vesicles)	+++
Edema and bubbles	++++

Based on the results of irritation tests carried out on volunteers above, Formula 5 did not give an irritating reaction so it was safe to use. So, it can be concluded that F1 to F5 also do not cause irritation to the skin and it can be said that all sunscreen cream preparations are safe to use.

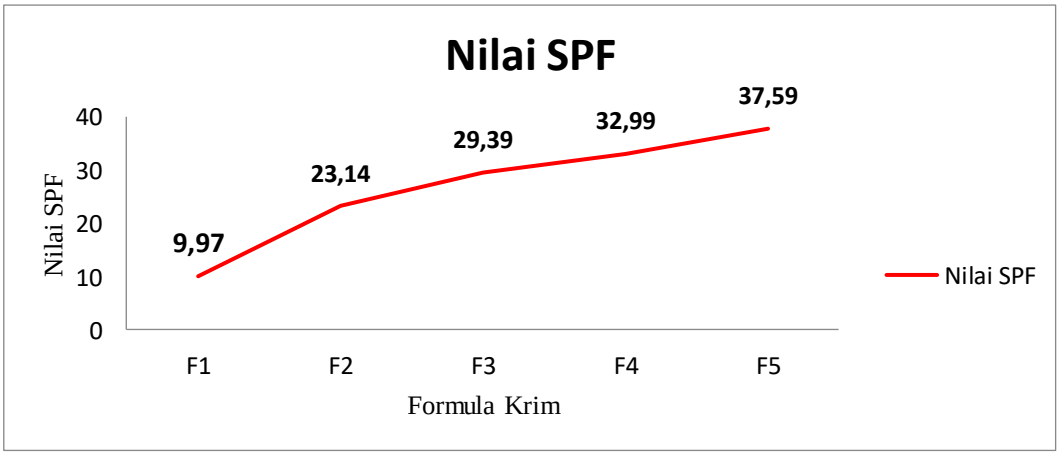
SPF Value Determination Results

The determination of the SPF value was carried out in vitro using a UV-Vis spectrophotometer by dissolving the cream preparation in a solvent and measuring and obtaining absorbance. The absorbance of each preparation is then entered into the calculation of the Mansur equation. The results of the calculation of the Mansur equation can be seen in the Appendix.

Table 4.3. The results of the average value of the Sun Protection Factor (SPF) and its category

Formula	SPF value						AVG SPF value	SPF Category
F1	9,98	9,98	9,97	9,96	9,98	9,96	9,97	Maximum
F2	23,43	22,91	22,97	23,05	23,44	23,01	23,14	Ultra
F3	29,18	29,54	30,26	29,24	29,1	29,05	29,39	Ultra
F4	32,51	32,7	32,31	32,38	32,5	35,54	32,99	Ultra
F5	37,54	37,92	37,17	37,36	38,09	37,46	37,59	Ultra

Figure 4.1. Graph of the effect of macadamia nut oil concentration on the SPF value of sunscreen cream preparations.



The results of the calculation of the value of the sun protection factor (SPF) refers to the Mansur method, it can be concluded that the higher the concentration of macadamia nut oil used, the higher the SPF value obtained. Meanwhile, the categories of sun protection factors [12] according to Wasitaatmadja (1997) are as follows:

1. Minimum, if the SPF is between 2-4
2. Medium, if the SPF is between 4-6
3. Extra, if the SPF is between 6-8
4. Maximum, if the SPF is between 8-15
5. Ultra, when the SPF is more than 15

From Table 4.3 and Figure 4.1 it can be seen that F1 (blank/cream base) has a value of 9.97 where this SPF value indicates a protective effect against UV-B rays. This is because the value for minimal protection against UV-B rays is 2. Oxybenzone and octyl methoxycinnamate are good UV B absorbers. These two active substances are the most widely used ingredients in sunscreen preparations worldwide [22].The addition of macadamia nut oil also increased the SPF value significantly when compared to F1 and F2. This is because macadamia nut oil contains vitamin E which acts as an antioxidant. Vitamin E is very effective against free radical damage caused by UV-B rays. Vitamin E absorbs strongly in the UV-B region of 280-320 nm. It can therefore act as a photoprotective sunscreen on skin cell membranes. Alpha-tocopherol and its acetate derivatives have been shown to act as UV sunscreen photoprotectants by scavenging mechanisms of free radical reduction [28].Topical use of vitamin E can reduce erythema, skin cancer risk, and premature skin aging in rat skin irradiated with ultraviolet light. Topical use of vitamin E also prevents DNA damage that triggers skin cancer due to ultraviolet radiation on rat skin. The photoprotective properties of vitamin E have also been shown to inhibit melanogenesis in the skin [29].

Statistical Test Results

After statistical testing of the SPF value of the preparation using One Way Anova, a significance value of 0.000 was obtained, it can be concluded that there is a significant difference with a probability of less than 0.05 between each formula with differences in the concentration of macadamia nut oil added. Based on the results of post-Hoc testing using the Tukey method, there are significant differences in SPF values between each formula with the addition of macadamia nut oil in different concentrations. F5 with macadamia

nut oil concentration of 10% gave the highest average SPF value when compared to other formulas, which was 37.59. In this study it can be concluded that the greater the concentration of macadamia nut oil added, the greater the SPF value obtained. This shows that macadamia nut oil can increase the SPF value of sunscreen preparations combined with oxybenzone and octyl methoxycinnamate.

V. CONCLUSION

The addition of macadamia nut oil can increase the effectiveness of the combination of oxybenzone and octylmethoxycinnamate sunscreen preparations in cream preparations, where the average SPF value of F1 (blank) is 9.97; F2 (blank + Oxybenzone 2% + Octyl methoxycinnamate 5%) has an average SPF value of 23.14; F3 (1% macadamia nut oil) has an average SPF value of 29.39; F4 (5% macadamia nut oil) has an average SPF value of 32.99; and F5 (10% macadamia nut oil) has an average SPF value of 37.59.The addition of macadamia nut oil in various concentrations gave a significant difference in increasing the SPF value between each formula combined with oxybenzone and octylmethoxycinnamate.It is recommended for further researchers to test the effect of adding macadamia nut oil in sunscreen lotion formulas so that the results can be compared. And conduct an initial medical check-up on volunteers before testing the lotion.

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