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Formulation and Physical Evaluation of Sunscreen Cream with Methanol Extract of *Eucheuma cottonii*

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Abstract

Seaweed has been widely used as a traditional medicinal ingredient by the community for generations. One species of seaweed, *Eucheuma cottonii*, is known that contains many antioxidant compounds. The antioxidant in seaweed is mainly in the form of polyphenolic antioxidative compounds, especially flavonoids. Flavonoid and tannin are two compounds that perform as antioxidant activity and have been considered as potential sunscreen ingredients. The purpose of this study were to make sunscreen cream preparations with the addition of *Eucheuma cottonii* extract, to get the best formulation of *E. cottonii* extract in sunscreen cream, to determine the physico-chemical quality of the sunscreen cream and to analyze the sensory quality of sunscreen. The test performed used in this study include SPF (Sun Protection Factor) value test, homogeneity test, pH test, viscosity and sensory test. The data were statistically analyzed using one-way ANOVA SPSS version 21.0. The best concentration of *E. cottonii* extract that is efficient for sunscreen formula is F3 i.e 3.5 g (3.6%) of extract. Physical evaluation of sunscreen cream showed that all three cream (F1, F2, and F3) had a good formula. The pH value, viscosity and homogeneity test results met the requirements for sunscreen standards. The SPF value of three sunscreen formula respectively 3, 4, and 6, which provides a fairly good protective effect on skin. The sensory test results showed that the F3 sunscreen had the best appearance, color, texture and aroma.

INTRODUCTION

Skin is one of human organs that covers the surface of the body and has a function as protector from ultraviolet (UV) radiation. Ultraviolet rays from the sun damage the skin and causes such as redness, bleeding, aging and increase the risk of skin cancer. On the other hand, the skin has its natural protection system against the effects of sunlight, but it is not effective to prevent excessive sun exposure (Yanuarti, 2017). Therefore additional protection, such as sunscreen cream, is needed.

Eucheuma cottonii L. has the potential as an active ingredient in sunscreen cream. The active compouns in this seaweed include flavonoids, hydroquinone phenols and triterpenoids are supposed to be potential compounds for sunscreen cream. The *E. cottonii* also contains proteins, lipids, carbohydrates, α-tocopherol, minerals, vitamin C, and vitamin E which can synthesize mycosporine

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compounds (MAAs) which play important role in UV ray absorption (Fahrudin, 2017). Seaweed is commonly used in the cosmetic manufacture in the form of carrageenan for topical lotion and gel soap products and in the form of seaweed extract for sunscreen cream (Fahrudin, 2017). The objectives of this study were to make sunscreen cream preparations with the addition of *E. cottonii* extract, to get the best formulation of *E. cottonii* extract in sunscreen cream, to determine the physico-chemical quality of the sunscreen cream and to analyze the sensory quality of sunscreen.

MATERIALS AND METHODS

Tools and materials

The tools used in this study included UV-Vis spectrophotometer Biochrom, analytical balance, stirrer spoon, hot plate stirrer, pH meter, and viscometer Brookfield and other laboratory glassware. The materials include semi-wet *E. cottonii* seaweed, methanol, emulgade, stearic acid, cetyl alcohol, liquid paraffin, glycerin, TEA, methyl paraben, essential oil, and aquades. The base formula according to fahrudin (2017) i.e 8 g of emulgade, 4 g of stearic acid, 2 g of cetyl alcohol, 2 g of liquid paraffin, 2 g of glycerin, 1 g of TEA, 0.2 g of metyl paraben, 0.1 essential oil, and 74 g of aquadest. The weight of seaweed extract added into sunscreen base cream can be seen in Table 1.

Table 1. Sunscreen Cream Ingredients

Ingredient	Formula (grams)			
	F0	F1 (1.6%)	F2 (2.6%)	F3 (3.6%)
Seaweed extract	0	1.5	2.5	3.5
Base	93.3	93.3	93.3	93.3

Preparation of *Eucheuma cottonii* extract

Semi-wet seaweed is cleaned in running water to remove dirt and adhering salt, this step is done repeatedly. The clean seaweed is then soaked for 5 days to remove the remaining salt. During the soaking process, the seaweed is washed and the soaking water is replaced with clean water twice a day (morning and evening). The soaked seaweed is then chopped to reduce its size and to make it easier for grinding process. The chopped seaweed is dried under the sun for 5 days in the hot weather or 7 days in the cloudy weather. The dried seaweed is then cut into smaller pieces. One hundred grams of dried seaweed is extracted using 1000 ml of methanol 96% as solvent for 3 × 24 hours in a closed container with occasional stirring (Fahrudin, 2017).

Production of sunscreen cream

The production of sunscreen cream begins with weighing all the ingredients in Table 1. The process is divided into three phases i.e. oil phase, water phase and the refinement phase. The oil phase consists of emulgide, stearic acid, cetyl alcohol and liquid paraffin and the water phase consists of glycerin, TEA, and distilled water. The refinement phase consists of dry seaweed methanol extract, essential oil, and methyl paraben. The oil and water phase were heated separately at 70o C until all the ingredients are homogenous. The oil phase is heated to 70o C to melt all of the ingredient together then cooled down to 50 o C. The oil phase is poured into the water phase (m/a) and stirred until two phases form a creamy consistency then all the refinement phase ingredients added into it. The final product of sunscreen cream is packed in sample packs for further tests (Fahrudin, 2017).

Determination of SPF value

Determination of SPF value is done using UV-Vis spectrophotometer based on Pissavini *et al.* (2004). One gram of each sample is dissolved and mixed into 100 mL of methanol 96%. A total of 5 mL of the solution was transferred to a volumetric flask and added with methanol to the final volume 25 mL. Befote the test, spectrophotometer is calibrated using methanol 96%. The next step is testing the absorption of all samples in wavelength between 290-320 nm with an interval of 5 nm and using methanol 96% as the blank. The average of absorbance (Ar) from all the wavelength were recorded to calculate the SPF value (Equatipn 1) (Yulianti, 2016).

Table 2. EE x I values at a wavelength of 290-320 nm

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	1.0000

Calculation method:

1. The absorption value obtained is multiplied by the EE x I value for each wavelength which is shown in Table 3.
2. The absorption multiplication results and EE x I are added up SPF value of sample = the sum result is then multiplied by the correction factor whose value is 10.

Equation for SPF value:

$$SPF = CF \times \sum_{290}^{320} EE\ \lambda \times I \times Abs \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

How to calculate period of SPF, homogeneity, pH and viscosity test

Normal human skin will stand for 10 minutes under direct sun exposure, so the SPF number determines 10 times the skin can withstand the sun heat. For example, SPF 15 will provide the protection for 10 minutes x 15 = 150 minutes or 2.5 hours (Yulianti, 2016)**.**

The homogeneity test is carried out visually by smearing a portion of cream on a piece of glass or other transparent material. The cream must show a homogeneous composition and no coarse grains are visible.

The pH measurements were carried out using a pH meter that had previously been calibrated using 4.01 and 6.86 buffer solutions. Measurements were performed by directly dipping the pH meter electrode into the sample that has been diluted with distilled water, then waited for the number that appears on the pH meter to stabilize (Hamsinah *et al*. 2016).

Viscosity testing was carried out to determine the thickness of the sunscreen cream using *Brook field viscometer*. The tool is set to spindle number 4 with the speed of 60 rpm. Viscosity values are expressed in centipoise units (cPs) (Pratama *et al*. 2019).

RESULTS AND DISCUSSION

In this study, physical evaluation of preparations was carried out including Sun Protection Factor (SPF) using a UV-Vis spectrophotometer, homogeneity test, pH test, viscosity test.

Sun Protection Factor (SPF) Testing

The Sun Protection Factor (SPF) test aims to determine the ability of sunscreen to absorb radiation that hits the skin. SPF is a value that shows the ability of sunscreen to protect the skin from UV rays. Result of Table 3 shows that the SPF value of cream is higher along with higher concentration of seaweed extract. Higher SPF value means longer the protection against sun UV radiation on the skin. Based on this, the F3 formula has the longest protection period compared to the other formulas, with the addition of 3.5 g of methanol extract *E. cottonii*. Ultra violet rays are divided into 3 namely UV A (320-400 nm) which can cause skin browning, UV B rays (290-320 nm) which can cause erythema and premature aging, and UV C rays (200-290 nm) which can cause skin cancer (Probowati, 2015). Prevention of the harmful effects of UV rays can be done by using sunscreen.

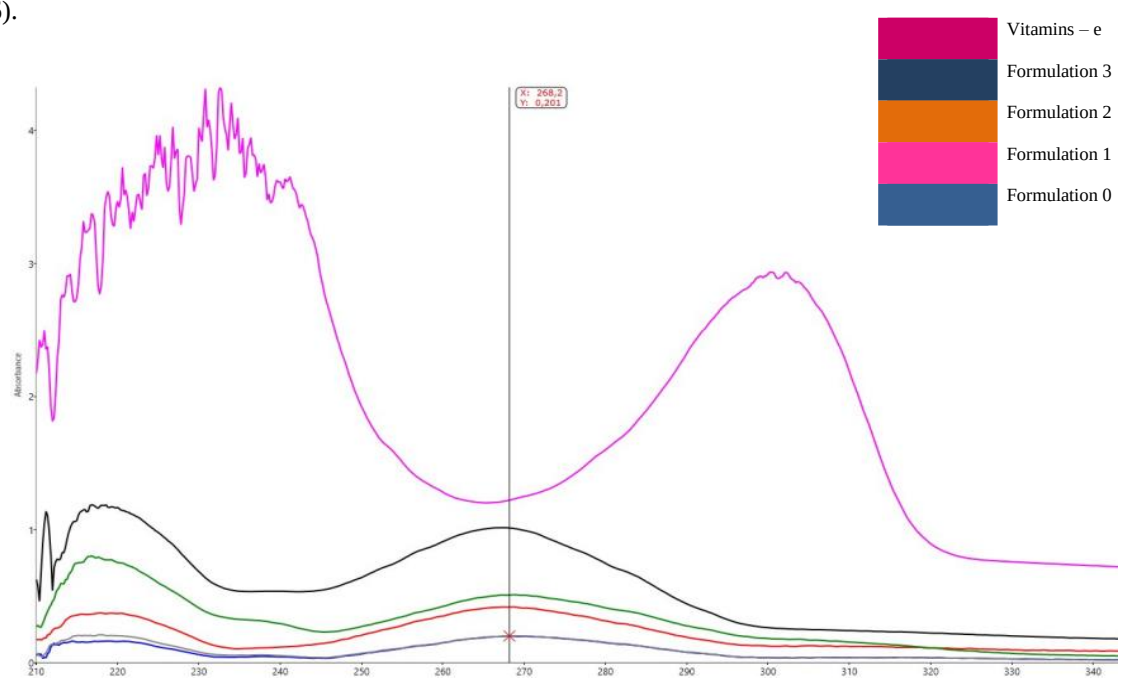

Figure 1. Ultraviolet absorption spectrum of sunscreen cream formulations

Sunscreen is a chemical skin protector that absorb at least 85% of sunlight. The sunscreen with the addition of *Eucheuma cottonii* extract can not only protect against UV A and UV B rays, but can also protect against UV C (Amelia, 2019). The ozone layer provides protection from UV rays. But greenhouse gases and pollutants have caused the ozone layer to deplete so that increase UV intensity which causes exposure to UV C rays to reach the earth. We can get exposure to UV C rays not only from sunlight but also from man-made lamps which cause burns on the skin.

Table 3. Calculation of Sun Protection Factor

Formulas	SPF value	Durability	Provision
F0	1	10 minutes	10 minutes
F1	3	30 minutes	10 minutes
F2	4	40 minutes	10 minutes
F3	6	60 minutes	10 minutes

Sunscreen cream with the addition of Eucheuma cottonii extract can protect from UV C even though UV C does not enter the earth because of the ozone layer, UV C is still very dangerous for the skin. Exposure to UV C in the short term can cause redness and inflammatory reactions such as skin irritation.

Skin sensitivity test

The sensitivity test for each group was carried out to 20 semi-trained panelists. This skin sensitivity test is carried out on the skin of the back of hand for 1 hour by checking at intervals of 30 minutes to see if irritation appears or not. The results of the observations showed that all preparations met the sensitivity test requirements because they did not show symptoms of redness on the skin of the back of the hand that had been smeared with the preparation so that the preparations were safe to use for the first 30 minutes or the next 30 minutes.

Table 4. Result of Sensitivity, Homogeneity, pH, and viscosity test.

Test	F0	F1	F2	F3
Sensitivity Test*	-	-	-	-
Homogeneity Test	Homogeneous	Homogeneous	Homogeneous	Homogeneous
pH	7.55	7.58	7,68	7.95
viscosity	3134 cps	3670 cps	3782 cps	3865 cps

Homogeneity Test

From the results of tests carried out on each preparation to see whether there are parts that are not mixed properly in the mixture. Based on the test results, cream F0, F1, F2 and F3 containing Eucheuma cottonii seaweed extract showed homogeneous result, seen as an even color and the absence of lumps in the preparation. The sample is said to be homogeneous if there is an even color equation and no different particles or lumps are found (Al Mansyur, Djajasastra, and Hanani, 2017).

pH test

The results of the pH test in the experimental groups F0, F1, F2 and F3 were in accordance with SNI for sunscreen i.e. 4.5-8.00. The pH test aims to evaluate the safety of the sunscreen cream so it does not irritate the skin. Therefore it is suspected that the addition of Eucheuma cottoni methanol extract has an effect on the increasing pH of sunscreen cream.

Viscosity test

The viscosity test aims to observe the consistency of the sunscreen cream. The resulst shows that the viscosity value of the F0 sample was 3134 cPs, the viscosity value of the F1 sample was 3670 cPs, the viscosity value of the F2 sample was 3782 cPs, the viscosity value of the F3 sample was 3865 cPs (Table 4). This shows that the viscosity value increases along with higher the concentration of Eucheuma cottonii seaweed extract added. According to applicable standards, viscosity value between 2,000 and 50,000 cPs is the ideal viscosity for cream preparations (SNI Sunscreen, 1996). So it can be said that preparations F0, F1, F2 and F3 meet the good viscosity standards.

CONCLUSION

Physical evaluation of sunscreen cream preparations showed that the three preparations with a concentration of 1.5 g, 2.5 g and 3.5 g had a good formula, namely the pH value met the requirements for pH value, viscosity and homogeneous preparations. *Euheuma cottonii* seaweed has the potential for sunscreen cream because it shows SPF value. i.e. SPF 3 for cream with concentration of 1.5 g, SPF 4 for cream with concentration of 2.5 g and SPF 6 for cream with concentration of 3, 5 g which provides a fairly good protective effect.

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