Potential of *Caulerpa racemosa* extracts as sunscreen creams

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Abstract. *Caulerpa racemosa* contains phenol compounds that have bioactivation as an active ingredient to capture UV radiation. The purpose of this study was to determine the potential of *Caulerpa racemosa* extract in some solvents. This study used an experimental method consisting of four treatments and five replications, namely Control: Commercial seaweed sunscreen labeled SPF 18, P1: Sunscreen cream with a concentration of 1% extract of *Caulerpa racemosa* n-hexane, P2: Sunscreen cream with a concentration of 1% extract of *Caulerpa racemosa* ethyl acetate, P3: Sunscreen cream with a concentration of 1% extract of *Caulerpa racemosa* ethanol 96%. The best treatment, in sunscreen cream with a concentration of 1% extract of *Caulerpa racemosa* ethyl acetate which has an SPF value of 2.32 ± 0.07 (the effectiveness of protective sunscreen at least 2-4), supported by the results of pH value (Day 0: 7.80 ± 0.11; Day 7: 7.82 ± 0.14). The best treatment hedonic test results, namely in sunscreen cream with a concentration of 1% extract of *Caulerpa racemosa* ethyl acetate which has an SPF value of 2.32 ± 0.07 (the effectiveness of protective sunscreen at least 2-4), supported by the results of pH value (Day 0: 7.80 ± 0.11; Day 7: 7.82 ± 0.14). The best treatment hedonic test results, namely in sunscreen cream with a concentration of 1% extract of *Caulerpa racemosa* ethyl acetate which has an SPF value of 2.32 ± 0.07 (the effectiveness of protective sunscreen at least 2-4), supported by the results of pH value (Day 0: 7.80 ± 0.11; Day 7: 7.82 ± 0.14). The best treatment hedonic test results, namely in sunscreen cream with a concentration of 1% extract of *Caulerpa racemosa* wine 96%, which has an appearance value of 7.13; odor 7.59; texture 6.42; and color 7.09.

1. Introduction

Sunscreen preparations are cosmetic preparations that are usually applied to the skin surface [1]. Sunscreen contains protective skin against sunlight so that UV light cannot enter the skin (preventing skin disorders due to radiation from the light) [2].

Ultraviolet (UV) light is a ray emitted by the sun that can reach the surface of the earth. UV rays are in the wavelength range of 200-400 nm. According to [3] the skin has a natural protection system against the effects of sunlight, but it is not effective to withstand excessive sun exposure, therefore additional protection is needed using cosmetic products.

Sea wine (*Caulerpa racemosa*) is a type of green algae that lives in several Indonesian waters. The ability of *Caulerpa racemosa* to ward off free radicals because they contain folic acid, thiamine, and ascorbic acid [4]. According to Ridhowati [4] *Caulerpa racemosa* contains phenol compounds as non-nutritional components. This component is thought to function as an antioxidant [4].

According to Yanuarti [5] stated that bioactive phenol compounds can act as active ingredients of solar dust and can increase the SPF value of sunscreen creams. In addition to phenol compounds, there is a chromophore group which has the ability to absorb UV light waves thereby reducing its intensity to the skin [6]. Based on this, it is necessary to use seaweed extract *Caulerpa racemosa* with several solvents. The extracts can be applied as an active ingredient in sunscreen preparations.
2. Methodology

2.1. Research tools
The tools needed in 5L dark glass bottles, aluminum gauze, 1000 ml (HERMA), beaker glass (AGC IWAKI APROX), digital scales, spoons, iron spatula, Petri dish (ANAMBRA), rotary evaporator (HANSHIN HS-2005S HAHNVAPOR), UV / Vis spectrophotometer, Spectro cuvette, 0.5-5 mlcircopipet (EPPENDORF RESEARCH PLUS BRAND), hot plate, large porcelain cup, water bath, cosmetic cream pot, vortex, and pH meter (EUTECH Instruments).

2.2. Research material
The research materials used were sea grapes fresh Caulerpa racemosa obtained from the Jepara Brackish Aquaculture Center (BBPBAP), redistilled technical n-hexane, redistilled technical ethyl acetate, and redistilled technical ethanol 96%, 5% FeCl₃ brand SAP extra pure grade, Aquadest, 0.039432 gr / 39.432 mg DPPH reagent (Sigma Aldrich), pro analysis ethanol (MERCK), emulgade, stearic acid, methyl paraben, acetyl alcohol, liquid paraffin, glycerin, triethanolamine (TEA), fragrance (Fragrance), and commercial creams obtained from stores located in Surabaya, East Java.

2.3. Research design
This study uses an experimental method. The research design used was a Completely Randomized Design (CRD). This study consisted of four treatments and five replications. The addition of extract concentrations on sunscreen creams refers to the [7] study with modifications, which are three dosage formulations including: Control (commercial seaweed sunscreen labeled SPF 18), P1 (Sunscreen cream with concentration 1% extract of Caulerpa racemosa n-hexane), P2 (Sunscreen cream with 1% concentration extract of Caulerpa racemosa ethyl acetate), and P3 (Sunscreen cream with 1% concentration extract of Caulerpa racemosa ethanol 96%).

2.4. Work procedure
2.4.1. Caulerpa racemosa extraction
Fresh Caulerpa racemosa is cleaned with running water. Next is drying and cutting to form a simplicia (powder). Samples were dried at room temperature before being used for analysis. The extraction process refers to [8] using n-hexane, ethyl acetate, and ethanol 96% with multilevel maceration methods.

500 g of Caulerpa racemosa was immersed in 2 L of n-hexane, ethyl acetate, and ethanol 96% solvent alternately for 3 days x 24 hours for each solvent. The solution is filtered using aluminum and cotton gauze to separate solid and liquid components. The solution obtained was separated between filtrate and supernatant using a rotary evaporator at a maximum temperature of 40°C until extracts were obtained in the form of paste or powder.

2.4.2. Qualitative test of phenol compounds phytochemical analysis method
Phytochemical analysis of phenol compounds refers to [9], which is as much as 0.05 gr of the sample put in a test tube. Then mixed with 2 ml ethanol. Then add 5% FeCl₃ as much as 2 drops. Positive reactions are indicated by the formation of green or blue or black-green.

2.4.3. Test antioxidant activity (2,2-diphenyl-1-picrylhydrazyl)
The antioxidant activity test in the extract with several solvents aims to determine the antioxidant activity (IC₅₀ value) contained in the sample so that it is assumed that if the content of the phenol compound is high then the antioxidant activity will be high. The antioxidant activity test refers to [10] which has been modified by dissolving DPPH 1 mM crystals weighing 0.039432 gr / 39.432 mg in 100 ml ethanol p.a. DPPH solution is put in a 100 ml volumetric flask and stored in a dark or slightly light space.

The main raw solution of the sample extract was made with a concentration of 1000 ppm. The raw solution of the parent extract was diluted using ethanol p.a with a solution concentration of 125 ppm, 250 ppm, 500 ppm, and 750 ppm, respectively. The extract solution of each concentration was
pipetted as much as 4.5 ml into a dark vial bottle, then 0.5 ml of DPPH 1 mM solution was added. The mixture between extract and DPPH solution was incubated at room temperature with dark conditions for 30 minutes. Then the absorbance is measured using a spectrophotometer with a wavelength of 517 nm [10]. Each concentration was carried out three times (triplo). For blank absorptions using ethanol solvent p.a. While the control absorbance was obtained from DPPH absorbance without being given extract sample solution.

2.4.4. Making Sunscreen Cream (Sunscreen)
The formulation of preparations and the process of making cream preparations refer to the [11] study which has been modified by [12]. The initial stage of making sunscreen creams begins with weighing all ingredients. Oil-soluble ingredients include 20 gr emulgade, 3 gr of cetyl alcohol, 3 ml of liquid paraffin, and 3 gr of stearic acid dissolved to homogeneously mixed at ±75°C, called the oil phase (preparation 1). Water-soluble materials include 3 ml of glycerin, 3 ml of triethanolamine (TEA), and 50 ml of distilled water dissolved to homogeneous at ±75°C, called the water phase (preparation 2).

Mixing (preparation 1) and (preparation 2) at ±75°C so that it is formed (preparation 3) in the form of a homogeneous cream. 0.2 gr of methyl paraben and 0.1 ml of fragrance are added to preparation 3 at ±40°C. Then added 1% extract of *Caulerpa racemosa* solvent n-hexane, ethyl acetate, and ethanol 96%.

2.5. Data analysis
Data obtained from the antioxidant activity test (IC₅₀) carried out data processing methods by regression of linear equations y = ax + b. Data from SPF and pH test results were analyzed using ANOVA (Variant Analysis) then continued with Duncan's Multiple Distance Test [13]. For data from the hedonic test results were analyzed using the Kruskal Wallis Test then carried out further tests with the Mann Whitney Test. Data analysis was performed using SPSS software and using a real level α = 0.05.

3. Result and discussions
3.1. Result
3.1.1. SPF and pH value

| Treatment                                      | SPF±SD     | Sunscreen Protection Category | pH±SD      | Day 0  | Day 7  |
|------------------------------------------------|------------|-------------------------------|------------|-------|-------|
| Control - Commercial Seaweed Cream Labeled SPF 18 | 8.44±0.37  | SPF 8-15 (Maximum Protection) [5] | 7.27±0.20  | 7.61±0.13 |
| P1 - Sunscreen Cream with 1% Concentration *Caulerpa racemosa* Extract n-hexane solvent | 1.03±0.02  | SPF 2-4 (Minimal Protection) [5] | 7.50±0.22  | 7.76±0.11 |
| P2 - Sunscreen Cream with 1% Concentration *Caulerpa racemosa* Extract ethyl acetate solvent | 2.32±0.07  | SPF 2-4 (Minimal Protection) [5] | 7.80±0.11  | 7.82±0.14 |
| P3 - Sunscreen Cream with 1% Concentration *Caulerpa racemosa* Extract ethanol 96% | 1.16±0.03  | SPF 2-4 (Minimal Protection) [5] | 7.58±0.37  | 7.61±0.02 |
solvent

Note: Different superscript letter notations show a comparison between treatments with significant differences (p < 0.05). However, the same superscript letters indicate that between treatments were not significantly different (p > 0.05).

Analysis of variance (ANOVA) showed that each additional treatment of *Caulerpa racemosa* extract in several solvents had a significant effect on the value of SPF sunscreen cream (p < 0.05). Table 1 shows the highest SPF value of sunscreen cream obtained on commercial seaweed sunscreen labeled SPF 18, which is equal to 8.44 and sunscreen cream with a concentration of 1% extract of *Caulerpa racemosa* ethyl acetate solvent, which is equal to 2.32. While the lowest SPF value was obtained on sunscreen cream with a concentration of 1% extract *Caulerpa racemosa* ethanol 96% solvent, which amounted to 1.16 and sunscreen cream with a concentration of 1% extract of *Caulerpa racemosa* n-hexane solvent, amounting to 1.03.

Analysis of variance (ANOVA) showed that each additional treatment of *Caulerpa racemosa* extract in several solvents had a significant effect on the pH value of sunscreen cream (p < 0.05). Table 1 shows the lowest average pH value found in commercial seaweed sunscreen labeled SPF 18. For the highest pH value found on sunscreen cream preparations with the addition of 1% concentration of extract of *Caulerpa racemosa* ethyl acetate solvent.

3.1.2. Hedonic value

![Hedonic Test Results](image)

**Figure 1. Hedonic Test Results**

The Kruskal-Wallis test results showed that each additional treatment of *Caulerpa racemosa* extract in several solvents had a significant effect on the hedonic test value of sunscreen cream on appearance, odor, texture, and color parameters (p < 0.05). So that the treatment given affects the level of preference of the panelists for sunscreen creams on these different parameters.

The appearance, odor, texture, and color parameters that have the highest value, namely on commercial seaweed sunscreen labeled SPF 18, and sunscreen cream with a concentration of 1%
extract *Caulerpa racemosa* solvent ethanol 96% which has a hedonic mean value of 6-7 which means rather like to like.

The appearance, odor, texture and color parameters of sunscreen cream with a concentration of 1% extract of *Caulerpa racemosa* solvent n-hexane and ethyl acetate have an average value of 6 which means rather like.

### 3.2. Discussion

The highest SPF value was obtained from commercial seaweed sunscreen labeled SPF 18 and sunblock cream with a concentration of 1% *Caulerpa racemosa* extract ethyl acetate solvent. According to [14] that the SPF content is found in samples that are semi polar and polar, generally found in vegetable sources such as seaweed.

Factors that influence the determination of SPF values, namely the use of different solvents, combinations and concentrations of sunscreens, emulsion types, effects and interactions of carrier components such as esters, emollients, and emulsifiers used in formulations, carrier interactions with the skin, addition of active ingredients, and pH system [15]. SPF and antioxidant activity can increase with the presence of high phenolic compounds in the extract [16].

The pH value of sunscreen cream in the study is in accordance with [17] which states that the recommended pH of sunscreen cream products ranges from 4 to 8. A good cream must have a pH that is in accordance with the pH of the skin, which is 4.5 – 8 [18].

If the preparation has a pH lower than the physiological pH of the skin it will cause an irritation reaction. Whereas if the sunscreen cream has a higher pH than the physiological pH of the skin it will cause dry and scaly skin [19]. Changes in the pH of sunscreen cream preparations during storage indicate a lack of stability of the preparation during storage which is affected by components in the formulation which are degraded by high temperatures when making or storing which produce acids or bases. In addition, changes in pH are also caused by environmental factors such as temperature and poor storage [20].

The more active compounds contained, the more acidic pH is. It is assumed that the greater the SPF value, the lower the value of a pH, the greater the value of the antioxidant activity. That is because the lower the value of a pH, the more H⁺ is free. This H⁺ can regenerate antioxidant compounds by binding to phenoxy radicals then reshaping antioxidant compounds [21]. The phenol compounds in the extract have acidic properties, so they tend to easily release H⁺ ions from their hydroxyl groups (–OH).

This is also supported by [22] that the antioxidant activity of natural compounds is bound to a relationship with their reducing strength because of the level of donating hydrogen.

The hedonic test is a test that uses panelists to judge based on their level of preference. Panelists in the hedonic test responded to the likes and dislikes of the appearance, odor, texture, and color parameters of the product of this study, namely sunscreen.

Appearance is a parameter to see the effectiveness of whether or not the mixing of ingredients in the product is evenly distributed [23]. The panelist’s favorite values for cream appearance ranged from 6.19-7.15 which showed an influence on the panelist’s preference for cream appearance parameters. Where the more polar a solvent is used, it will result in the consistency of cream products that are close to their appearance such as commercial cream products (commercial seaweed sunscreen labeled SPF 18) [11]. The factors that affect the consistency of the cream, namely the mixing technique that is done, and the tools used in the manufacturing process [24].

Fragrance or fragrance can duplicate the desired odor [11]. The higher the percentage of aromatic compounds, the longer the intensity and aroma are obtained. The panelist's favorite value for the odor of the cream ranged from 6.07-7.29 which showed that there was an influence on the level of preference of the panelists on the parameters of cream odor. Where the more polar a solvent is used, it will produce the smell of cream products that are increasingly preferred by panelists. According to [25] that a pleasant and easily recognizable odor will generally be preferred over an odor that is not recognized because it is rarely found in cream products.
The texture is a very important parameter in a cosmetic product. This type of emulsion affects the texture of sunscreen creams and the level of consumer preference for the product. Cream with an oil in water emulsion base (M/A) has more comfortable properties and tends to be preferred, because it is not sticky, does not feel heavy when used, and is easier to absorb on the skin [26]. The panelists’ favorite values for the texture of sunscreen cream ranged from 6.06-6.42 which showed that there was an influence on the level of preference of the panelists on cream texture parameters. The basic ingredient in making a cream, which uses the type of emulate M/A, which functions as an emulator which can reduce the interface tension of the oil phase and water phase, thereby increasing the stability of the preparation in the cream and affect the texture produced [27].

4. Conclusion

The addition of Caulerpa racemosa extract to several potentially low solvents as a sunscreen cream preparation material. The best treatment, namely on sunscreen with a concentration of 1% extract of Caulerpa racemosa ethyl acetate solvent which has an SPF value of 2.32 (the effectiveness of protective sunscreen cream at least 2-4).

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