
Testing of UV Protection Activity, SPF Determination, and Irritation Assessment of Coastal Vegetation Ipomoea Pes-Caprae

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ABSTRACT: Total solar radiation contains approximately 10% ultraviolet light. Ultraviolet rays have benefits such as providing warmth, light, and helping to synthesise vitamin D3. However, ultraviolet rays can also have negative impacts on the skin such as browning, hyperpigmentation, erythema, and premature ageing. Natural sunscreens with high SPF are useful in reducing the negative effects of ultraviolet rays. This study aims to determine anti-UV activity, SPF value, and assessment of human skin irritation or allergy to sunscreen cream from Ipomoea pes-caprae leaves. Anti-UV activity test and SPF value determination were carried out in vitro using UV-Vis Spectrophotometry. Irritation testing was conducted using the patch test method for 6 hours. The results showed that Ipomoea pes-caprae has anti-UV-A and anti-UV-B activities. Ipomoea pes-caprae leaf extract provides extra protection at a concentration of 2000 ppm. The irritation test of the cream on human skin found no skin abnormalities such as edema, urticaria, irritation and edema.

KEYWORDS: Anti-UV; Ipomoea pes-caprae; Sunscreen; Vegetation on Coastal; SPF

INTRODUCTION

Indonesia is a tropical country because it is located around the equator so that throughout the year it gets sunlight. Total solar radiation contains approximately 10% UV (ultraviolet) light. According to the wavelength, there are three types of UV light, namely UV-A (315-400 nm), UV-B (280-325 nm) and UV-C (100-280 nm) (Amnuait and Boonme, 2013). UV light has benefits for human life, including providing warmth and light and helping to synthesize and release vitamin D3 in the skin (Holick et al., 1980). Exposure to UV-A and UV-B rays can cause skin browning, premature aging, hyperpigmentation, decreased skin elasticity, erythema, and sunburn (Amnuait and Boonme, 2013). UV-C rays have carcinogenic activity, so the result of exposure is skin damage (Geraldine et al., 2018).

Coastal vegetation is a group of plants that inhabit tidal areas to land areas or islands that are still influenced by the sea. In general, coastal vegetation is divided into three, namely true mangroves, associated mangroves and non-mangrove coastal vegetation (Noor et al., 1999 in Kurniasari, 2020). Associated mangroves are non-timber plants or vines that live in the coastal environment and also in mangrove forests. Mangrove associations have ecological functions as bioremediation and coastal stability (Zaman et al., 2014). Coastal vegetation found in Sario Tumpaan Beach, Sario District, Manado City is Ipomoea pes-caprae. Ipomoea pes-caprae grows well in coastal areas with extreme environmental conditions, namely high salinity levels, low nutrients in the soil, exposure to sunlight, high soil temperatures, and frequent disturbances such as bad weather, storms and hurricanes (Devall and Thien, 1992). I. pes-caprae leaf extract contains secondary metabolite compounds flavonoids, saponins, tannins, and alkaloids (Andayani and Nugrahani, 2018). Flavonoid compounds are compounds that have strong antioxidant activity, can protect the skin from UV damage by capturing free radicals (Bonina et al., 1996).

WHO recommends the use of sunscreen as an early preventive measure to protect the skin from UV exposure (Suryantari et al., 2019). Sunscreens made from natural ingredients and having a high SPF will be very beneficial (Purwaningsih et al., 2015). This study aims to determine the anti-UV activity, SPF value, and assessment of human skin irritation or allergy to sunscreen cream from Ipomoea pes-caprae leaves.

METHODS

The research was conducted at the Marine Biotechnology and Pharmaceuticals Laboratory, Faculty of Fisheries and Marine Sciences, Sam Ratulangi University and the Integrated Laboratory Unit of Sam Ratulangi University. The materials used were I.

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pes-caprae leaves taken from Sario Tumpaan Beach, Sario Subdistrict, Manado City with coordinates 1°28'5.07" Northern Latitude 124°49'47.85" East Longitude.

Sample Identification

Sampling of fresh *I. pes-caprae* leaves was carried out around the coast of Sario Tumpaan, Sario sub-district, Manado city. Leaves were collected and put into plastic samples. Identification of coastal vegetation leaf samples was carried out by observing morphology (leaf shape, leaf size, stem shape, and stem color) and adjusted to the Mangrove guidebook for Southeast Asia (Giesen et al., 2007).

Sample Preparation

The collected *I. pes-caprae* leaf samples were washed thoroughly to remove dirt, chopped and drained. The leaves were then dried using an oven at temperature 40 for 1 day. The leaves were blended until smooth for ± 1 minute, then weighed to determine the weight (Ali, 2015; Otay et al., 2022).

Sample Extraction

Extraction of *I. pes-caprae* leaves was carried out by maceration method using ethyl acetate solvent. Simplisia was put into a plastic bottle then added ethyl acetate solvent with a ratio of leaves and solvent 1: 6, closed and soaked for 324 hours protected from light and shaken once a day (Ali, 2015; Otay et al., 2022). The leaf extract was then filtered with filter paper to separate the filtrate from debris. The filtrate was evaporated using a 40°C oven until the ethyl acetate evaporated completely and the crude extract was obtained (Otay et al., 2022). The crude extract was weighed to determine its weight.

Anti-UV Activity Test

Determination of the protective effectiveness of *I. pes-caprae* leaf extracts against UV light was carried out in vitro. Each leaf extract was dissolved with 95% ethanol. The cuvettes used in one reading were 2 cuvettes. First, the spectrophotometer was turned on, then the first cuvette was filled with 95% ethanol as a blank, while the second cuvette was filled with a solution of leaf extract to measure its absorption. Each cuvette is filled as much as ± 3 ml. The absorption value of the spectrophotometer at a wavelength of 200-400 nm was observed to determine the anti-UV activity of the sample.

Determination of SPF Value

SPF (Sun Protection Factor) is a general indicator to determine the effectiveness of a substance/product that is UV protective (Susanti et al., 2012). The method of measuring SPF value in vitro aims to determine the absorption characteristics of extract samples using spectrophotometric analysis of dilution solutions.

SPF value testing was carried out by dissolving each *I. pes-caprae* leaf extract in 95% ethanol, until a concentration solution of 500, 1000 and 2000 ppm was obtained. The reading of the absorbance of each extract concentration was carried out using a UV-Vis spectrophotometer at a wavelength of 290-320 nm with an interval of 5 nm and was carried out three times. After obtaining the average results of UV absorption in the extract, the SPF value was determined using the formula of Mansur et al. (1986) as follows

$$SPF = CF \times \sum EE \times I \times abs \quad 320$$

$$Description: \quad 290$$

CF: Correction Factor (=10)

EE: Erythema Effect Spectrum

I: Light Intensity Spectrum

Abs: Absorbance of sunscreen sample (milli absorbance units / mAU)

EE, I value at wavelengths of 290-320 nm

The results of the analysis to obtain the level of sunscreen ability of the sample extract are categorized based on the categories in Table 1 (Food and Drug Administration, 2023). According to research by skin experts, SPF 1 in sunscreen cream can protect the skin for 10-15 minutes before being burned by sunlight (Anessa, 2021).

Table 1. Level of sunscreen ability based on the determination of SPF value (Food and Drug Administration, 2023)

No	SPF	Category
1	2 - < 12	Low
2	12 - < 30	Medium
3	≥ 30	High

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Irritation Test

Irritation test is a test that aims to determine the feasibility of *I. pes-caprae* leaf extract as a sunscreen product preparation. The results of the irritation test in this study were consulted with Prof. dr. Jimmy Posangi, M.Sc., Ph.D., Sp.FK. Irritation testing was carried out using the patch test method on ten volunteers who met the following criteria (Pambudi et al., 2021), who had previously been examined by the requested doctor and had filled out an informed consent sheet: (1) Male and female aged more than 20 years, (2) Physically and mentally healthy, (3) No history of allergies. Formulation F1 is the positive control and formulation F2 as the negative control can be seen in Table 3. The two formulations were applied to the skin of the human arm for 6 hours. The reaction of the cream to the skin was observed during and after the test such as irritation, edema and erythema. Symptoms noted were rash or itching, swollen and raised skin areas, small red spots on the skin, itching, stinging, or burning sensations, and dry or cracked skin. Furthermore, an assessment was made based on the International Contact Dermatitis Research Group (ICDRG) Grading system in Lachapelle et al. (2012).

Table 2. Formulation of *I. pes-caprae* leaf extract cream preparation (Otay et al., 2022)

Ingredients	Ingredient Concentration (%)		Usage
	F1	F2	
<i>I. pes-caprae</i> leaf extract	1	-	UV protectant
Emulsifier	99	100	Cream base

RESULTS AND DISCUSSION

Sample Identification

The results of the identification of beach vegetation leaf samples obtained from Sario Tumpa Beach are *Ipomoea pes-caprae*. After knowing the type, leaf samples were taken as many as 50 leaves. *I. pes-caprae* plants grow vines and their leaves are bright green, look stiff, shiny and notched at the ends. The flower crown of *I. pes-caprae* has a funnel-like shape, purple in color and darker in color on the inner crown (Figure 1).



Figure 1. Types of beach vegetation at Sario Tumpa Beach. A = *Ipomoea pes-caprae* leaf; B = *Ipomoea pes-caprae* flower (Source: Personal documentation, 2023).

I. pes-caprae leaf extract showed an absorption peak at a wavelength of 278 nm with an absorbance value of 3.019 mAU (Figure 2), categorized as having anti-UV-B activity and an absorption peak at a wavelength of 325 nm with an absorbance value of 2.777 mAU categorized as having anti-UV-A activity. The first peak was able to absorb at a wavelength of 278 and began to decrease to a wavelength of 305 (2.723 mAU), then rose to the second peak at a wavelength of 325 and decreased further to a wavelength of 356 (2.217 mAU).

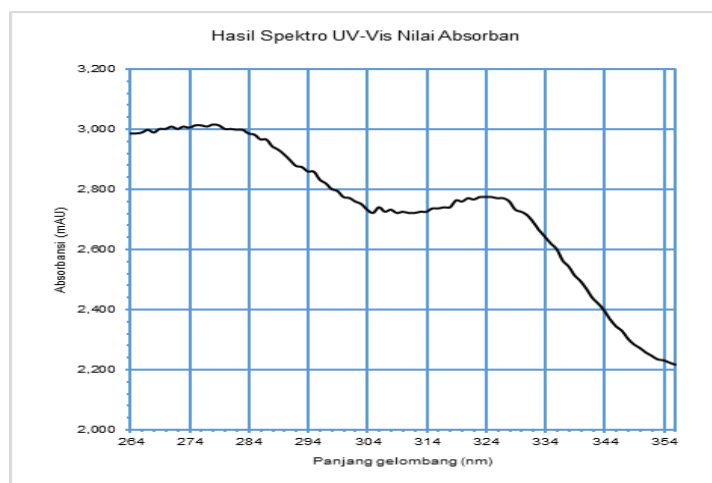


Figure 2. Graph of spectrophotometer test results of *I. pes-caprae* samples

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Plants exposed to solar UV radiation produce anti-UV compounds as a form of plant adaptation. These anti-UV compounds can be used as ingredients in sunscreen preparations that function to reduce the adverse effects of solar UV radiation. Based on the absorption of *I. pes-caprae* leaf extract samples, it has anti-UV activity so that the SPF value of the extract is determined.

Table 3. SPF values of *I. pes-caprae* leaf extracts

Sample	Concentration (ppm)	SPF Value	UV protection power category
I. pes-caprae leaf extract	500	10	Low
	1000	16	Medium
	2000	39	High

This study shows the results of absorbance values that have SPF values that increase proportional to the amount of ppm concentration of the test solution. Based on these data, the SPF value is categorized according to (Food and Drug Administration, 2023). The results obtained by calculating the formula Mansur et al. (1986) on the sample extract of *I. pes-caprae* leaves with a concentration of 500 produces an SPF value of 10 located in the SPF <12 category, namely protection from sunlight needed, at a concentration of 1000 has an SPF value of 16 which is included in the category of moderate protection, and extra protection is obtained at a concentration of 2000 with an SPF value of 39.

In tropical and subtropical countries it is recommended to use sunscreen with SPF 30 which aims to provide maximum protection against erythema and skin cancer (Poon and Barnetson, 2002). A sunscreen with an SPF value of 30 allows a person 30 × 5 minutes, which is 150 minutes or 2.5 hours without burning, and after that time, reapplication of sunscreen can be done (Sinala and Salasa, 2019). SPF values on sunscreens only indicate UV-B protection because SPF values are determined through tests of protection against sunburn caused by UV-B radiation. Since June 2011, sunscreens that pass the broad spectrum test can indicate that UV-A protection is present (U.S. Food and Drug Administration, 2023).

Sunscreen cream preparations containing 1% *I. pes-caprae* leaf extract have a concentration of 10,000 ppm, which means that in 10 grams of sunscreen cream from *I. pes-caprae* extract has an SPF value of around 160. The test cream was applied to the inner arm because this part was not disturbed when the participants performed activities during the test. Irritation testing used 10 test objects for 6 hours based on research conducted by Laras, et al. (2014) using 6 test objects for 4 hours because the number of 6 test objects is the minimum number of sample calculations and this number has met the level of sample representation (Sugandi and Sugiarto, 1993; Abadi, 2006 in Laras, et al., 2014).

The observation results of 10 participants of the patch test of *I. pes-caprae* leaf extract were not found reactions such as irritation, edema and erythema on the skin, this encourages further development regarding the manufacture of sunscreen from natural ingredients. The following tests were carried out on the skin of female participants (22 years old), information: K = negative control, IP = 1% *I. pes-caprae* cream .

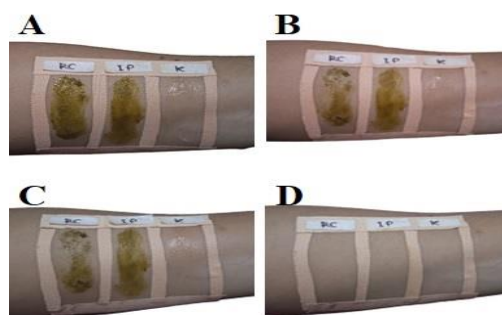


Figure 2. Irritation test of 1% cream of *I. pes-caprae* leaf extract. A = Condition of test arm irritation for 0 hours; B = Condition of test arm irritation for 3 hours; C = Condition of test arm irritation for 6 hours; D = Condition of arm after cleaning from test cream.

The results of irritation testing of sunscreen preparations on 10 skins of experimental objects did not fall into the category of skin disorders such as edema, urticaria, irritation, and erythema. The main characteristics of allergies are erythema and itching. Allergic skin disorders can be seen by the presence of inflammation that expands slowly and the boundaries of inflammation are not clear.

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CONCLUSION

Anti-UV activity testing on *Ipomoea pes-caprae* leaf extract showed protection from UV rays. *Ipomoea pes-caprae* leaf extract has an SPF value of 39 at a concentration of 2000 ppm, this SPF value provides extra protection based on the Food and Drug Administration index (2023). The irritation test of *Ipomoea pes-caprae* leaf cream found no skin abnormalities in the form of edema, urticaria, irritation and edema on human skin. *Ipomoea pes-caprae* leaf extract has the potential to be developed as a natural sunscreen for human skin use.

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