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THE IN VITRO TEST OF SUNSCREEN SUN PROTECTING FACTOR FROM KENCUR EXTRACT (*Kaempferia galanga* L.) : A POSTER AS A SUPPLEMENT FOR LEARNING NATURAL MATERIALS CHEMISTRY

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Abstract: This study aims to determine the sunscreen potential of kencur (*Kaempferia galanga* L.*)* rhizome extract in vitro by using UV-Vis spectrophotometer. Testing the sunscreen potential of kencur extract is done by calculating the *Sun Protecting Factor* (SPF) value. This research design uses quantitative methods. Quantitative methods are carried out to obtain quantitative data on the results of laboratory research as the content of learning supplement material. The learning supplement chosen in this study is a poster that includes an introduction, methodology for determining sunscreen potential and the results of determining sunscreen potential. The poster was then validated by three validators. The results of data analysis in this study are: (1) The average value of SPF with concentrations (125, 250, 375 and 500 ppm) is 9.0; 13.61; 14.63; 18.22 which shows that the highest SPF value of 18.22 includes ultra protection based on *Food and Drug Administration (*FDA) standards. (2) The results of validation by three validators obtained an average value of Aiken V index value = 0.84 with an average reliability level of R = 0.9675 which indicates that the posters developed are very valid and feasible to use.

Keywords: *In Vitro, Kencur, Sunscreen, SPF, UV-Vis Spectrophotometry, Poster*

Introduction

Indonesia as one of the tropical countries gets sunlight throughout the year. Sunlight rays have a negative impact on the body if exposed excessively [1]. Sunlight radiation consists of infrared light, visible light, and ultraviolet (UV) light consisting of UV-A (λ 320-400 nm), UV-B (λ 290-320 nm), and UV-C (λ 220-290 nm). The Earth is protected by an ozone layer that is able to absorb UV rays, thus reducing the negative effects caused by UV exposure. However, UV-A and UV-B can penetrate the ozone layer so that it can penetrate the skin [2].

UV exposure is one of the factors that can accelerate damage to human skin tissue. UV-A exposure can penetrate to the dermis layer, while UV-B only reaches the epidermis layer. The negative effects caused by UV exposure are sun burns, skin pigmentation, premature aging, and cancer. Chronic exposure to UV can form *reactive oxygen species* (ROS) such as hydrogen peroxide, superoxide anion, and hydroxyl radicals that can cause accelerated aging [3]. UV exposure is also one of the biggest contributors to the pathogenesis of skin cancer, which is a multifactor event.

Various ways can be done to protect the skin from UV exposure, one of which is by using *sunscreen*. The use of sunscreen is one of the efforts that can be made to protect the skin from adverse effects caused by UV radiation. *Sunscreens* are cosmetic ingredients that can physically or chemically inhibit UV rays from entering the skin [4].

Sunscreen has a mechanism of action by reflecting and refracting UV rays emitted by the sun [5]. The ability of a *sunscreen* to protect the skin by delaying erythema is expressed by the *Sun Protection Factor* (SPF) [6].

Plants contain natural substances that can be extracted and can act as a potential source of *sunscreen* because they are *photoprotective* [7]. This is associated with the fact that plants cannot avoid exposure to sunlight because plants need sunlight for the photosynthesis process. Even so, plants have a self-protection mechanism so that plants are not damaged. This gives a little idea about the ability of plants to protect the skin through compounds contained in plants in the form of bioactive compounds such as phenolic compounds and supported by the presence of compounds that are antioxidants [8].

The use of antioxidant substances can prevent various diseases caused by UV radiation, several classes of antioxidant active compounds such as flavonoids, tannins, anthraquinones, cinnamates and others have been reported to have the ability to protect against UV rays [9]. The potential of natural ingredients as *sunscreen is* owned by Kencur (Kaempferia *galanga* L.). There are several compound components contained in kencur including ethyl cinnamate, ethyl *p-methoxycinnamate*, *p-methoxystyrene*, karen, bomeol and paraffin. Ethyl *p-methoxycinnamate* is one of the compounds isolated from the kencur rhizome (*Kaempferia galanga* L). Ethyl *p-methoxycinnamate* is one of the main phytochemical contents of the kencur plant rhizome which is commonly used for cosmetics, food, intexidal and medicine [10]. Ethyl *p-methoxycinnamate* compounds are *sunscreen* compounds that absorb UV-B rays in the 290-320 nm range [11]. Kencur rhizome has an ethyl-p-methoxycinnamate content of 38.6% [12]. Based on the report, it can be used as an additional active ingredient in the manufacture of *sunscreen*.

Some of the processes of making *sunscreen* seem to have a connection to the CPL, CPMK and Sub-CPMK in the natural material chemistry course. The Graduate Learning Outcome (CPL) 3 imposed on the course and its

study materials reads "Structure, properties, changes, composition, reactions and synthesis of organic compounds, and their role in everyday life", then Course Learning Outcome (CPMK) M6 reads "Students are able to design strategies for separating natural material compounds from plants" and Sub-CPMK 12 "Explain the understanding of isolation, isolation methods/techniques, and identification of isolated compounds".

Growing students' learning motivation can be assisted by the use of learning media. Media is something that is used to stimulate the thoughts, feelings, attention, interests of learners in such a way that the learning process occurs [13]. One type of media that is used to increase students' knowledge is visual media. There is an important role of learning media in the teaching and learning process including: (1) Media as a teaching aid can be referred to as dependent media because it acts as a tool (effectiveness), (2) Media as a learning resource that is used by students independently or called independent media [14]. One form of visual media is posters. Posters can increase learning effectiveness, stimulate the desire to learn, encourage social skills, motivate and encourage students to read more [15].

Based on the explanation (background) above, this study aims to determine the sunscreen potential of kencur rhizome extract (*Kaempferia galanga* L.) in vitro using a UV-Vis spectrophotometer. Testing the sunscreen potential of kencur extract is done by calculating the *Sun Protecting Factor* (SPF) value which is then outlined in the form of a poster as a learning supplement.

Research Methods

Research Design

This study uses a quantitative design that aims to determine the *sunscreen* potential of kencur extract (*Kaempferia galanga* L.). The research results in the form of quantitative data obtained were poured as a learning supplement. The learning supplement that has been made is then subjected to expert validation.

Laboratory Research Tools and Materials

Quantitative data collection in the form of research was carried out in the Chemistry Laboratory, Joint Basic Building 2nd Floor FKIP, Mataram University. The tools used were blender, maceration container, measuring cup, cuvette, volumetric flask, analytical balance, drop pipette, spatula, hot plate, mixer, clamp, static, funnel, rotary evaporator, centrifuge, and UV-Vis spectrophotometer. The materials used are distilled water, kencur rhizome (*kaempferia galanga* L.), 90% ethanol solvent, 70% ethanol, phenoxyethanol, carbomer, stearic acid, *virgin coconut oil*, trimiristin.

Sample Preparation

Kencur rhizomes are washed thoroughly using running water, then the sorting process is carried out. Sorting is done to get quality rhizomes and separate from unwanted foreign objects. Next, it is sliced thinly and dried by not using direct sunlight so that the kencur rhizome simplisia is obtained. Furthermore, extraction is carried out using the maceration method. The simplisia was taken and weighed as much as 300 grams and then placed in a maceration container. Then poured 90% ethanol as much as 1 liter, closed and left for 3 days protected from light, while occasionally stirring. After 3 days, the juice was filtered and taken, and stored again for 3 days. The juice was then concentrated and evaporated with a rotary evaporator at a temperature of 70^o C until a thick extract was obtained. ^{o}The thick extract was allowed to stand for 3 days and then evaporated again using a hot plate with a temperature of 70 ° C so that the kencur oleoresin was obtained.

Sunscreen Gel Preparation

The water phase, namely carbomer, was sprinkled on distilled water, waited to dissolve and then homogenized. Then the oil phase, namely stearic acid, phenoxyethanol, was heated on a bath, waited until it melted. Then measured the temperature at 70^o C then added virgin coconut oil, trimiristin crystals and kencur extract. Stirred until homogeneous using a stirrer. Then the oil phase was mixed in the water phase little by little while homogenized using a mixer, waiting until a gel was formed.

Determination of SPF Value of Sunscreen

Sunscreen extract of galangal was taken as much as 0.125 g, 0.250 g, 0.375 g and 0.500 g. Each was transferred to a 100 ml volumetric flask and then diluted with 70% ethanol. Each was transferred to a 100 ml volumetric flask and then diluted with 70% ethanol. Next, centrifugation was carried out for 5 minutes at 4000 rpm. The absorbance value was measured using a spectrophotometer. The absorbance spectrum of the sample in solution form was obtained in the range of 290-320 nm with an interval of 5nm. SPF value of sunscreen preparation using Mansur method [16]:

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

Description:

CF : *Correction Factor* = 10
EE : *Erythemal Effect Spectrum*
I : Intensity of the solar spectrum at wavelengths
Abs : Absorbance of *sunscreen* product

The value of EE x I is a constant and is shown in the following table:

Table 1. Normalization Constants EE (λ) x I (λ)

Wavelength (λ nm)	**EE(λ) x I(λ)**
290	0,0150
295	0,0817
300	0,2874
305	0,3278
310	0,1864
315	0,0837
320	0,0180
Total	**1**

According to the FDA (*Food and Drug Administration*), the assessment of the SPF ability level of *sunscreen* [17] can be seen in Table 2.

Table 2. SPF assessment according to the *Food and Drug Administration* (FDA)

Protection Type	SPF Value
Minimal	1-4
Medium	4-6
Extra	6-8
Maximum	8-15
Ultra	>15

Making Learning Supplements

The type of learning supplement chosen in this study is a poster. After the research was conducted, the results of the research were presented on poster media. The poster design is well designed so that it can attract the interest of readers and can convey the message to be conveyed.

Validation of Learning Supplement

Collecting poster validation results was done by distributing posters and validation sheets to experts (validators). The validation sheet uses a Likert scale assessment (1-4) in accordance with the assessment rubric which contains several indicators, the number of statement items for each validated aspect, including aspects of content, presentation, grammar and language feasibility. Data from expert validation results for chemical posters about the potential of kencur extract (*Kaempferia galanga* L.) as a sunscreen base material were analyzed by considering comments, suggestions and input from validators. The results of the analysis became a reference for the poster improvement process. The validity of the data can be calculated using Aiken's V formula [18]. After the validity value is obtained, grouping is done based on the Aiken index category.

Table 3. Aiken index categories

Index Range	Category
$V \leq 0,4$	Less valid
$0,4 < V \leq 0,8$	Valid
$0,8 < V \leq 1$	Very valid

Furthermore, the analysis used to determine the level of reliability by two validator observers (on the same two aspects) on the module instrument sheet used percentage of agreement. The instrument is said to be good if it has an agreement index ≥ 0.75 or 75% [19].

Results and Discussion

Analysis of In Vitro Test Results SPF Value

Measurement and testing of the activity of *sunscreen* compounds can be done in many ways, namely in vivo and in vitro testing[20]. The efficacy of *sunscreen is* generally shown from the SPF value, a high SPF value is generally more effective in protecting the skin from UV radiation. However, it is sometimes necessary to standardize methods to determine the SPF value of a product. Methods to determine the SPF value are generally divided into two, namely in vivo and in vitro, the in vitro method itself can be divided into two, which can be done by measuring the absorbance or transmission of UV radiation on biomembranes and the second can be done by measuring absorbance using spectrophotometry.

Determination of *sunscreen* potential of galangal extract (*Kaempferia galanga* L.) used in this study is in vitro by spectrophotometric method[21], namely the sunscreen gel of galangal extract is diluted and then measured its absorption in the ultraviolet b (UV-B) wavelength range, namely 290-320 nm with an interval of 5 nm. Determination of *sunscreen* effectiveness is based on the calculation of SPF (*Sun Protecting Factor*) value[22]. Measurement of absorbance of *sunscreen* extract of kencur at a wavelength of 290-320 nm obtained the maximum wavelength in the entire concentration variation (125; 250; 375; 500 ppm) is at 295 nm with consecutive absorbance values of (1.125; 1.549; 1.622; 1.943).

Table 4. SPF value of *sunscreen of* galangal extract in vitro

Concentration	SPF
125 ppm	9.0
250 ppm	13.61
375 ppm	14.63
500 ppm	18.22

From the table of measurement results above, the SPF value is obtained which shows that the *sunscreen* preparations with concentrations of 125, 250 and 375 ppm are in the maximum protection category because they are in the range of 8-15, while the concentration of 500 ppm is in the ultra category because it is in the range >15. The results obtained show that the *sunscreen* preparation with 500 ppm is the best because it has ultra-protection power with an SPF value of 18.22, meaning that it can protect the skin longer under sunlight.

The factor that can affect the determination of SPF value is the difference in concentration of *sunscreen*. This factor can increase or decrease the UV rays of each *sunscreen* [23]. Based on the above, it shows that as the concentration increases, the *sunscreen* protection power also increases[24]. This can be seen from the results of the SPF value obtained on the *sunscreen of* galangal extract, which shows that as the concentration increases, the SPF value of the *sunscreen is* also getting bigger.

Analysis of Validity and Reliability Results

1. Validation Result Analysis

The expert validation stage aims to ask for theoretical considerations to experts (validators) to find out whether the product is feasible or not suitable for use in learning [25]. The validation test pays attention to several aspects, namely aspects of graphics, presentation aspects, aspects of content feasibility and linguistic aspects. Aiken's V index was used to determine the validity level of the poster and was conducted by three material expert validators from lecturers from the Chemistry Education Study Program and Chemistry Study Program.

Table 5. Results of the average analysis of the validity of learning supplement posters

Assessment Aspect	V
Graphics	0.79
Presentation	0.78
Content Feasibility	0.90
Linguistics	0.9175

Based on the table above, the validity of the natural material chemistry learning supplement posters analyzed using the Aiken index (V) with the value of each aspect, namely, the graphic aspect of the V value of 0.79 with the valid category, the presentation aspect of the V value of 0.78 with the valid category, the content feasibility aspect of the V value of 0.90 with the very valid category and the linguistic aspect of the V value of 0.9175 with the very valid category. So that the results of the poster validity test obtained an average V value of all aspects in the poster of 0.84. Based on the Aiken index category, the validity results obtained are $0.8 < V \leq 1$ so that it includes a very valid category.

2. Reliability Result Analysis

The reliability test was conducted using the *Percentage of Agreement* (R) equation with two validators (on the same two aspects) to determine the level of reliability. The R value was determined for each aspect and the results are shown in Table 6.

Table 6. Results of poster reliability analysis on each aspect

Assessment Aspect	R
Graphics	1
Presentation	0.97
Content Feasibility	0.97
Linguistics	0.93

Based on Table 6, the results of the calculation of reliability using *percentage of agreement* on each aspect, namely, the graphic aspect, the presentation aspect, the content appropriateness aspect and the linguistic aspect, the R values are 1; 0.97; 0.97 and 0.93, respectively. Based on this data, the average R value for all aspects is R = 0.9675. An instrument can be said to be good if it has an index of agreement R greater than 0.75 to 1. It can be concluded that the poster learning supplement of natural chemistry has been reliable or trustworthy.

Conclusion

Based on the results of research and discussion that has been done, the following conclusions can be obtained. The results of the in vitro test analysis of the SPF value of the *sunscreen of* kencur extract (*Kaempferia galangal* L.) at concentrations of 125, 250 and 375 ppm are 9.0, 13.61 and 14.63 respectively which are included in the maximum protection category, while at a concentration of 500 ppm it is 18.22 which is included in the ultra protection category based on the provisions of the Food and Drug Administration (FDA). The results of the analysis of the validity of the learning supplement poster have an overall V average value of 0.84 so that it is included in the category or class is very valid. Then, for reliability, it has an overall average R value of 0.9675 so that it can be said to be reliable or trustworthy.

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