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OPTIMIZATION OF GUMITIR FLOWER EXTRACT (*TAGETES ERECTA L.*) SUNSCREEN CREAM: SIMPLEX LATTICE DESIGN METHOD

I Gusti Ngurah Agung Windra Wartana Putra[1]*, I Gusti Ayu Agung Septiari[1]

[1]Pharmacy Department, Bali International University, Denpasar-Indonesia

Corresponding author email: agungwindra@mail.com

ABSTRACT

Background: Sunscreen cream is used to protect the skin from the bad effects of sunlight. Making a good sunscreen cream requires paying attention to the composition of the constituent compounds to obtain a standardized cream form quality. Formula optimization is carried out in each cream formulation, including to produce of Gumitir flower extract sunscreen cream. **Objective:** The aim of this research is to produce an optimum formula for Gumitir flower extract sunscreen cream. **Methods:** The method used in this research is the Simplex Lattice Design optimization method to find the optimum base between stearate acid cream base and triethanolamine. **Results:** Optimization results show that variations in stearic acid and triethanolamine cream bases influence the physical properties of viscosity and adhesiveness of sunscreen cream preparations, with stearic acid as the dominant factor influencing viscosity. **Conclusion:** The conclusion obtained from this research is that the optimum formula for Gumitir flower extract sunscreen cream was obtained with a base composition of 13.5% stearic acid and 2.5% triethanolamine.

Keywords: Optimization; Gumitir; Extract; Sunscreen

INTRODUCTION

Indonesia is known as an archipelagic country located on the equator so it gets sunlight all year round[1]. Sunlight can have both beneficial and detrimental effects. The beneficial effects of sunlight such as photosynthesis and light sources[2]. However, excessive sun exposure can be detrimental to unprotected skin such as wrinkles, sunburn, and long-term effects can cause skin cancer[3].

Sunscreen sources can come from natural or synthetic sources. Nowadays the "back to nature" trend has developed rapidly, the use of plants and other natural ingredients can be used as alternative medicines and cosmetics. Natural ingredients that have the potential to act as sunscreens in plant compounds are preferred due to concerns about the side effects of synthetic chemicals used in sunscreen formulations[4]. One of the side effects that can be caused by synthetic chemical sunscreen active ingredients is mutagenic activity when using dioxybenzone at doses of 4, 6, 8 and 10 µL[5]. Natural ingredients have potential as sunscreen because they contain flavonoid compounds which have chromophore groups with their ability to strongly absorb sunlight at wavelengths of 290 to 320 nm[6].

One of the plants that contains flavonoids is the gumitir flower with a total flavonoid of 97.00 mg RE/g in ethyl alcohol:

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water (7:3) solvent[7]. Research on the sunscreen activity of gumitir flowers was carried out with a concentration of 1% gumitir flower extract in petroleum ether solvent giving an SPF value of 1.08 ± 0.02 which is included in the minimum category[8]. Other research conducted by Bambal[9], stated that a concentration of 1% ethanol extract from gumitir flowers in sunscreen cream obtained an SPF value of 8.67 ± 1.3 which was included in the extra category. Based on this data, gumitir flower extract has sunscreen activity.

The form of sunscreen dosage form that is commonly used in society is cream. Creams are preferred because they are easy to clean[10], easy to spread, practical, and moisturize the skin[11]. In sunscreen cream formulations, the additional ingredients stearic acid and triethanolamine are often found in the cream base. According to the Indonesian National Standards, there are several parameters that must be met by sunscreen cream preparations so that they can be said to be of quality, namely appearance, pH, viscosity, and so on[12]. Research conducted by Widianto[13], stated that stearic acid and triethanolamine had an effect on reducing viscosity and adhesive power, while the spreadability value increased in the ethanol extract of rosella flower petals with a cream preparation as sunscreen.

In making cream preparations, for every addition of ingredients formulated with certain active compounds, optimization needs to be carried out in order to obtain the best composition from the formula mixture so as to create good quality cream preparations. The aim of this research is to carry out optimization to produce the optimum formula for the compounds that make up the cream, namely stearic acid and triethanolamine with the active substance gumitir flower extract.

METHODS

1. Tools

The tools used in this research have been calibrated. Rotary Evaporator (R1050), Brookfield viscometer, mixer (philips), water bath (nesco), blender (philips), glass equipment.

2. Material

Ethyl acetate, gumitir flower obtained from Selabih village, Tabanan district, stearic acid, triethanolamine, cetyl alcohol, glycerin, nipasol, nipagin, and distilled water.

3. Procedure

a. Making Gumitir Flower Extract

A total of 5 kg of gumitir flowers were macerated with 96% ethanol in a ratio of 1:10 (w/v). Maceration is carried out for 3x24 hours. Then the macerate obtained was evaporated using a rotary evaporator with a temperature of 500 C and a rotation of 100 rpm[14].

b. Formulation Cream

The formulation was obtained from the trial version of Design Expert 13.0 software and the following comparison of stearic acid and triethanolamine (TEA) was used:

Table 1. Formulation Cream

Formula	Stearic acid (%)	TEA (%)	Alcohol cetyl (%)	Glycerin (%)	Extract (%)
1	12	4	4	10	1
2	12	4	4	10	1
3	14.25	1.75	4	10	1
4	15	1	4	10	1
5	13.5	2.5	4	10	1
6	12.75	3.25	4	10	1
7	15	1	4	10	1
8	13.5	2.5	4	10	1

Each formula is made into 100 grams of sunscreen cream. Making gumitir

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flower extract sunscreen cream begins with weighing the ingredients needed in the formulation according to predetermined levels. Next, the stearic acid, cetyl alcohol, nipagin, and nipasol were evaporated in a water bath at a temperature of 950C until they melted. Then mix the melted oil phase, grind it quickly with triethanolamine until a white cream base appears, then add glycerin and distilled water, and stir until homogeneous using a mixer. Next, add the gumitir flower extract, stir until homogeneous. Then the homogenized cream formula is stored in an appropriate container[15].

c. Viscosity Test

The cream viscosity was used using a Brookfield LV viscometer and replicated three times. The viscosity results are recorded after showing a number that does not change[16].

d. Spreadability Test

Gumitir flower extract cream was placed in 1 gram on a glass scale, then covered and given a weight of 50 g within 1 minute, then the diameter of the spread was measured with a ruler. Then the weight of the load was added to 100 g and 150 g within 1 minute and the diameter of the spread was measured with the help of a ruler. Replication was carried out 3 times[16].

e. Adhesion Test

Gumitir flower extract cream is placed 1 gram between two glass objects that have been given a weight of 1 kg for 5 minutes. Then the weight is lifted, the object glass containing the cream is placed on the test equipment. A load of 80 g was attached to the test equipment and the time required for the cream to be released from the object glass was recorded. Replication was carried out three times[16].

4. Data analysis

Data were analyzed using One Sample T-Test statistical analysis with a confidence level of p>0.05. To compare the characteristics of sunscreen cream that have been predicted from expert design software with the actual characteristics from laboratory experiments[16].

RESULTS

1. Physical Properties of Gumitir Flower Extract Cream

Gumitir flower extract cream is made in 8 formulas with varying concentrations of stearic acid and triethanolamine according to the design expert 13.0 software trial version. The 8 formulas were then tested for viscosity, adhesion and spreadability.

a. Viscosity

Testing the viscosity of gumitir flower extract cream using a Brookfield Viscometer. Viscosity testing was carried out using rpm 50 and with spindle No. 64. Viscosity test results can be seen in table 2 and figure 1:

Table 2. Viscosity Cream

Formula	Stearic Acid (%)	Triethanolamine (%)	Viscosity (Cps)
1	12	4	1620
2	12	4	1615
3	14.25	1.75	2740
4	15	1	3635
5	13.5	2.5	2446
6	12.75	3.25	1930
7	15	1	3620
8	13.5	2.5	2435

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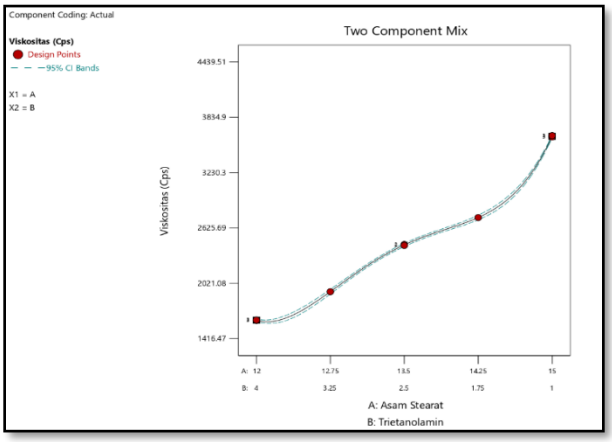

Figure 1. Viscosity results

b. Spreadability

The following are the results of measuring the spreadability of 8 gumitir flower extract cream formulas.

Table 3. Spreadability cream

Formula	Stearic Acid (%)	Triethanolamine (%)	Spreadability (cm)
1	12	4	6.8
2	12	4	6.75
3	14.25	1.75	6.22
4	15	1	5.7
5	13.5	2.5	6.46
6	12.75	3.25	6.74
7	15	1	5.8
8	13.5	2.5	6.43

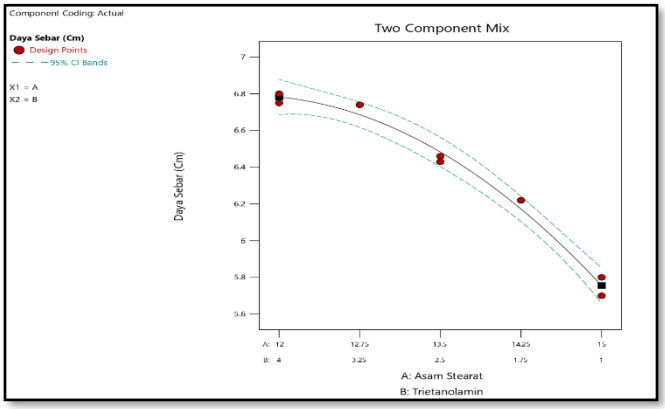

Figure 2. Spreadability results

c. Adhesion

The following are the results of measuring the adhesive power of 8 gumitir flower extract cream formulas:

Table 4. Adhesion cream

Formula	Stearic Acid (%)	Triethanolamine (%)	Adhesion (s)
1	12	4	0.78
2	12	4	0.75
3	14.25	1.75	1.24
4	15	1	1.51
5	13.5	2.5	1.15
6	12.75	3.25	0.97
7	15	1	1.47
8	13.5	2.5	1.12

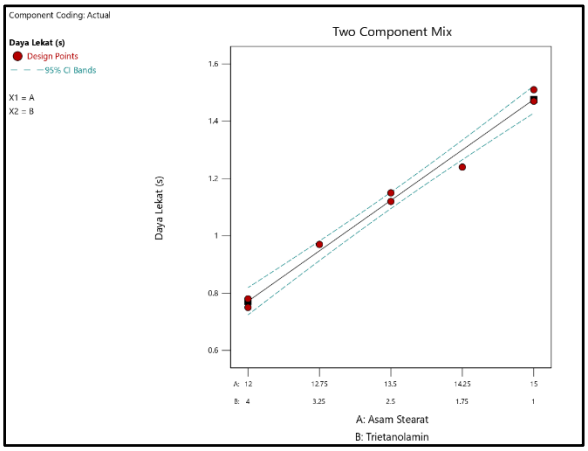

Figure 3. Adhesion Results

d. Optimum Formula

The optimum formula obtained from expert design software is based on the highest desirability value with a ratio of stearic acid and triethanolamine, namely 13.5: 2.5. Then the formula was replicated three times to compare the physical property values with predictions from expert design software.

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Table 5. Optimum Formula Cream

Ingredients	Proportion (%)
Gumitir flower extract	0.05
Alcohol cetyl	0.2
Stearic Acid	13.5
Triethanolamine	2.5
Glycerin	10
Nipagin	0.18
Nipasol	0.05
Aquadest ad	100

2. Physical Properties of Optimum Gumitir Extract Cream

a. Viscosity Properties

The viscosity measurement of the gumitir flower extract cream preparation was carried out using a Brookfield spindle viscometer no. 64 at a speed of 50 rpm. The following are the results of testing the viscosity of the gumitir flower extract cream preparation:

Table 6. Viscosity

Replication	Viscosity (Cps)
1	2420
2	2377
3	2490
average	2429
SD	7.8

b. Spreadability Properties

The following are the results of measuring the spreadability of the optimum formula for gumitir flower extract with three replications:

Table 7. Spreadability

Replication	Spreadability (cm)
1	6.5
2	6.34
3	6.41
average	6.42
SD	0.05

c. Adhesive Properties

The following are the results of measuring the adhesive strength of the optimum formula for gumitir flower extract with three replications:

Table 8. Adhesion

Replication	Adhesion (s)
1	1.2
2	1.05
3	1.14
average	1.13
SD	0.03

3. Verification of Optimum Formula

From the results of the formula predictions produced by the design expert software, verification is carried out by making the formula real and testing its physical properties. Then an unpaired t test was carried out to find out whether the predictions and responses given by the formula were different from the responses given after the cream preparation was made.

Table 9. Physical properties comparison test (T-Test)

Physical Properties	Prediction	Results	P value
Viscosity	2440	2429	0.064
Spreadability	6.48	6.42	0.086
Adhesion	1.12	1.13	0.071

DISCUSSION

1. Viscosity

Cream viscosity testing aims to determine the viscosity of the cream preparation. The viscosity of a preparation should not be too high or too low, if the cream formed is too viscous it will be difficult to remove from the packaging, whereas if the preparation is too runny then the preparation will not stay on the skin for long when used.

To determine the effect that stearic acid and triethanolamine can have on viscosity, researchers used quadratic

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polynomial analysis and obtained the following equation:

$$Y = 3627.5 (A) + 1617.5 (B) – 728 (A)(B)$$

Based on the equation above, it shows that there is an interaction between stearic acid and triethanolamine which has a negative influence on the viscosity of the gumitir flower extract cream preparation with a coefficient value of -728. Judging from the coefficient value, stearic acid has a dominant influence on viscosity properties. The increase in cream viscosity is influenced by the presence of fatty acids contained in the cream, namely stearic acid. The more fatty acids used, the thicker the cream produced. The use of stearic acid as an emulsifier in topical preparations will form a thick base and the level of viscosity is determined by the amount of triethanolamine used[17].

2. Spreadability

This spreadability test assessment is to describe the ease of the cream when applied to the skin. The easier it is to spread on the skin means it will expand the area of skin in contact with the cream. Cream preparations can be said to fulfill optimal mechanical properties, if the preparation is easy to remove from the container and has good spreading power on the skin when the preparation is applied so that it can provide comfort for use by consumers. Specifications for the diameter of spreading power are 5–7 cm. To determine the effect that stearic acid and triethanolamine can have on spreadability, researchers used quadratic polynomial analysis and obtained the following equation:

$$Y = 5.76 (A) + 6.78 (B) + 0.85 (A)(B)$$

Based on the equation above, it shows that there is an interaction between stearic acid and triethanolamine which has a positive influence on the spreadability of the gumitir flower extract cream preparation with a coefficient value of +0.85. Judging from the coefficient value, triethanolamine has a dominant influence on the spreadability properties. The lower the concentration of triethanolamine, the viscosity of the cream will decrease so that the spreadability becomes smaller[17].

3. Adhesion

Cream adhesion testing is carried out to determine the adhesion power of the cream to the skin by measuring the length of time the cream adheres to the adhesion test tool. This will be related to the length of time the cream is in contact with the skin. To determine the effect that stearic acid and triethanolamine can have on adhesive strength, researchers used quadratic polynomial analysis and obtained the following equation:

$$Y = 1.48 (A) + 0.77 (B) - 0.01 (A)(B)$$

Based on the equation above, it shows that there is an interaction between stearic acid and triethanolamine which has a negative influence on the adhesive power of the gumitir flower extract cream preparation with a coefficient value of -0.01. Judging from the coefficient value, stearic acid has a dominant influence on the adhesive properties. The higher the concentration of stearic acid, the viscosity of the cream will increase so that the adhesion becomes higher[17].

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4. Optimum Formula

From the results of the verification and t test, the significance value for each viscosity, spreadability and adhesiveness response was obtained above p value >0.05. This means that there is no significant difference between the response from the prediction formula and the response from the formula created, which means that the formula model is valid for optimizing the preparation of gumitir flower cream[17].

CONCLUSION

Variations in the concentration of stearic acid and triethanolamine affect the physical properties of the gumitir flower extract cream preparation. Stearic acid is a constituent component as the dominant factor that influences the viscosity and stickiness of cream. Meanwhile, triethanolamine is the dominant factor that influences the spreadability response of cream. The optimum formula for sunscreen cream with gumitir flower extract is 13.5% stearic acid and 2.5% triethanolamine.

CONFLICT OF INTEREST

There is no conflict of interest in this article. This article is written independently without the involvement of other parties who could improperly influence this article.

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