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Optimization of Polysorbate 80 and Sorbitan Monooleate 80 as Emulsifiers in Foundation Makeup Containing Ethyl Cinnamate

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ABSTRACT

Foundation is a type of decorative makeup, and some typically also include a sunscreen agent. Ethyl cinnamate is one of potential organic essential oils for sunscreens. Nevertheless, there is little study on ethyl cinnamate usage in cosmetics, particularly in oil-in-water foundation cream. Although using an emulsifier in oil-in-water foundation at a higher concentration may not guarantee higher oil phase recovery, using an optimum combination of emulsifiers such as polysorbate 80 and sorbitan monooleate 80 could be the right solution. This study aims to optimize polysorbate 80 and sorbitan monooleate 80 in cream foundation using ethyl cinnamate as an active ingredient. Ethyl cinnamate has an effective ability to protect facial skin from ultraviolet radiation and is safe to use. The optimization used simplex lattice design with Design-Expert® version 10.0.1. The evaluated parameters were the value of pH, viscosity, spreadability, adhesion, and Sun Protection Factor (SPF) value. Stability and skin irritation tests for optimum formula were also conducted. Revlon Colorstay Foundation (National Food and Drug Agency of Indonesia number NA18140300519) served as a positive control. The optimum ratio of polysorbate 80 and sorbitan monooleat 80 were 9.565 and 1.435 respectively with physical properties and parameters as follow: pH 6.478$\pm$0.008, viscosity 5844.2$\pm$31.82 cPs, spreadability 6.16$\pm$0.11 cm, adhesion 3.346$\pm$0.14 seconds, SPF Value 22.385$\pm$0.48, and no irritation symptoms. The foundation created was physically stable, and did not irritate the skin, making it safe to wear. It also provides effective protection from UV radiation.

Key words: foundation, SPF, cinnamate

INTRODUCTION

Cosmetics have become part of both men and women's lives. Various kinds of cosmetics are also increasingly in demand in various markets. Cosmetics are mixture or substance intended for use on the external parts of the human body (epidermis, hair, nails, lips and external genital organs) or on the teeth and mucous membranes of the mouth, especially for cleaning them, perfuming them, altering their appearance and/or correcting body odor or protecting them or maintaining the body in good condition (Ministri of Health Indonesian Republic, 2010).

Cosmetics can be categorized as skin care and decorative cosmetics. Decorative cosmetics are applied to enhance or to modify the appearance of people and cover skin imperfections. This type of cosmetics is used for makeup and to cover blemishes on the skin to produce a more attractive appearance which can have a good psychological effect, such as increasing self-confidence. One form of decorative cosmetics is foundation which is used to make the skin tone even, cover flaws, and sometimes to change the natural color of the skin.

Sunscreen agent is commonly included in foundation, which acts as a second layer of protection against ultraviolet (UV) radiation on the face. Ethyl cinnamate is one of the potential organic sunscreen agents. The use of ethyl cinnamate in cosmetics and pharmaceutical industries is also very potential because of its particular taste and aroma, as well as its high boiling point and stability (Das *et al.*, 2017). Nevertheless, to the best of our knowledge there is little study on ethyl cinnamate usage in cosmetics, particularly in foundation cream.

One of the crucial components in oil-in-water foundation cream is emulsifier. Cream is a pharmaceutical preparation containing one or more well-dispersed medicinal ingredients in the form of a water-in-oil (w/o) or oil-in-water (w/o) emulsion, containing not less than 60% water. In the manufacture of water-in-oil cream, an emulsifier with a high HLB is needed, which is between 8-15. Stable emulsions can be achieved using a single emulsifier or a combination of emulsifiers close to the HLB oil phase called the required HLB. However, this will be difficult to accomplish if the oil phase consists of more than one active pharmaceutical ingredients and excipients, especially in foundation cream preparations containing ethyl cinnamate. Polysorbate 80 has a high HLB value with hydrophilic properties, while span 80 has a low HLB value with lipophilic properties (Damayani *et al*., 2021). The combination of these two surfactants can make the emulsion more stable than using a single surfactant.

To produce a good cream emulsion, optimization is needed to determine a balanced mixture of lypophilic and hydrophilic emulsifiers in the cream formulation. Therefore, this study was undertaken to determine the optimum composition of tween 80 and span 80 combination to produce foundation cream preparations with suitability for makeup use and effective prevention of UV radiation exposure.

MATERIAL AND METHODS

For ethyl cinnamate synthesis, ethanol (Mallinckrodt Chemicals), magnesium sulphate (Merck), concentrated sulphuric acid (Merck), ether and sodium bicarbonate (Merck) were used. The ingredients used in the foundation cream formulation were stearic acid (MKR Chemicals, Ltd. Indonesia), cetyl alcohol (MKR Chemicals, Ltd. Indonesia), liquid paraffin (MKR Chemicals, Ltd. Indonesia), span 80 (Brataco Chemika, Indonesia), dimetichon, triethanolamine (MKR Chemicals, Ltd. Indonesia), tween 80 (Brataco Chemika, Indonesia), propylene glycol (MKR Chemicals, Ltd. Indonesia), propylparaben (Brataco Chemika, Indonesia), methylparaben (Brataco Chemika, Indonesia), titanium dioxide(Brataco Chemika, Indonesia), zinc oxide (Brataco Chemika, Indonesia), iron oxide yellow (CAS#2-C33A436, Shengzhou Wotrhside Chemical Co, Ltd.), iron oxide brown (CAS#1332-37-2, Shengzhou Wotrhside Chemical Co, Ltd.), aquadest (Brataco Chemika, Indonesia), and ethanol (Mallinckrodt Chemicals).

Synthesis of Ethyl Sinnamate

In recent years, sonochemistry has been chosen for synthesis, including natural syntheses. This method is a handy resource and less difficult to manipulate than conventional methods. The application of ultrasonic irradiation in organic synthesis offers shorter response times, less difficult operation, cleaner reactions, easier and better yield, minimum waste and less energy. Therefore, it is far more environmentally friendly.

A mixture of cinnamic acid (0.03 mol), ethanol (25 mL), and sulfuric acid (1 mL) was placed in an Erlenmeyer flask. The flask was stored in an ultrasonic device and set at 60°C for 40 minutes. The mixture was then evaporated under pressure to reduce the ethanol. The residue was mixed with saturated $NaHCO_3$ to pH 8-10 and extracted with ether. Anhydrous $MgSO_4$ was added to the ether phase and evaporated on a vacuum evaporator to produce a pure ester. With the vacuum treatment, the ester obtained was already in the form of pure ethyl cinnamate. The pure ethyl cinnamate was characterized and identified using GC-MS with SHIMADZU GCMS-QP2010S with Rtx 5 MS column, helium carrier gas, injection temperature at 300°C, ion source temperature at 250°C, and flow rate of 0.58 mL/min (Purwaningsih *et al*., 2020).

Foundation Cream Formulation

Foundation is formulated into cream preparations. The combination of emulsifier polysorbate 80 and sorbitan mono-oleate 80 was optimized using the simplex lattice design with Design Expert 10.0.1 software. The input data in the design software was polysorbate 80 and sorbitan mono-oleate 80 concentration ranges from 1% to10% with number of replication was five (Table I).

All oil phase components (stearic acid, cetyl alcohol, liquid paraffin, span 80, propyl *p*-hydroxybenzoat, and dimethicone) were melted at 70˚C on a hotplate stirrer, at a speed of 100 rpm. The aqueous phase components (TEA, tween 80 and methyl *p*-hydroxybenzoat) were dissolved separately and then propylene glycol was added. The solid phase (TiO2, ZnO, and pigment) was mixed until homogeneous and sieved with a mesh of 100.

Table I. Foundation Cream Formula Containing Ethyl Cinnamate

Ingredients	Total % (b/b)									
	FI	**F II**	**F III**	**F IV**	**F V**	**F VI**	**F VII**	**F VIII**	**F IX**	**FX**
Ethyl Cinnamate	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Oil Phase										
Stearic acid	3	3	3	3	3	3	3	3	3	3
Cethyl alcohol	6	6	6	6	6	6	6	6	6	6
Paraffin liquid	10	10	10	10	10	10	10	10	10	10
Sorbitan Monooleate 80	**5.5**	**10**	**1**	**7.75**	**1**	**10**	**5.5**	**3.25**	**10**	**1**
Propil *p*-hydroxybenzoate	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Dimethicone	5	5	5	5	5	5	5	5	5	5
Aqueous phase										
Triethanolamine	2	2	2	2	2	2	2	2	2	2
Polysorbate 80	**5.5**	**1**	**10**	**3.25**	**10**	**1**	**5.5**	**7.75**	**1**	**10**
Metil *p*-hydroxybenzoate	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Propilene glycol	5	5	5	5	5	5	5	5	5	5
Solid Phase										
Titanium Dioxide	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
ZnO	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Iron Oxide Yellow	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Iron Oxide Brown	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Aquadest	added up to 100%									

Ethyl cinnamate was added to the oil phase and the aqueous phase. It was then stirred continuously and the solid phase was added and stirred again using a hotplate magnetic stirrer until homogeneous. Finally, aquadest was added.

Foundation Cream Evaluation

The first evaluation of the foundation cream was with organoleptic test. Then it was evaluated for the response of the formula optimization which includes the value of pH, viscosity, adhesion test, spreadability test and the determination of the SPF value of the preparation. ANOVA was then performed with Design Expert® version 10.0.1. After obtaining the optimum formula, the test was carried out again and continued with the stability test and irritation test.

Organoleptic Test

Organoleptic test was carried out by observing changes in consistency, color, odor and homogeneity of the foundation cream.

pH Test

In this test the pH value was measured using a pH-meter (Trans instrument HP 9000®). The pH value appeared on the pH meter and was then recorded.

Adhesion Test

A total of 500 mg of the preparation was placed on a couple of object glass. Then it was given a load of 1.0 kg for 5 minutes. After that, the object glass was attached to the test equipment and measuring the time of adhesion starting when the load on the test equipment was carried out removed until the second slide was removed.

Spreadability Test

The spreadability test was carried out by placing 0.5 grams of cream on a glass cylinder and leaving it for 1 minute. Then the spread was measured on 4 sides using a ruler. Another 50 g was added to the load until the spread was constant.

Viscosity Test

Viscosity of the sample was measured using Brookfield viscometer fitted with a spindle. The spindle was set to a speed of 50 rpm.

SPF Test

250 mg of the preparation was weighed, then it was put into a 25.0 ml volumetric flask dissolved with 96% ethanol to obtain a concentration of 10,000 ppm. The absorption was measured using a UV-Vis spectrophotometer with an interval of 5 nm with wavelength ranges from

290 nm to 320 nm using an ethanol blank. According to Mansur *et al*., (1986), the calculation of the SPF value uses the following equation:

$$SPF = CF \sum_{290}^{320} EE(\lambda)\ x\ I(\lambda)\ x\ bs(\lambda) \quad \text{.....(1)}$$

EE : Minimal effect spectrum; I : Intensity spectrum; Abs : Absorbance of sunscreen products; CF : Correction Factor, value = 10; EE × I : A predetermined constant

Evaluation of Optimum Formula for Foundation Cream

Stability Test

Sentrifugal test

A total of 10 grams of cream was put into a centrifuge tube, and was centrifuged in a room at 25°C at 3,800 rpm by 30 minute time interval for 5 hours. Stable emulsion system indicated that there was no phase separation after being centrifuged. The speed at 3800 rpm indicated that the preparation was stable the whole year at room temperature (Pratasik *et al*., 2019).

Determination of stability after 30 days of storage at room temperature

After 30 days of storage at room temperature, the physical characteristics of the foundation cream were re-tested with organoleptic and evaluation tests to measure the pH, viscosity, adhesion, spreadability and SPF value.

Irritation Test

The irritation test was approved by the ethics committee at Sekolah Tinggi Ilmu Farmasi Semarang (291b/AHW-SW/KEPK/STIFAR/EC/X/2021). The irritation test used an open patch test (Patch Test) on the inner forearm of 10 panelists. This was done by applying the prepared preparation to a quarter-sized patch skin (2.5 x 2.5 cm). After left open for approximately 24 hours, the skin was observed for reactions. A positive reaction was indicated by the presence of rashes, itch or swelling at the application site. The criteria of the panelists were female ages 20-30 years, physically and mentally healthy, and had no history of allergic disease (Noviandini, 2014). The test site was evaluated using the following scales: 0 = no erythema; 0.5 = minimal erythema; 1 = erythema (within patch margins); 2 = erythema (fiery color) within patch margins; 3 = erythema (fiery color) or slight vesiculation (beyond patch margins), or both; 4 = erythema (fiery color), marked edema, substantial vesiculation (far beyond patch margins) (Walters *et al*., 2015).

RESULT AND DISCUSSION

Ethyl cinnamate was synthesized by Fischer esterification with ultrasonic probe which produced excellent yield. The cinnamic acid reaction with ethanol was catalyzed with sulfuric acid in ultrasonic bath for 40 minutes. Based on GC (Figure 1.a), there was only one peak at a retention time of 32.329 minutes with an abundance of 100%, indicating that ethyl cinnamate was successfully obtained without any impurities. The mass spectra (Figure 1.b) showed that the m/z value of the synthesized sample was 176 and it is the molecular weight of ethyl cinnamate (Pubchem, 2021), which confirms that the sample obtained was ethyl cinnamate. The yield of ethyl cinnamate produced using sonochemical method in this study was 96%. It was similar to that of a previous study (Zhang *et al*., 2015) with the classical method. In this method, cinnamic acid is reacted with absolute ethanol at 0°C at room temperature with the addition of dropwise thionyl chloride. This results in the yield of ethyl cinnamate by 95%.

Ethyl cinnamate was then formulated into foundation preparations. In cosmetic emulsions such as foundation cream, substances known as amphipathic substances or surfactants are primarily used to solubilize, disperse, improve stability, and improve adsorption of the oily or aqueous phase (emulsions on the skin). A unique feature of cosmetic formulations is that they consist of a mixed surfactant system instead of a single surfactant, creating a synergistic effect (Venkataramani *et al*., 2020).

The most commonly used surfactants in cosmetic emulsions include polysorbate 80 or tween 80 and sorbitan monooleate or span 80 (Garg A. *et al.,* 2002). Several factors were considered when selecting emulsifiers, such as manufacturing and processing methods, types, concentrations, hydrophilic-lipophilic balance, molecular weight, particle surface charge, ambient temperature, oxidants and antioxidants, and food matrix types (Marhamati *et al*., 2021).

Based on the compositional standards of the National Standardization Agency (SNI) 1643991996, a cream containing sunscreen needs to meet some physical parameters including pH 4.5-8.0, viscosity 2,000-50,000 cPs, SPF value of at least 4 (Table II). From the first to the tenth formula, the value of pH, viscosity, and SPF met the above standards (Indonesia, 1996). The ten formulas also met the standard for the adhesion power of the cream (2-300 seconds) (Mudhana & Pujiastuti, 2021).

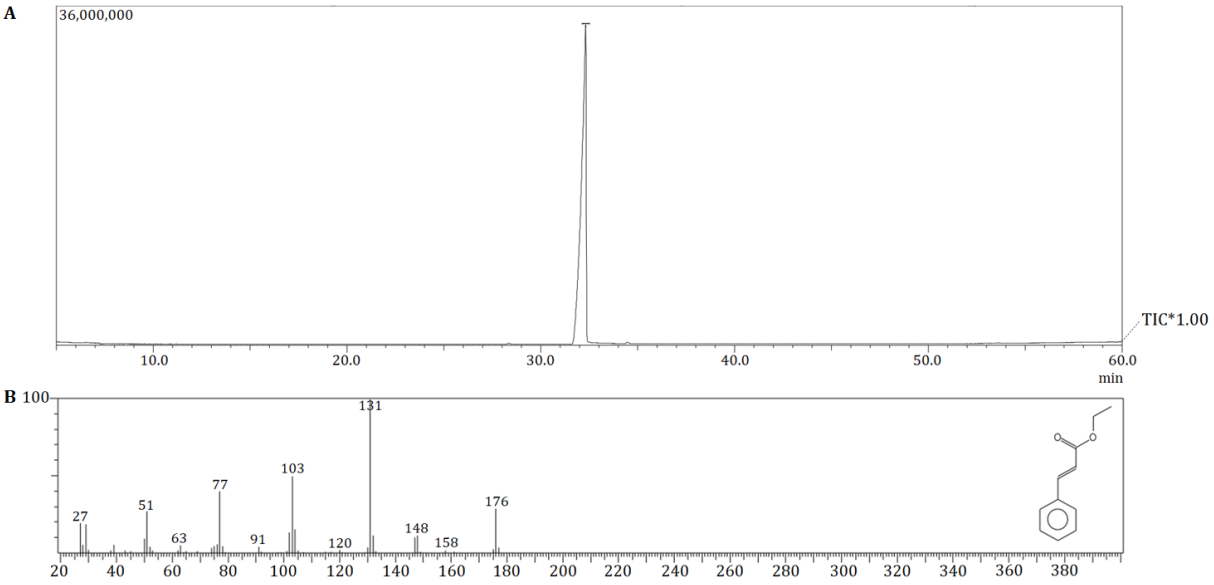

Figure 1. a) GC-Chromatogram and b) Mass Spectra of Ethyl Cinnamate

Table II. Pysichal Characteristic of Several Optimization Emulsifier on Foundation Cream containing Ethyl Cinnamate

F	A	B	PH	VISCOSITY (CPS)	ADHESION (SECOND)	SPREADABILITY (CM)	SPF VALUE
I	5.5	5.5	6.84	5747	2.18	5.8	21.0702
II	10	1	6.6	3359	2.11	8.1	21.8005
III	1	10	6.64	5969	3.37	5.1	23.60733
IV	7.75	3.25	6.77	5831	2.14	7.4	22.78618
V	10	1	6.43	3467	2.09	8.5	22.13791
VI	1	10	6.54	5897	3.38	5.2	22.68517
VII	5.5	5.5	6.87	5795	2.18	5.7	21.84507
VIII	3.25	7.75	6.7	5867	3.29	7.2	23.63072
IX	10	1	6.56	3971	2.13	8.3	22.67088
X	1	10	6.67	5987	3.3	5.6	21.68075

: acceptable : not acceptable

Each semisolid formulation was specifically designed according to the intended use, site of application, and consumers acceptance. Spreadability of the formulation can be increased or decreased according to the end application and depending on the choice of the formulator. In this case the researcher used the spreadability ranging 5-7 cm according to Garg A. *et al*. (Garg A. *et al.,* 2002), thus there were five formulas that did not meet the requirements.

Using Design Expert 10.0.1 software, each response was analyzed to obtain polynomial equations of the order (linear, quadratic, special cubic, cubic, quartic and special quartic). There are three processes involved in obtaining polynomial equations: based on sequential model of sum of squares [Type I], fit test, and model summary statistics. The process of selecting the first model (sequential model of sum of squares [Type I]) and the second (lack of fit) is based on the value of "Prob>F". In the first process, the selected order model had a value of "Prob>F" less than or equal to 0.05 (significant). In the second process, the model did not have a deficiency greater than or equal to 0.1 (not significant). The third process was based on model summary statistics. The best model was the model that had the maximum adjusted R-Squared and predicted R-Squared (close to 1.0).

Table III. ANOVA for Quadratic Mixture Model of Optimization Emulsifier Polysorbate 80 and Sorbitan Monooleate 80 in Foundation Cream Formula with Design Expert 10.0.1

Respons	Model	Lack of Fit	Final Equation
pH	Significant	Not significant	y = 6.40 A + 6.48 B + 1.56 AB
Viscosity	Significant	Not significant	y = 2902 A + 5562 B + 6774 AB
Adhesion	Significant	Not significant	y = 2.13 A + 3.75 B – 2.29 AB
Spreadability	Significant	Not significant	y = 8.83 A +5.41 B – 3.03 AB
SPF value	Not significant	Not significant	y = 25.34 A + 26.08 B – 0.58 AB

A = Sorbitan Monooleate 80; B= Polysorbate 80; AB= Interaction between Sorbitan Monooleate 80 and Polysorbate 80

Based on the third process, the Design Expert® 10.0.1 software identified a polynomial model with the best order for each response. Furthermore, each response was tested statistically (ANOVA) for the optimized model formula (Table III) (Stat-Ease, 2021).

The "lack of it" parameter (Table III) was necessary because it showed deviations or inaccuracies of replication in an equation. The ten formulas indicated by Design Experts showed that there were formulas with optimal ingredient compositions that differ from other formulas such as those in Formula I and Formula II, which represented the "model". There were also formulas with the same optimal composition of ingredients as in Formula II and Formula IX, which represented "lack of it". This parameter was used to detect whether the formula model with optimized ingredient composition in the same ratio produced the same result. If it did not produce data that was not significantly different, it means that an error occurred during manufacturing.

A good topical formulation should have a pH suitable for the skin, i.e. 4.0-6.5 (Schmid-Wendtner & Korting, 2006) and in sunscreen preparation, based on SNI, is 4.5-8.0 (Indonesia, 1996). This becomes the optimization criterion in this study. Formula with a pH ranges outside 4.0-6.5 were not included in the optimization criteria. Final equation for pH response (Table III) showed that polysorbate 80 had higher coefficient value than that of sorbitan monooleate 80 - in other words polysorbate 80 had the greatest effect on increasing pH. This is because polysorbate 80 has a higher pKa (14.64) (Pharmacopeia, 2021b) than sorbitan monooleate 80 (12.75) (Pharmacopeia, 2021a). pKa is the pH value at which a chemical species will accept or donate a proton. The lower the pKa, the stronger the acid and the greater the ability to donate protons in aqueous solutions.

Viscosity requirements between types of topical preparations may differ between each type depending on the purpose of therapy, for example, a burn cream preparation has a different viscosity from an acne cream which has a higher viscosity. Spreadability can be measured using different types of viscometers and depends on the requirements of the formulator (Garg *et al*., 2002). In the viscosity response equation formula, the combination of polysorbate 80 and sorbitan monooleate 80 could increase the viscosity of the preparation compared to single use. It was possible that the optimum combination of polysorbate 80 and sorbitan monooleate 80 could form a stable emulsion so that the preparation was homogeneous and the viscosity increased. In the equation, however, the coefficient of sorbitan monooleate 80 was the smallest, indicating the smallest effect on increasing viscosity. Possible anti-agglomerate effects at high sorbitan monooletae 80 concentrations may lead to lower viscosities (Foo *et al*., 2020). This would be linear to spreadability. In the spreadability equation, the coefficient of sorbitan monooleate 80 was the largest, meaning that it can increase spreadability. It is important to note that viscosity decreases linearly with increasing spreadability.

In addition, polysorbate 80 is hydrophilic which will bind to the water portion in the cream composition, thus increasing the viscosity (Marhamati *et al*., 2021). Its effect can also be seen on the response of adhesion and spredability, in which it will increase the adhesion when viscosity increases. It should be noted that polysorbate 80 coefficient in the adhesive response equation has the highest value. The optimum formula of foundation cream formula consists of polysorbate 80 and sorbitan monooleat 80 of 9.565 and 1.435 with desirability 0.949.

Table IV. Physical Characteristic of Optimum Foundation Cream. before and after 30 Days Storage in Room Temperature

Replication to	Physical Characteristics (before stability testing)				
	pH	Viscosity	Spreadability	Adhesion	SPF Value
1	6.47	5.879 cPs	6.12 cm	3.460 s	21.52
2	6.48	5.843 cPs	6.22 cm	3.300 s	22.63
3	6.48	5.807 cPs	6.22 cm	3.200 s	22.56
4	6.47	5.819 cPs	6.15 cm	3.520 s	22.26
5	6.49	5.873 cPs	6.10 cm	3.250 s	22.95
Average	6.48	5.844.2 cPs	6.16 cm	3.346 s	22.38
Standard Deviation	0.008	31.82	0.06	0.14	0.54
Replication to	**Physical Characteristics (after stability testing)**				
	pH	**Viscosity**	**Spreadability**	**Adhesion**	**SPF Value**
1	6.39	5.141 cPs	6.25 cm	3.090 s	14.06
2	6.40	5.135 cPs	6.25 cm	3.080 s	14.15
3	6.43	5.123 cPs	6.25 cm	3.070 s	14.04
4	6.42	5.129 cPs	6.23 cm	3.060 s	13.98
5	6.41	5.111 cPs	6.25 cm	3.010 s	14.01
Average	6.41	5.127.8 cPs	6.25 cm	3.062 s	14.05
Standard Deviation	0.016	11.54	0.008	0.03	0.07

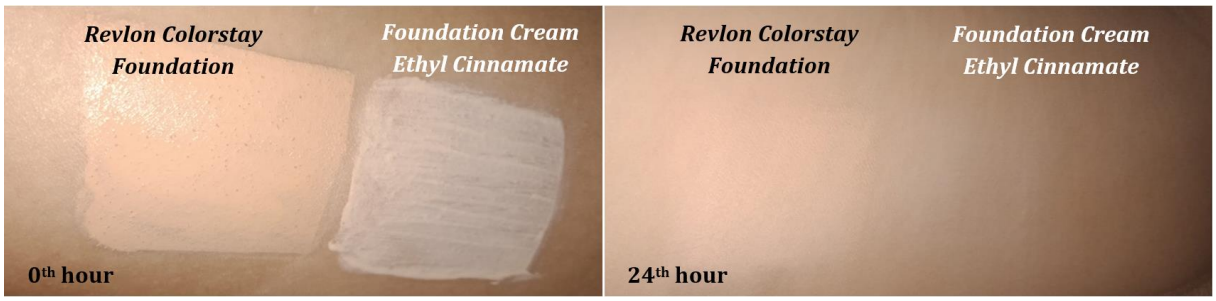

Figure 3. Irritation test of foundation cream containing ethyl cinnamate

The higher the sun protection factor, the higher the observed absorption (Chou J, Robinson T, 2017). The SPF value of ethyl cinnamate in foundation cream was higher than the SPF value of the active ingredient ethyl cinnamate. There are several factors that can affect the determination of the SPF value, including the effect and interaction of diluents such as emulsions, esters used in formulations, plasticizers, and emulsifiers (Imam *et al.*, 2015). In this study the calculated SPF is the SPF of the preparation minus the SPF base cream foundation.

Based on the independent sample T-Test using the SPSS program, there were differences in the parameters of pH, viscosity, adhesion and SPF after storage stability test (with a 2-tailed sig value <0.05). The final equation in SPF value response showed that the interaction coefficient between polysorbate 80 and sorbitan monooleate 80 was negative, which means it could reduce the SPF value. This can be seen from the SPF value after 30 days of storage which decreased up to 37% (Table IV). There are many studies to determine the SPF of sunscreens in various semi-solid dosage forms (lotions, gels, creams), but the majority do not address the behavior of the sunscreen when the package is exposed to different temperatures in a stability study. According to the National Standardization Agency, the minimum SPF is 4 in Indonesia (Indonesia, 1996), while the US FDA requires that the minimum requirement of sun protection product is low protection sunscreens with SPF values of 2 to below 12, while medium sun protection products with an SPF value of 12 to below 30 and high sun protection products with SPF values above 30 (FDA, 1999). Thus, the

preparation of ethyl cinnamate foundation cream in this study, although decreased, was still in the same level or moderate sun protection products.

No phase separation was observed after centrifugation in any of the samples stored under different conditions for up to 30 days. No other phase separations were observed until the end of the experimental period. This was due to the correct homogenization rate in the cream formulation, which may have prevented the formulation from being damaged during the test.

Irritation test was conducted to determine whether the use of foundation cream containing ethyl cinnamate was safe to use and did not cause irritation. The experimental procedure of irritation test was approved by the ethics committee of Sekolah Tinggi Ilmu Farmasi Semarang (291b/AHW-SW/KEPK/STIFAR/EC/X/2021). The variables observed in the irritation test in this study were the presence of erythema and edema. The presence of erythema and edema can be used as a parameter which indicates irritation (Figure 3). The results of this test indicate that the foundation cream containing ethyl cinnamate does not cause erythema and edema in 10 probands (with each of probandus score is 0), so it could be concluded that the foundation cream preparation containing ethyl cinnamate does not cause irritation to humans and is safe to use. (Nigam, 2019; Walters *et al*., 2015).

CONCLUSION

The optimum ratio of polysorbate 80 and sorbitan monooleat 80 were 9.565 and 1.435, which had given the ethyl cinnamate foundation did not irritate the skin, making it safe to wear. It also provided effective protection from UV radiation. Stability test is needed in further study such as needed to determine the expiration date and beyond use date.

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