Advances in Health Sciences Research, volume 40
2nd International Conference on Contemporary Science and Clinical Pharmacy 2021 (ICCSCP 2021)

Formula Optimization of a Sunscreen Cream of Tomato‘s Purified Extract

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ABSTRACT
Tomatoes are rich in lycopene; a strong antioxidant and a potential sunscreen agent. The use of tomatoe ‘s extract is limited as functional foods, not much as cosmeceutical raw materials. This study aims to optimize the formulation of sunscreen cream of purified tomato extract and to evaluate the sunscreen activity by determination of the Sun Protection Factor (SPF). The formula consisted of virgin olive oil as an oil phase, Olivem®1000 as cream base and water. Optimization was performed by using factorial design of 4 factors and 2 levels. The independent variables are the concentration of Olivem® (2% and 5%), olive oil (10% and 20%), stirring time (10 and 30 minutes), and stirring speed (800 rpm and 1500 rpm). The dependent variables are viscosity and globule size of the globules. Data were analyzed using Design Expert software. The optimum formula was chosen based on the intersection of the results of the superimposed contour plot. Results showed that the optimum formula obtained was the concentration of Olivem® 3.14%; olive oil 16.91%; stirring speed 828.91 rpm; and stirring time 27.88%. The SPF value of tomatoes extract sunscreen cream was 21.09.

Keywords: *Tomato, optimization, cream, sunscreen, factorial design*

1. INTRODUCTION

Sunscreen creams are cosmetic preparations that can scatter, reflect, or absorb the sunlight effectively, especially in the area of UV radiation [1]. Most of the active ingredients for sunscreen are synthetic materials, which often have toxic and irritating effects on the skin. Natural components are considered safer to use because they are harmless and do not cause irritation when applied to the skin. Natural ingredients have a potential as sunscreening agents because of their ability to block the UV radiation, such as phytoconstituents in Aloe vera, tomatoe, pomegranate, green tea, cucumber, grapes, and Ficus deltoides [2,3].

Tomatoes are a natural source of antioxidants because it contains lycopene. Lycopene can scavenge reactive oxygen species (ROS) twice better than β-carotene, and ten times better than α-tocopherol [4]. Tomatoes are classified as very perishable commodities, because of its water content ≥ 93% [5]. Therefore tomatoes are often thrown away or left rotten on the stems when overproduction occurs. Tomatoes need to be processed to extend the shelf life and produce useful products such as jams and sauce.

Literature search showed that processing tomatoes by heating resulted in a better yield of lycopene and cause a transformation from a trans to a cis isomer of lycopene, which is more easily absorbed by the body [6]. The chemical structure of lycopene (Figure 1) is characterized by a long polyene chain that can capture free radicals and potential to adsorb UV radiation. This study aims to optimize the formulation of a sunscreen cream of the purified tomato extract using Olivem® and olive oil, and evaluate the physicochemical properties of the dosage form.

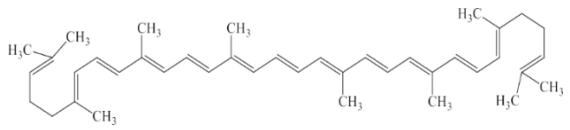

Figure 1. Chemical Structure of Lycopene.

2. METHODS

2.1 Tomato Paste

1 kg of tomatoes were washed, steamed for 5 minutes, and crushed using a blender for ± 2 minutes until smooth. The tomato pure was heated on a water bath while stirring for 1 hour. The temperature during the evaporation process was kept constant at 80 ^{o}C.

2.2 Tomato Paste Extract

Tomato paste was fractionated with chloroform and water in a separatory funnel, then shaken. It was left for 24 hours to form 2 layers, the chloroform layer was taken and concentrated using a rotary evaporator at 45^{o}C to obtain a thick extract.

2.3 Extract Standardization

2.3.1 Thin Layer Chromatography (TLC) Profile

Silica gel was used as the stationary phase. The eluent consisted of ethyl acetate: methanol (4:6). The extract was dissolved in chloroform with a concentration of 100 µg/mL, then spotted on a TLC plate and eluted to the boundary line. The Rf value of the resulting spot was determined [7].

2.3.2 Determination of the maximum absorption wavelength of lycopene in the purified extract

The extract was dissolved in chloroform with a concentration of 50 µg/mL. The absorption spectrum was measured using a UV-Vis spectrophotometer at a wavelength of 400-800 nm.

2.4 Optimization of Cream Formula

The optimization was conducted by using an experimental design consisted of four factors and two levels, sixteen (2^4) formulas were prepared as described in Table 1. The independent variables were processing conditions (stirring time and speed) and the composition of cream ingredients (concentration of Olivem® and olive oil). The dependent variables were the viscosity and the globule size of cream.

Optimization of the stirring speed was carried out for 10 minutes at various stirring speeds, starting from 200 rpm, 400 rpm, 600 rpm, 800 rpm, 1100 rpm, to 1500 rpm. The level of stirring speeds used in Table 1 were selected from the resulting globule size of the cream base. Optimization of the stirring time of cream base preparation was performed with the same steps as the optimization of the stirring speed, but at various stirring times. The selected stirring times (Table 1) was determined by observation of the resulting globule size.

Table 1. Cream base formula

Formula	Olivem	Olive oil	Aquadest	Stirring time (minutes)	Stirring speed (rpm)
A1	2%	10%	88%	10	800
A2					1500
A3				30	800
A4					1500
B1		20%	78%	10	800
B2					1500
B3				30	800
B4					1500
C1	5%	10%	75%	10	800
C2					1500
C3				30	800
C4					1500
D1		20%	85%	10	800
D2					1500
D3				30	800
D4					1500

In the preparation of cream, the oil phase and the water phase were heated separately at the same temperature (70°C). The water phase was added into the oil phase consisting of Olivem® 1000, olive oil, and purified tomato extract slowly while continuously stirring using a magnetic stirrer (IKA, Germany) with a stirring speed and time as described in Table 1, left the cream on the magnetic stirrer while stirring until a homogeneous cream mass was formed.

2.5 Evaluation of the Cream

2.5.1 Organoleptic observation

Organoleptic observations were done visually including the physical form, color, and the smell of cream [8].

2.5.2 Homogeneity

The examination was carried out by applying 0.1 gram of the preparation on a slide or other suitable transparent material, and observed. It should be homogeneous and should not show any particle specks [9].

2.5.3 pH examination

pH examination was carried out using a pH meter (Hanna Instrument, Germany). The instrument was calibrated previously with a standard pH solution of pH 4 and 9. The electrodes were washed with distilled water and then dried. Measurements were carried out by diluting 1 gram of the preparation with distilled water to 10 mL. The electrode was immersed into the tested solution. The number shown by the pH meter is the pH value of the preparation [8].

2.5.4 Globule size examination

The globule size distribution was performed by using a microscope equipped with Optilab® (Olympus). A small amount of the cream was put on the object-glass covered with a cover glass. The size distribution of at least 300 globules was observed at 400 magnification [10].

2.5.5 Viscosity Measurement

Viscosity was measured using a Brookfield Viscometer (DV2T, USA). Measurements were carried out at a set speed starting from 0.5; 1; 2; 2.5; 5; 10; and 20 rpm, then reversed by 20; 10; 5; 2.5; 2; 1; and 0.5 rpm. Rheograms were made by plotting the shearing stress (dyne/cm2) against the shearing velocity (rpm) [11].

2.5.6 Cream type examination

The examination was carried out by staining the cream with methylene blue solution. Observation of the cream type was done visually [8].

2.5.7 Physical Stability Test

The preparation was stored at 4ºC for 24 hours and then transferred to an oven at 40ºC for 24 hours for one cycle, examination were carried out for 7 cycles. The cream was observed whether a phase separation occured [11].

2.5.8 Irritation Test

The skin irritation test was carried out directly on 12 human volunteers using a patch test on the inner arm of volunteers. Approximately 0.5 gram of cream was applied to the inner arm two times a day. Observation was made after 24 hours, to check whether there were swelling, itchiness or redness on the contact skin [12, 13].

2.5.9 Determination of the SPF value

The SPF value determination was carried out in vitro with and without ultraviolet light exposures to the cream. The preparation was dissolved with chloroform to obtain the concentration of 200 µg/mL. The absorbance of the solution was determined in the wavelength range of 290-320 nm at each 5 nm increment, chloroform was used as a blank. The data obtained were processed using the Mansur equation as described below [14,15].

$$\text{SPF} = \text{CF} \times \sum_{290}^{320} EE\ (\lambda) \times I\ (\lambda) \times \text{Abs}\ (\lambda) \quad (1)$$

Where: EE = erythemal effect spectrum; I = solar intensity spectrum; Abs = absorbance of sunscreen product; CF = correction factor. The values of EE x I are constant. They were determined by Sayre *et al.* (1979), and are showed in Table 2 [16].

Table 2 The values of EE x I

Wavelength (λ)	**EE x I**
290	0.015
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0839
320	0.0180

2.6 Data Analysis

The viscosity and globule size of the cream base were analyzed using the Design Expert 11®. An equation related to the response value and an optimum formula is obtained with predictions of theoretical results

3. RESULTS AND DISCUSSION

3.1. Characterization of the purified extract of tomatoes

3.1.1. TLC Profile

The Rf value of the lycopene in the purified extract was 0.6666. The results obtained are the same as previous studies, these results confirmed the identity of the purified extract used as lycopene.

b. Determination of the maximum absorption wavelength of lycopene in the extract

The UV-VIS spectrum showed that there are three peaks at the wavelengths of 457 nm, 484 nm, and, 517 nm, respectively (Figure 2). This spectrum is similar to the spectrum of standard lycopene (Figure 3) with the wavelengths of 456 nm, 484 nm and, 517 nm. The maximum wavelengths of lycopene in chloroform in the literature are 458 nm; 484 nm; 518 nm [17].

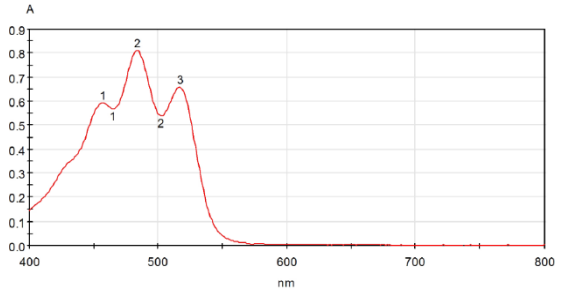

Figure 2. The maximum wavelength of tomatoes purified extract obtained by UV-Vis Spectrophotometer

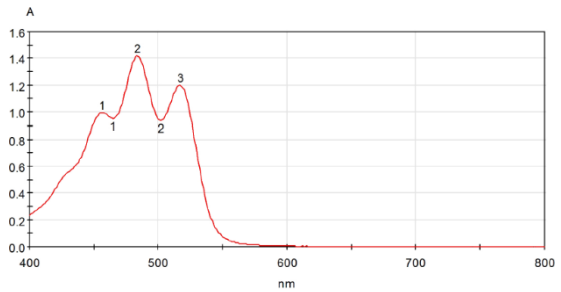

Figure 3. The maximum wavelength of standard lycopene obtained by UV-Vis Spectrophotometer

3.2 Optimization of Cream Base Formula

Results showed that the cream base with higher stirring speeds have a smaller globule size than those with lower stirring speeds (Table 3). Therefore, the stirring speed levels used to optimize the preparation are 800 and 1500 rpm, respectively.

Table 3 The globule size of the cream base at various stirring speed

Stirring speed (rpm)	Globule size (µm)
200	135.75
400	121.47
600	100.60
800	90.90
1100	78.21
1500	62.36

3.3 Evaluation of Cream base formula

3.3.1 Organoleptic

Formula A1, A4, and B2 were having white color, odorless, semisolid, slightly watery and foamy characteristics. While formulas A2, A4, B1, B3, and B4 were having yellowish white color, odorless, semisolid and slightly watery properties. Formula C1, C2, C3, C4, D1, D2, D3, and D4 were having a yellowish white color, odorless and semisolid form.

3.3.2 Homogeneity

The results of the homogeneity examination showed that all formulas were homogeneous. This is indicated by the absence of any particle specks in the transparent material

3.3.3 pH examination

The results in Table 4 show that the pH values of cream are varied, the sixteen formulas meet the requirements as sunscreen cream preparations, because sunscreen cream preparations have a pH range of 4.0 – 8.0 [18].

3.3.4 Globule size examination

Results in Table 4 show that the average globule size of sixteen formulas is in the range of 61.80 - 92.29. The

lowest average globule size is formula C4 and the highest is formula C3 and D4.

3.3.5 Viscosity Measurement

The rheogram in Figure 4 shows the thixotropic flow property of Formula D3. All the sixteen formulas show the same flow properties. Flow properties and viscosity are interrelated quality control parameters. The viscosity of the cream was described in Table 4.

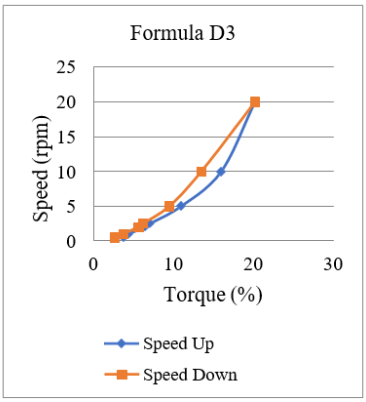

Figure 4. The rheogram of Formula D3

Table 4. The pH value, globule size, and viscosity of the cream base

Formula	pH	Globule size (µm)	Viscosity (cP)
A1	5.9	68.43	2,500
A2	7.1	65.56	4,100
A3	7.4	73.67	2,450
A4	7.1	68.02	2,600
B1	7.0	78.07	4,150
B2	7.2	84.49	4,050
B3	7.2	79.41	4,500
B4	7.1	85.75	4,520
C1	7.2	69.55	11,500
C2	7.2	68.08	8,550
C3	7.2	92.29	10,150
C4	7.1	61.80	7,800
D1	7.0	90.90	14,000
D2	7.2	73.15	17,550
D3	7.4	62.36	14,250
D4	7.0	92.29	11,550

3.3.6 Cream type examination

All formulas are oil-in-water type of emulsion because the methylene blue solution colors the entire cream base, leaving the oily phase globules colorless.

3.3.7 Cream Stability Test

The freeze and thaw test for 7 cycles show that all formulas are physically stable. There are no changes in shape, color, and odor occurred during examination.

3.4 Data analysis

The data obtained are analyzed using Design Expert® 11 software to find an optimal cream formula. The superimposed contour plot in Figure 5 the shows the yellow area which refers to the predicted optimum area for the desired sunscreen cream formula.

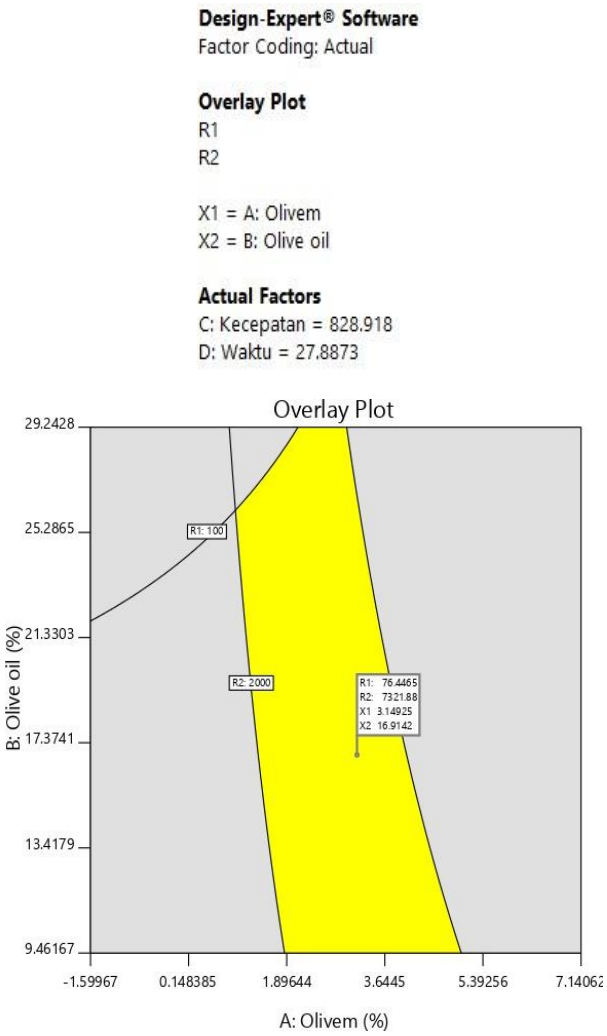

Figure 5. Superimposed contour plot of the purified tomato extract cream

The selected point in the overlay plot (Figure 5) is the composition with Olivem® concentration of 3.1492% and olive oil 16.9142% with a speed of 828.9180 rpm for

27.8873 minutes. At that point, the viscosity value is 7321.88 cP and the particle size is 76.4465 µm. A purified tomato extract cream containing the optimum composition and conditions was then prepared for confirmation. Figure 6 is the optimum formulation of tomatoes purified extract cream, and data in Table 5 showed the physicochemical properties of the optimum cream formulation.

Figure 6. The optimum formulation of Tomatoes Purified Extract Sunscreen Cream

Statistical analysis using an independent sample T-test is employed to check the validity between the theoretical results and the optimum. Data in Table 6 show the p-value > 0.05, which means that there is no significant difference between the theoretical and the experimental results.

Table 5. The physicochemical properties of purified tomato extract optimal cream formulation

Evaluation	Result
Organoleptic	Semi - solid, yellow and odorless
Homogeneity	Homogenous
pH	6.7
Globule size	63.37
Type cream	Oil in water
Stability	Stable
Irritation test	Not irritating
Viscocity	10,250 cP
SPF	21.09

The data obtained from the SPF value determination of tomatoes purified extract sunscreen cream in Table 7 were analyzed using equation (1). The sum of EE x I x A at seven different wavelengths is 0.7383 with a correction factor of 28.56, the SPF obtained is 21.09 which is classified as having an ultra protection against UV radiation (SPF value ≥15).

Table 6. Validation of the Optimum formula using a T-test

Response	Predicted value	Experimental value	p-values
Viscosity (cP)	7,321.88	7.850	0.4580
Globule size (µm)	76.4465	78.31	0.527

Table 7. The data of SPF values determination of the purified tomatoe extract sunscreen cream

λ	Abs 1	Abs 2	Abs 3	EE x I	EE x I x Ābs
290	0.906	0,906	0.906	0.0150	0.0136
295	0.826	0.827	0.828	0.0817	0.0676
305	0.768	0.769	0.770	0.2874	0.2210
300	0.731	0.731	0.731	0.3278	0.2396
310	0.692	0.692	0.692	0.1864	0.1290
315	0.665	0.665	0.665	0.0839	0.0558
320	0.652	0.652	0.652	0.0180	0.0117
∑					0.7383

4. CONCLUSION

The optimum formula of the purified tomato extract sunscreen cream is at concentrations of Olivem® 3.14% and olive oil 16.91%, stirring speed 828.91 rpm and stirring time 27.88 minutes. The formula obtained a viscosity value of 7850 cP and a globule size of 78.31 µm. The sunscreen cream provides ultra protection against UV radiation because it has an SPF value of 21.09.

REFERENCES

[1] Wilkinson JB. Moore R. editors. *Harry's Cosmeticology: The Principles and Practice and Practice of Modern Cosmetic*. Seventh Ed. London: Leonard Hill Book; 1982.

[2] Priyanka Kantivan Goswami. Mayuri Samant. Rashmi Srivastava. Natural Sunscreen Agents: A Review. *Scholars Academic Journal of Pharmacy*. 2013; 2(6):458-463.

[3] Suryati . Henny Lucida . Dachriyanus. Formulation of Sunscreen Cream of Germanicol cinnamate from the Leaves of Tabat barito (Ficus deltoides Jack) and an Assay of its' Sun Protection Factor. *Int. J. Pharm. Sci. Rev. Res*. 2015; 32(1): 104-107.

[4] Agarwal S. Rao AV. Tomato Lycopene and its Role in Human Health and Chronic Diseases. *Canadian Medical Association Journal*. 2000;163(6):23–6.

[5] Chairunnisa R. Pengaruh Jumlah Pasta Tomat Terhadap Penurunan Kadar GulaDarah pada Mencit Diabetes. *Jurnal Teknologi Industri Pertanian*. 2012;1–12.

[6] Stahl W. Sies H. Uptake of Lycopene and Its Geometrical Isomers Is Greater from Heat-Processed than from Unprocessed

[7] O'neil MJ. editor. *The Merck Index: An Encyclopedia of Chemicals. Drug andBiologicals*. 14th ed. New Jersey: Merck and Co. Inc; 2006.

[8] Voigt R. *Buku Pelajaran Teknologi Farmasi*. Yogyakarta: Gadjah Mada University Press; 1994.

[9] Departemen Kesehatan RI. *Farmakope Indonesia Edisi III*. Jakarta: DepartemenKesehatan Republik Indonesia; 1979

[10] Martin A. *Farmasi Fisik*. Edisi Ketiga. Jakarta: Universitas Indonesia Press; 1993.

[11] Rieger M. *Harry's Cosmeticology*. Eight. New York: Chemical Publishing Co Inc; 2000.

[12] Tranggono, R.I., dan Latifah, F. (2007). *Buku Pegangan Ilmu Pengetahuan Kosmetik*. Jakarta: PT. Gramedia Pustaka Utama.

[13] Wasitaatmadja, S.M. (1997). *Penuntun Ilmu Kosmetik Medik*. Jakarta: Universitas Indonesia.

[14] de Oliveira Junior RG. Araújo C de S. Souza GR. Guimarães AL. de Oliveira AP. de Lima-Saraiva SRG. et al. In Vitro Antioxidant and Photoprotective Activities of Dried Extracts from Neoglaziovia Variegata (Bromeliaceae). *Journal of Applied Pharmaceutical Science*. 2013;3(1):122–7.

[15] Dutra EA. Olviera DAG da C. Kedorheckman ERM. Santoro MIRM. Determination of Sun Protection Factor (SPF) of Sunscreens by Ultraviolet Spectrophotometry. *Brizilian Journal of Pharmaceutical Sciences*.2004;40(3):381–5.

[16] Sayre, R. M.; Agin, P. P.; Levee, G. J.; Marlowe, E. Comparison Of *In Vivo* And In Vitro Testing of Sunscreening Formulas. *Photochem. Photobiol.* 1979.

[17] Britton G. Liaaen-Jensen S. Pfander H. editors. *Carotenoids*. I. Berlin: Bitkhauser Verlag Basel; 1985.

[18] SNI. *Sediaan Tabir Surya* -. 1996.