Formulaon and SPF Evaluation of a Lip Oil Serum Combining Ethanol Extract of Butterfly Pea Flower and Lavender Oil

Nurus Shobah Salsabila, Annisa Fatmawati*), Sundari Desi Nuryanti, Emelda, Ade Puspitasari, Latifa Amalia
Bachelor of Pharmacy Program, Faculty of Health Sciences, Alma Ata University
*email: annisafatma20@almaata.ac.id

Abstract

Exposure to ultraviolet (UV) radiation due to ozone layer depletion increases the risk of skin damage, particularly on the lips, which are more vulnerable due to their lack of melanin and sebaceous glands. This study aimed to formulate and evaluate the Sun Protection Factor (SPF) of a lip oil serum containing ethanol extract of butterfly pea flower (*Clitoria ternatea* L.) and lavender oil (*Lavandula angustifolia*). The formulation was prepared in a single base with four variants: a control (F0) and three active concentrations (F1, F2, F3). Physical evaluations included organoleptic tests, homogeneity, pH, spreadability, adhesion, and viscosity. The SPF values were assessed in vitro using UV-Vis spectrophotometry. All formulations demonstrated acceptable physical stability with pH values between 6.7–7.33, spreadability ranging from 6.85–7.34 cm, adhesion from 3.51–5.07 seconds, and viscosity from 777.6–839 cPS. The SPF increased proportionally with lavender oil concentration (F1 = 3.70, F2 = 4.09, F3 = 4.25), showing a strong positive correlation (r = 0.969). These findings suggest that the combined use of butterfly pea extract and lavender oil may offer mild UV protection and desirable physical properties, making it a promising candidate for natural, herbal-based lip care products.

Keywords: butterfly pea flower, lavender oil, lip oil serum, SPF

1. INTRODUCTION

The depletion of the ozone layer leads to an increase in the intensity of ultraviolet (UV) radiation that adversely affects human skin, especially lips that tend to be more sensitive because they lack natural protection such as hair follicles and sweat glands. UV rays can trigger skin damage, premature aging, and the risk of skin cancer. This drives the need for lip care products that not only moisturize but also have UV protection (Suleman et al., 2022).

As awareness of the dangers of synthetic ingredients in cosmetics increases, people are starting to switch to natural products that are considered safer. Herbal ingredients have great potential because they contain bioactive compounds such as flavonoids, phenolic compounds, and essential oils that can act as antioxidants as well as natural photoprotective agents (Allemann 2008).

Butterfly pea flower extract (*Clitoria ternatea* L.) contains anthocyanins and flavonoids that can absorb UV rays and have a high Sun Protection Factor (SPF) value

(Puspitasari et al., 2019). Meanwhile, lavender oil (*Lavandula angustifolia*) is known to contain linalool and linalyl acetate, compounds that act as antioxidants and have a protective effect against UV exposure (Jhabarmal et al., 2018). As explained in the Qur'an Surah Ash-Shu'ara verse 7:

أَوَلَمْ يَرَوْا۟ إِلَى ٱلْأَرْضِ كَمْ أَنۢبَتْنَا فِيهَا مِن كُلِّ زَوْجٍ كَرِيمٍ

"And do they not consider the earth, how much We have planted therein of every good herb?" (QS. Ash-Shu'ara: 7)

This verse emphasizes that plants have great benefits for humans, including in the fields of health and beauty. Therefore, cosmetic formulations based on herbal ingredients such as bay flower and lavender oil can be a relevant alternative and in accordance with a safer and more sustainable natural approach.

Based on the above problems, a lip oil serum preparation was developed, in which ethanol extract of butterfly pea flower is combined with lavender oil. This study also evaluated the physical properties and SPF value of the preparation in vitro using UV-Vis spectrophotometry.

2. METHOD

MATERIALS

The tools used are Uv-Vis Spectrophotometer (Thermo Scientific Evolution™ 201/220), analytical balance (Ohaus), maceration jar, aluminum foil, glassware (Iwaki), waterbath (Memmert), stirring rod, object glass, cover glass, lip oil serum container, pH universal, extensometer, ruler, viscometer (NDJ-5S), adhesion tester, filter paper. The materials used are bay flower simplisia powder, lavender oil, 70% ethanol, cera alba, liquid paraffin, tocopherol, nipasol, glycerin, 5% $FeCl_3$, concentrated HCl, and Mg powder.

Butterfly pea flower simplisia powder and lavender oil were obtained from Lansida Herbal Technology located at Jalan Karanglo, No. 519, Bumen KG III, Purbayan, Kec. Kotagede, Yogyakarta City, Yogyakarta Special Region 55173 which both have a Certificate of Analysis (CoA).

EXTRACTION

A total of 500 grams of butterfly pea flower powder was macerated for 24 hours in a ratio of 1:5 using 2.5 L of 70% ethanol. After that, the mixture was filtered using flannel cloth and filter paper. The filtrate obtained was then evaporated using a waterbath at 60^{o}C until a thick extract was obtained (Salsabila et al., 2022).

PHYTOCHEMICAL SCREENING

Identification of phenolic compounds is done by adding the extract to a test tube, the sample is added 5% $FeCl_3$ reagent. The formation of blue to blackish color indicates positive phenolic. Identification of flavonoid compounds is done by adding a little Mg powder and dropping concentrated HCl into the test tube into the test tube that has been filled with the test sample. Positive results are indicated by the formation of red-orange color on the test sample (Syamsudin et al., 2022).

FORMULATION OF LIP OIL SERUM

The lip oil serum formula used in this formulation was adopted from Setiawati's (2019) research, as shown in Table 1. The active ingredients in this study, butterfly pea flower and lavender oil, were formulated in three concentrations: formula 1 (2% butterfly pea flower; 0.5% lavender oil), formula 2 (1.25% butterfly pea flower; 1.25% lavender oil), and formula 3 (0.5% butterfly pea flower; 2% lavender oil). The formula 0 used was a lip oil serum base without active ingredients.

Table 1. Formula Lip oil serum Combination of Ethanol Extract of Butterfly Pea Flower and Lavender Oil

Ingredients	F0 (%)	F1 (%)	F2 (%)	F3 (%)	Function
Butterfly pea flower extract	-	2	1.25	0.5	Active substance
Lavender oil	-	0.5	1.25	2	Active substance and parfume
Liquid Paraffin	10	10	10	10	Emollient
Beeswax	3	3	3	3	Emulsifier
Tocopherol	0.5	0.5	0.5	0.5	Antioxidant
Nipasol	0.5	0.5	0.5	0.5	Prevervative
Gliceryn	3	3	3	3	Humectant
Castor oil	Ad 100	Ad 100	Ad 100	Ad 100	Solvent

Lip oil serum was prepared by direct melting and mixing method. Beeswax was melted at low temperature, and then a mixture of tocopherol and castor oil was added while stirring until uniform. After that, nipasol, glycerin, and liquid paraffin were gradually introduced into the mixture. Butterfly pea flower extract and lavender oil were added at the final stage, and the mixture was stirred until homogeneous. The formed preparation was then poured into a container. Three formulas were made with varying concentrations of active ingredients.

EVALUATION TEST OF LIP OIL SERUM

The evaluation of the lip oil serum involved several tests, including organoleptic, homogeneity, adhesion, spreadability, pH and viscosity (Ambari et al., 2020).

Organoleptic Test

Test organoleptically using the five senses, which consists of testing the color, smell, and texture of the preparation (Ambari et al., 2020).

Homogeneity Test

The homogeneity test was conducted by weighing 0.5 grams of lip oil serum preparation and applying it to the glass slide. After that, observe the presence of coarse particles by feeling them. A homogeneous preparation is one that shows no coarse particles (Desnita et al., 2022).

Adhesion Test

The adhesion test was conducted by weighing 0.25 grams of lip oil serum preparation and placing it on an object glass. Then, stick the two pairs of object glasses together until they are joined. Apply a weight of 1 kg for 5 minutes, then release. Next, apply a weight of 80 grams and record the time until the two object glasses separate. Repeat this process three times (Ambari et al., 2020).

Spreadability Test

The spreading power test was conducted by weighing 0.5 grams of lip oil serum preparation. Then, place the preparation on a spreading power test device consisting of a glass plate with a scale paper as its base, and cover it with a matching glass plate by adding weights of 50 g, 100 g, 150 g, and 200 g periodically. This procedure is repeated three times using the same steps. Good spreadability ranges from 5 to 7 cm (Ambari et al., 2020).

pH Test

The pH test is conducted by dissolving 2 grams of lip oil serum preparation into 20 mL of distilled water, then dipping a universal pH indicator into the solution. The pH value obtained should be within the neutral range, neither too acidic nor too alkaline. A pH that is too acidic may cause skin irritation, while a pH that is too alkaline can lead to dry or flaky skin. The physiological pH range of human skin is between 4.5 and 6.5 (Sawiji, 2024).

Viscosity Test

Viscosity testing is conducted using a Brookfield viscometer. Select the spindle number and speed to be used. The sample is placed on the Brookfield viscometer until the spindle reaches the sample. Run the Brookfield viscometer until the viscosity value of the sample is read (Sawiji, 2024).

DETERMINATION OF SPF VALUE OF LIP OIL SERUM

The SPF value was determined in vitro using a UV-Vis spectrophotometer to assess its effectiveness as a sunscreen. The preparations were diluted to 5000 ppm by taking 0.5 grams of each formula (F0, F1, F2, and F3) and dissolving them in 10 mL of 70% ethanol, then shaking until homogeneous. Then, 1 mL of the stock solution was diluted in 10 mL of 70% ethanol. Subsequently, measurements were taken using 70% ethanol as a blank, and an absorption curve was plotted in a cuvette over the wavelength range of 290–320 nm. The average absorption value (Ar) was measured at 5 nm intervals and recorded to calculate the SPF value. The absorbance results are recorded, and the SPF value of the lip oil serum formulation is calculated using the Mansur equation (Kurnianto & Rahman, 2021):

$$SPF = CF \times \sum^{320} EE\ (\lambda) \times I\ (\lambda) \times \mathrm{A}bs\ (\lambda)$$

Notes:

CF = Correction factor

EE = Erythema effect spectrum

I = Sun intensity spectrum

Abs = Absorbance

DATA ANALYSIS

The data analysis in this study was conducted using SPSS version 25. The statistical test used was the Kruskal-Wallis test to assess the differences in SPF values between formulas, followed by the Tukey HSD post hoc test to identify significant differences between treatment groups. This analysis aimed to determine the effectiveness of each formula in providing protection against UV rays (Bhirawa, 2020).

3. RESULT AND DISCUSSION

EXTRACTION

Extraction in this study was performed using the maceration method because the procedure is simple and does not require heating, thereby maintaining the stability of

thermolabile compounds such as flavonoids and anthocyanins. This method involves soaking the powdered crude drug in 70% ethanol solvent. The use of 70% ethanol was chosen because ethanol can extract more active compounds compared to other organic solvents. This concentration of ethanol is also safer, non-toxic, and widely used in natural-based cosmetic formulations. Compared to 96% ethanol, 70% ethanol has a higher polarity level, which supports the solvent's penetration into plant cell walls and dissolves polar compounds more optimally. The ethanol extract yield of butterfly pea flowers was 37.4%, which meets the requirements for concentrated extract yield according to the Indonesian Herbal Pharmacopoeia, which stipulates a minimum value of 10% (Departemen Kesehatan Republik Indonesia, 2022).

PHYTOCHEMICAL SCREENING

This study identified phenolic compounds and flavonoids in ethanol extracts of butterfly pea flowers. Based on the results, ethanol extracts of butterfly pea flowers were found to contain phenolic compounds and flavonoids. Positive results were indicated by a change in the color of the solution to black or dark blue for phenolic compounds and to red for flavonoids (Syamsudin et al., 2022), as shown in Table 2.

Table 2. Phytochemical Screening Results of Ethanol Extract of Butterfly pea Flower

Sampel	Senyawa	Pereaksi	Hasil	Keterangan
Butterfly pea flower extract	Phenolic	$FeCl_3$ 5%	+	Blackish Blue Solution
	Flavonoid	Mg + Condensed HCl	+	Reddish Solution

Previous research showed that ethanol extract of butterfly pea flowers has a total phenolic content of 19.43 ± 1.621 mg GAE/g sample (Andriani & Murtisiwi, 2019). This finding was reinforced by a study by Kumar et al. (2023), which revealed that butterfly pea flowers (*Clitoria ternatea* L.) contain high levels of flavonoids, as evidenced by the characteristic color reaction in the Shinoda test. The high levels of phenolic compounds and flavonoids contribute to the pharmacological activity of butterfly pea flowers, particularly as antioxidants (Kumar & Manoj Kumar, 2019).

EVALUATION TEST OF LIP OIL SERUM

The evaluation of the lip oil serum involved several tests, including organoleptic, homogeneity, adhesion, spreadability, pH and viscosity. The results are summarized in Table 3.

Table 3. Results of Physical Properties Evaluation of Lip Oil Serum Preparation Combination of Ethanol Extract of Butterfly pea Flower with Lavender Oil

No	Physical Caracteristics	F0	F1	F2	F3
1	Organoleptic				
	Colour	Pale White	Dark Green	Green	Light Green
	Odor	None	Lavender	Lavender	Lavender
	Texture	Semi-solid and smooth	Semi-solid and smooth	Semi-solid and smooth	Semi-solid and smooth
2	Homogeneity	Homogeneous	Homogeneous	Homogenous	Homogeneous
3	Adhesion	2.27 ± 0.17	5.07 ± 0.54	4.11 ± 0.10	3.506 ± 0.19
4	Spreadability	7.05 ± 0.15	6.85 ± 0.22	6.93 ± 0.21	7.34 ± 0.15
5	pH	6.33 ± 0.58	6.7 ± 0.58	7.33 ± 0.58	7 ± 0,00
6	Viskosity	728 ± 25.16	839 ± 17.52	811 ± 4.36	777.6 ± 5.13

Description: F0: Lip oil serum base
F1: Lip oil serum with 2% EEBT and 0.5% Lavender Oil
F2: Lip oil serum with 1.25% EEBT and 1.25% Lavender Oil
F3: Lip oil serum with 0.5% EEBT and 2% Lavender Oil

The results of organoleptic observations of lip oil serum combining ethanol extract of butterfly pea flowers with lavender oil showed that all four formulas had a smooth, semi-solid texture. Formula 0 was pale white with no aroma, while the other three formulas were green . This was due to differences in polarity: EEBT is polar, while the lip oil serum base is non-polar (Rahmah et al., 2023). Therefore, the anthocyanin compounds, which are the natural pigments from the butterfly pea flower and are polar in nature, do not dissolve completely and only produce a green color that becomes lighter as the extract concentration decreases.

All formulas produced homogeneous preparations, which means that no coarse particles or phase separation were found (Desnita et al., 2022). The success in homogeneity is also supported by a good stirring process and formulations using castor oil and liquid paraffin as effective solvents for lipophilic compounds.

The adhesion test is conducted to determine the ability of the preparation to stick to the skin surface within a certain period of time. All formulas meet the requirements of the adhesion test, which is > 1 second (Sawiji, 2024). Increasing the concentration of butterfly pea flower extract significantly ($p<0.05$) increased the adhesion, as seen in F1 (EEBT 2%) which showed the highest adhesion.

Spreadability is an indicator of the ability of the preparation to spread evenly on the surface of the lip skin. The test results show that all formulas are still within the ideal limits

for lip products (5-7 cm), except F3 which slightly exceeds the upper limit, but is still acceptable because it has the potential to provide wider wearing comfort when applied (Budiarti et al., 2023).

The pH value of the preparation is very important for user comfort and safety, considering that lip skin is sensitive. The pH test results show that all lip oil serum formulas have an average pH value between 6.34 and 7.33, which is still within the physiological tolerance range of the lip mucosa (6.28-7.34) (Aframian et al., 2006). Although slightly exceeding the ideal pH limit of lip cosmetics (4.5-6.5), the value is still acceptable because it supports comfort and does not cause irritation. Ph stability between formulas showed that the addition of active ingredients did not significantly affect the acidity of the preparation, possibly due to the buffering role of glycerin and the neutral nature of the vegetable oils used.

Viscosity measures the thickness of a preparation, which affects its stability and comfort during use. All lip oil serum formulas exhibit viscosity within the ideal range. This is in accordance with the viscosity standard for topical serum preparations, which is between 230–3000 cPS (Sawiji, 2024). The increase in viscosity in F1 can be attributed to the higher concentration of EEBT, which tends to increase thickness due to the presence of polar polysaccharide and flavonoid fractions that partially dissolve in the oil phase. Meanwhile, the lower viscosity of F3 is caused by the high concentration of lavender oil, which has a light and easily spreadable nature, thereby reducing the thickness of the formulation. Viscosity is related to adhesion and spreadability. Viscosity and adhesion are directly proportional; the higher the viscosity, the longer the adhesion time of the formulation. Meanwhile, viscosity and spreadability have an inverse relationship; the lower the viscosity, the greater the spreadability of the formulation, and vice versa (Shradha Amraj et al., 2025).

DETERMINATION OF SPF VALUE OF LIP OIL SERUM

The Sun Protection Factor (SPF) test results showed consecutive values for formulas F0 (3.48), F1 (3.70), F2 (4.08), and F3 (4.25). Based on the BPOM RI (2020) classification, F0 and F1 are categorized as low protection, while F2 and F3 are classified as medium, as shown in Table 4.

Table 4. Results of Determination of SPF Value of Lip oil serum Preparation

Formula	R	SPF Value	Average ± SD	SPF Category
F0	1	3.478	3.48 ± 0.11[a]	Low
	2	3.598		
	3	3.372		
F1	1	3.790	3.70 ± 0.09[ab]	Low
	2	3.720		
	3	3.604		
F2	1	4.089	4.08 ± 0.03[b]	Medium
	2	4.056		
	3	4.110		
F3	1	4.259	4.25 ± 0.03[b]	Medium
	2	4.268		
	3	4.220		

[ab] Different letter notations indicate significant differences ($p < 0.05$) based on Tukey HSD test.

The increase in SPF value is in line with the increase in concentration of active ingredients, especially lavender oil, which is known to have an optimal UV absorption spectrum at 220-300 nm and protective activity against UV rays (Mali Shri Jagdishprasad Jhabarmal et al., 2018).

Formula F3 containing 0.5% butterfly pea flower extract and 2% lavender oil showed the highest SPF value, indicating a significant contribution from lavender oil. Butterfly pea flower extract also plays a role, albeit in small concentrations, through its anthocyanin content, which absorbs UV rays. However, the SPF value has not yet reached the high category, presumably due to the relatively low concentration of active ingredients.

DATA ANALYSIS

The results of data analysis showed a normal distribution (Shapiro–Wilk $p > 0.05$) and homogeneity of variance (Levene $p > 0.05$). The ANOVA test results showed significant differences between formulas ($p < 0.001$), and the Tukey HSD post-hoc test revealed significant differences between F1 and F3 ($p < 0.05$), while F0–F1 and F2–F3 were not significantly different. The Pearson correlation coefficient value of 0.969 indicates a very strong relationship between the increase in active ingredient concentration and the SPF value. Further development suggestions include increasing the concentration of active ingredients to obtain higher protection, along with safety and comfort of use.

4. CONCLUSION

The lip oil serum formulation with a combination of butterfly pea flower extract and lavender oil showed low to moderate sunscreen activity. There is a significant effect of variations in active ingredient concentration on SPF values. A strong positive correlation is observed between increased active ingredient concentration and UV protection efficacy. The best formula is F3, as it yields the highest SPF value and good physical stability. For further development, it is recommended to increase the concentration of active ingredients to achieve a more optimal level of protection.

5. ACKNOWLEDGMENTS

We would like to express our gratitude to the Pharmacy Program at Alma Ata University in Yogyakarta for providing research facilities and infrastructure.

6. REFERENCE

Aframian, D., Davidowitz, T., & Benoliel, R. (2006). The distribution of oral mucosal pH values in healthy saliva secretors. *Oral Diseases*, *12*(4), 420–423. https://doi.org/10.1111/j.1601-0825.2005.01217.x

Ambari, Y., Hapsari, F. N. D., Ningsih, A. W., Nurrosyidah, I. H., & Sinaga, B. (2020). Studi Formulasi Sediaan Lip Balm Ekstrak Kayu Secang (Caesalpinia sappan L.) dengan Variasi Beeswax. *Journal of Islamic Pharmacy*, *5*(2), 36–45. https://doi.org/10.18860/jip.v5i2.10434

Andriani, D., & Murtisiwi, L. (2019). Penetapan Kadar Fenolik Total Ekstrak Etanol Bunga Telang (Clitoria ternatea L.) dengan Spektrofotometri UV-Vis. *Cendekia Journal of Pharmacy*, *2*(1), 32–38. https://doi.org/10.31596/cjp.v2i1.15

Bhirawa, W. T. (2020). Proses Pengolahan Data Dari Model Persamaan Regresi Dengan Menggunakan Statistical Product and Service Solution (SPSS). *Statistika*, 71–83.

Budiarti, N. T., Ayuningtyas, N. D., & Pitarisa, A. P. (2023). Formulasi dan Evaluasi Sediaan Lip balm Ekstrak Bunga Telang (Clitoria ternatea L) dengan Variasi Beeswax. *Kunir: Jurnal Farmasi Indonesia*, *1*(2), 1–9. https://doi.org/10.36308/kjfi.v1i2.552

Departemen Kesehatan Republik Indonesia. (2022). *Farmakope Herbal Indonesia Edisi II 2022 Kementrian Kesehatan Republik Indonesia*.

Desnita, R., Anastasia, D. S., & Putri, M. D. (2022). Formulations and Physical Stability Test of Olive Oil (Olea europaea L.) Lip Balm with Illipe Butter. *Jurnal Farmasi Sains Dan Praktis*, *8*(1), 134–141. https://doi.org/10.31603/pharmacy.v8i1.4977

Kumar, M. N., & Manoj Kumar, C. N. (2019). Phytochemical analysis and bioactivity of selected medicinal plant of butterfly-pea (Clitoria ternatea L.) used by Kolam tribe Addjoing region of Telangana and Maharashtra states. *~ 417 ~ The Pharma Innovation Journal*, *8*(1), 417–421. www.thepharmajournal.com

Kurnianto, E., & Rahman, I. R. (2021). Potensi Tabir Surya Ekstrak Etanol Daun Matoa (Pometia pinnata) dengan Variasi Konsentrasi Pelarut. *Jurnal Ilmiah Ibnu Sina (JIIS): Ilmu Farmasi Dan Kesehatan*, *6*(2), 102–108. https://doi.org/10.36387/jiis.v7i1.835

Mali Shri Jagdishprasad Jhabarmal, S. S., Killedar Shri Jagdishprasad Jhabarmal, S. G., Jagdishprasad Jhabarmal, S., Mali, S. S., & Killedar, S. G. (2018). *The Pharma Innovation Journal 2018; 7(3): 85-90 Formulation and in vitro evaluation of gel for SPF determination and free radical scavenging activity of turpentine and lavender oil*. www.thepharmajournal.com

Rahmah, S., Ramdan, K., & Wulandari, R. (2023). *Determination of Anthocyanin Levels in Telang Flower (Clitoria Ternatae) Using the Differential pH Method Based on Three Types of Solvents*. *10*(01). https://ojs.stikesmucis.ac.id/index.php/jurkes

Salsabila, A. S., Dewi, I. K., & Atikah, N. (2022). Evaluasi mutu fisik sediaan lip balm kombinasi ekstrak kayu secang (Caesalpinia sappan L.) dan madu (Mel depuratum). *Borobudur Pharmacy Review*, *2*(2), 50–54. https://doi.org/10.31603/bphr.v2i2.7322

Sawiji, R. T. (2024). Pengaruh Variasi Konsentrasi Gelling Agent (Xanthan Gum dan Carbopol) pada Sediaan Serum dengan bahan Aktif Retinoic Acid. *Acta Holistica Pharmaciana*, *6*(1), 1–10. https://doi.org/10.62857/ahp.v6i1.157

Shradha Amraj, Anil Sori, & Tulsidas Nimbekar. (2025). Formulation And Evaluation of Herbal Cream by Using Butterfly Pea Flower. *Article Id IJPS/250304678*, *03*(05), 2250–2256. https://doi.org/10.5281/zenodo.15407112

Syamsudin, S., Alimuddin, A. H., & Sitorus, B. (2022). Isolasi dan Karakterisasi Senyawa Fenolik dari Daun Putat (Planchonia valida Blume) (Isolation and Characterization of Phenolic Compound from Putat Leaves (Planchonia valida Blume)). *Indonesian Journal of Pure and Applied Chemistry*, *5*(2), 85. https://doi.org/10.26418/indonesian.v5i2.56554