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Analysis of sun protection factor (SPF) values of facial cream cosmetics marketed in Sidenreng Rappang Regency

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ABSTRACT

Sun Protection Factor (SPF) is a critical indicator of a sunscreen's ability to protect the skin from ultraviolet B (UVB) radiation. Accurate SPF determination is essential to ensure product efficacy, regulatory compliance, and consumer safety. This study aimed to quantitatively evaluate the SPF values of commercial facial sunscreen creams circulating in Sidenreng Rappang Regency and to compare the measured values with the corresponding label claims. An analytical in vitro SPF assessment was conducted using UV–Vis spectrophotometry based on the Mansur method. Three products with SPF 30, SPF 40, and SPF 50 label claims were analyzed. The results revealed that all measured SPF values were substantially lower than the stated claims. Sample A (SPF 30), Sample B (SPF 40), and Sample C (SPF 50) exhibited SPF values of 19.29, 21.37, and 21.63, respectively. These findings demonstrate inconsistencies between labeled and experimentally determined SPF values, underscoring the need for rigorous quality control, routine verification of SPF claims, and improved oversight of sunscreen products in the market.

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1. INTRODUCTION

Indonesia has a tropical climate, where sunlight reaching the Earth's surface is very intense. Sunlight provides various benefits for life, such as serving as a natural source of illumination, supplying energy for plants to carry out photosynthesis, and supporting the formation of vitamin D in humans. Sunlight consists of three main components: infrared radiation, visible light, and ultraviolet (UV) rays. Ultraviolet radiation is further classified into three types: Ultraviolet A (UVA), with wavelengths between 320–400 nanometers (nm); Ultraviolet B (UVB), with wavelengths between 290–320 nm; and Ultraviolet C (UVC), with wavelengths below 290 nm (Nafiah et al., 2024). However, ultraviolet radiation can also exert harmful effects on human skin, including acute reactions such as erythema, uneven skin tone, photosensitivity, premature aging, and even an increased risk of skin cancer. To protect the skin from these detrimental effects of sunlight, one of the most widely used preventive measures is the application of sunscreen (Dwi Susiloningrum, 2023).

Cosmetics are products or mixtures of ingredients intended to be applied to the human body for the purposes of cleansing, caring for, enhancing attractiveness, or altering appearance. However, cosmetics are not classified as medicinal products. In general, cosmetics can be categorized into two types based on their function on the skin: skin care cosmetics (skincare) and decorative cosmetics (make-up) (Azizah et al., 2021).

A cream is a semisolid material or a mixture of solid and liquid substances used for skin care or therapeutic purposes. Creams function to maintain skin moisture, reduce irritation, treat specific skin conditions, and support cosmetic care. In general, creams consist of a mixture of water and oil, supplemented with additional components such as moisturizers, thickeners, fragrances, and other functional additives. The Sun Protection Factor (SPF) of a sunscreen represents the ratio between the amount of UV energy required to produce a minimal erythema dose (MED) on protected skin and the amount of UV energy needed to induce MED on unprotected skin. A higher SPF value indicates greater effectiveness of the sunscreen in providing protection against UV radiation (Farhamzah et al., 2022).

According to the study conducted by Sulistiyowati et al. (2022), the SPF values were determined in accordance with established standards stablished by the Food and Drug Administration (FDA), sunscreen products can be categorized based on their SPF values into three groups. First, products with an SPF of 2–12 provide low protection against sun exposure. Second, sunscreens with an SPF of 12–30 offer a moderate level of protection. Lastly, products with an SPF of 30 or higher provide a higher degree of protection against UV radiation.

The effectiveness of a sunscreen depends on its SPF value, which typically ranges from 1 to 50. It is recommended to use sunscreens with an SPF greater than 15 and broad-spectrum protection to shield the skin from both UVA and UVB radiation. Nonetheless, it should be noted that sunscreen does not provide complete protection against UV exposure (Mumtazah et al., 2020). Proper and appropriate use of sunscreen can provide maximum protection and prevent adverse effects on the skin. Several side effects may occur as a result of improper sunscreen use, including irritation, redness, allergic reactions, and other skin disorders. Therefore, it is essential for individuals to understand the correct method of applying sunscreen in order to obtain optimal

protective benefits (Arumbi, 2024).

Based on a previous study conducted by the researchers in three stores located in Pangkajene, Sidrap, it was found that all sunscreen products sold were registered with the Indonesian National Agency of Drug and Food Control (BPOM). Therefore, the samples used in the present study were selected from BPOM-authorized products circulating in Sidenreng Rappang Regency to assess the conformity of the tested components with the information stated on the product labels.

According to Erliani et al. (2020), based on the study "Analysis of Sun Protection Factor (SPF) Levels in Sunscreen Cream Cosmetics Circulating in Pati City Using an In Vitro Method," it was found that several cream products listed SPF values that did not correspond to the SPF values obtained from laboratory analysis. Therefore, the researchers were motivated to conduct a similar study on sunscreen products circulating in Sidenreng Rappang Regency to determine whether discrepancies exist between the laboratory-determined SPF values and those stated on the product labels.

2. METHODS

A. Type of Research

The type of research employed in this study is quantitative, involving the analysis of SPF values in facial cream cosmetics (sunscreens) using UV–Vis spectrophotometry

B. Research Location and Duration

The study was conducted in the Pharmaceutical Chemistry Laboratory of the Institute of Health and Science Technology Muhammadiyah Sidrap during the period of May to June 2025.

C. Instruments and Materials

a. **Instruments**

The instruments used in this study included filter paper, an analytical balance, a drop pipette, a measuring pipette, beakers, a stopwatch, volumetric flasks, and an I8-ONE UV–Vis spectrophotometer.

b. **Materials**

The materials used in this study consisted of three cream samples marketed in Sidenreng Rappang Regency and 96% ethanol.

D. Working Method

a. **Preparation of Sunscreen Samples**

A total of 50 mg of each cream formulation (A, B, and C) was accurately weighed using an analytical balance. The samples were transferred into 50 mL volumetric flasks and dissolved in 96% ethanol to the mark. The solutions were homogenized using a magnetic stirrer until a uniform dispersion was obtained. Following homogenization, the mixtures were filtered through Whatman filter paper to remove insoluble residues. The resulting filtrates were designated as stock solutions with a theoretical concentration of 1000 ppm. To obtain the working solutions, 3 mL of the 1000 ppm stock solution was pipetted into a 10 mL volumetric flask and diluted to volume with 96% ethanol, yielding a final concentration of 300 ppm. The working solutions were then analyzed using a UV–Vis

spectrophotometer within the wavelength range of 290–320 nm, with 96% ethanol serving as the blank. The absorbance spectra were recorded to determine the absorbance characteristics of each sample.

b. **Uji nilai SPF dengan metode spektrofotometri UV – Vis**
The samples analyzed using UV–Vis spectrophotometry at wavelengths ranging from 290 to 320 nm were then evaluated for their SPF values using the Mansur equation

$$SPF = CF\ x \sum_{290}^{320} X\ ABS\ X\ EE\ X\ I$$

Description:
CF : Correction factor (10)
Abs : Sample absorbance
EE : Erythemal effect of UV radiation
I : UV light intensity at wavelength λ (nm)

3. RESULTS AND DISCUSSIONS

A. Results

Based on the analysis of three commercially available facial cream (sunscreen) samples marketed in Sidenreng Rappang Regency, each bearing different SPF claims—SPF 30, SPF 40, and SPF 50—the SPF values were evaluated using a UV–Vis spectrophotometric method within the wavelength range of 290 to 320 nm at 5 nm intervals. During the analytical procedure, 96% ethanol was used as the solvent. The mean absorbance values obtained for each sample are presented in the table below.

Table 1. The mean absorbance of each sample

Wavelength (nm)	Absorbance of Sample A (SPF 30)	Absorbance of Sample B (SPF 40)	Absorbance of Sample C (SPF 50)
290	0.690	0.687	0.688
295	0.693	0.688	0.687
300	0.693	0.691	0.691
305	0.730	0.737	0.712
310	0.945	0.854	0.850
315	1.447	1.717	1.757
320	1.857	1.721	1.804
	∑= 3304	∑=3438	∑=3561

Table 1 presents the mean absorbance values of the three cosmetic samples measured using UV–Vis spectrophotometry within the wavelength range of 290–320 nm.

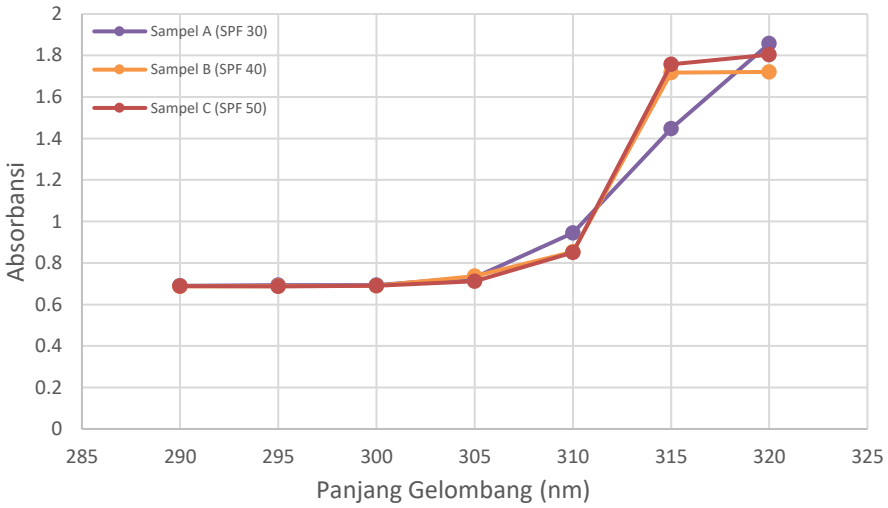

Figure 1. Absorbance versus Wavelength (nm) curves for three samples

Figure 1 illustrates the relationship between wavelength (290–320 nm) and the absorbance of the three sunscreen samples (SPF 30, 40, and 50). All three samples exhibit a similar absorbance pattern: the absorbance remains relatively stable at lower wavelengths, followed by a sharp increase beginning around 310 nm and reaching its peak at 320 nm

Table 2. SPF value calculation results

Sampel	SPF Label	SPF Calculation Results
A	30	19.29
B	40	21.37
C	50	21.63

Based on table 2, it can be seen that the SPF value calculated shows a quite large difference compared to the claims stated on the packaging, namely SPF 30, SPF 40 and SPF 50.

B. Discussion

This study was conducted experimentally in the Pharmaceutical Chemistry Laboratory of ITKES Muhammadiyah Sidrap from May to June 2025. The purpose of the research was to determine the Sun Protection Factor (SPF) values of facial cream cosmetic products marketed in Sidenreng Rappang Regency using UV–Vis spectrophotometric analysis, as well as to compare the laboratory-calculated SPF values with those declared on the product labels.

The Sun Protection Factor (SPF) is a measure of the level of protection provided by sunscreen formulations against UV-B radiation. A higher SPF value indicates increased protection against sunburn. The SPF number reflects how many times the skin's natural resistance to UV-induced

erythema is multiplied, allowing the skin to remain protected from sun exposure without experiencing burns. The Food and Drug Administration (FDA) recommends that compounds used in sunscreen formulations should have an SPF value greater than 2 and suggests that commercial sunscreen products contain a minimum SPF of 15 (Ninis Yuliati, Silvia Putri Agustini, Fery Eko Pujiono, 2023).

The Mansur equation is a calculation method used to determine the Sun Protection Factor (SPF) of sunscreen cosmetic formulations in vitro. This method was first introduced by Mansur et al. (1986) and has since become one of the most widely applied approaches in sunscreen evaluation studies. Its major advantages include practicality, rapid analysis, and the absence of the need for direct testing on human skin. Therefore, the Mansur equation is commonly employed as a preliminary assessment tool for determining sunscreen effectiveness based on absorbance data obtained from UV–Vis spectrophotometric measurements (Luthfi et al., 2024).

The determination of SPF values using UV–Vis spectrophotometry is carried out to evaluate the consistency between the SPF stated on product labels and the SPF values obtained through **in** vitro testing. SPF represents a quantitative measure of the effectiveness of a sunscreen formulation. An effective sunscreen product should exhibit significant absorbance within the wavelength range of 280–353 nm to optimally prevent sunburn and other forms of UV-induced skin damage (He hailun, Li anqia, Li shiqina, Jiea, Tang Lia, Li Lidana, 2021).

In this study, three sunscreen products with different labeled SPF values, commonly available on the market in Sidenreng Rappang Regency, were analyzed. Ethanol 96% was used as the solvent to extract the active compounds from the facial cream samples. The selection of ethanol was based on its ability to dissolve various non-polar and semi-polar organic compounds typically found in sunscreen formulations, such as avobenzone, octinoxate, and oxybenzone. Ethanol also exhibits excellent transparency to UV radiation, ensuring that it does not interfere with absorbance measurements within the 290–320 nm wavelength range. Moreover, ethanol is volatile and non-reactive toward sunscreen active ingredients, making it suitable for UV–Vis spectrophotometric analysis (Ign Edi Santosa, 2022).

At the initial stage of the research process, each sunscreen sample was weighed at 50 mg and subsequently dissolved in 96% ethanol to a final volume of 50 mL. The mass of 50 mg was selected because it produces a solution with a concentration of 1000 ppm, which is commonly used in UV–Vis spectrophotometric analysis. This concentration is considered ideal, as it provides absorbance values that are neither excessively high nor too low, thereby ensuring accurate and reliable instrument readings (Wardani et al., 2023).

In addition, the amount of 50 mg was selected because the cream-based samples are relatively difficult to weigh in very small quantities. Cream formulations possess a soft, adhesive texture and tend to stick to the weighing instruments, which may lead to inaccurate or unstable measurements when weighed in very small amounts (e.g., less than 20 mg). Therefore, 50 mg is considered an appropriate amount, as it is not too small and can still be weighed accurately using an analytical balance.

The selection of an appropriate sample mass and concentration is essential. If the solution is too concentrated, the absorbance values may become excessively high and fall outside the readable range of the instrument. Such conditions can lead to data deviation, in which the measured

absorbance does not accurately represent the true value because it exceeds the instrument's detection limits. Conversely, if the solution is overly diluted, the resulting absorbance may be too low, leading to reduced accuracy and unreliable measurements (Hanifah, 2019).

With an initial concentration of 1000 ppm, the solution was subsequently diluted to 300 ppm to ensure more stable measurements and to keep the absorbance values within the instrument's optimal detection range. This approach is also consistent with several previous studies that employed similar concentrations for in vitro SPF analysis.

The measurements were carried out at wavelengths ranging from 290 to 320 nm, which correspond to the region where UVB radiation exhibits the highest potential for inducing skin damage. The absorbance values obtained at each wavelength were then used to calculate the SPF value using the Mansur equation. This formula multiplies the absorbance at each wavelength by the erythemal effectiveness and UV intensity constants (EE × I), followed by summation and multiplication by the Correction Factor (CF = 10).

Based on these calculations, as shown in Table 4.2, the SPF values obtained were 19.29 for Sample A, 21.37 for Sample B, and 21.63 for Sample C.

When compared with the SPF values stated on the product labels, all calculated results demonstrate that the actual SPF values obtained from laboratory testing were lower than the values claimed by the manufacturers. This finding indicates a discrepancy between the labeled information and the actual UV protection effectiveness. For example, Sample C, which claims the highest SPF value of 50 on its label, showed an actual SPF value of only 21.63 based on laboratory analysis. Although this value remains higher than that of the other two samples, the difference is substantial and suggests that the level of protection provided is not as strong as advertised. Sample B, labeled as SPF 40, displayed a measured SPF of 21.37, slightly lower than Sample C. Meanwhile, Sample A, labeled SPF 30, exhibited the lowest SPF value at 19.29.

These discrepancies may be attributed to several factors. One possible cause is the decreased effectiveness of active ingredients such as avobenzone, octinoxate, and oxybenzone, which may degrade during the dissolution process, especially when exposed to light, heat, or oxygen. These active compounds are known to be sensitive to environmental conditions and susceptible to degradation, thereby reducing their ability to absorb UV radiation (Lidiawati et al., 2024). If the active ingredients do not dissolve completely in ethanol, or if chemical degradation occurs during the extraction process, the measured absorbance may be lower than expected. This directly affects the calculated SPF value obtained through UV-Vis spectrophotometric analysis. Lower absorbance values result in reduced SPF calculations when applying the Mansur equation. Another important factor to consider is the analytical method used in the testing process.

In this study, the determination of SPF was carried out using an in vitro approach, relying solely on laboratory-based analysis without involving real-life conditions in which the product is applied to human skin. However, the actual effectiveness of sunscreen on the skin can be influenced by various factors, including the thickness of application, skin type, perspiration, and direct interaction with sunlight. These variables cannot be fully replicated in an in vitro setting, which may contribute to discrepancies between laboratory measurements and the SPF values claimed on product labels (Kaur & Saraf, 2010), This factor may also contribute to the discrepancy between the SPF values stated on the product labels and those obtained from the analytical results, as the

measurements were not complemented by in vivo validation.

Based on several sources and journal articles related to studies analyzing SPF values in commercially available sunscreen products using UV–Vis spectrophotometric methods, one relevant reference is the study conducted by Erliani et al., (2020) which also demonstrated that most of the sunscreen products tested exhibited actual SPF values lower than their labeled claims, where only one out of the five samples showed an SPF value that closely matched the label. Similar findings were also reported in the study conducted by (Ninis Yuliati, Silvia Putri Agustini, Fery Eko Pujiono, 2023) which stated that discrepancies between labeled SPF values and laboratory results may be attributed to formulation factors, instability of the active ingredients, or the analytical method employed.

Based on the findings of the present study, as well as the two referenced sources, it can be concluded that the SPF values obtained through laboratory testing using UV–Vis spectrophotometry were lower than the SPF values stated on the product labels. This discrepancy may be attributed to differences in testing methods, variations in the effectiveness of active ingredients, the choice of solvent, and the potential degradation of compounds during the analytical process. These results highlight the need for laboratory verification of SPF claims in commercially available sunscreen products.

4. CONCLUSIONS

The results of this study indicate that all three facial cream samples exhibited SPF values lower than those claimed on their product labels. These findings underscore the importance of regulatory verification of SPF claims by authorities such as the Indonesian Food and Drug Monitoring Agency (BPOM) to ensure that the level of protection consumers receive meets established safety standards. For future research, it is recommended to conduct analyses on the stability of active ingredients, the effects of storage conditions, and in vivo testing to provide a more comprehensive assessment of the actual protective efficacy of sunscreen products.

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