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Formulation and Evaluation of Sunscreen Body Butter Preparation Containing Soursop Leaf Extract (*Annona muricata* L.) and Its Influence on Sun Protection Factor (SPF) Value

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ABSTRACT: The leaf part of the soursop plant (*Annona muricata* L.) contains phenolic compounds, especially flavonoids and tannins, which have sunscreen potential due to the presence of chromophore groups. These groups have conjugated double bonds capable of absorbing ultraviolet rays, thus reducing their intensity on the skin. This study aims to formulate sunscreen body butter preparations from soursop leaf extract with good stability and to determine the effect of varying concentrations of soursop leaf extract on the SPF value of the preparations. Soursop leaf ethanol extract was obtained by maceration with 70% ethanol. Body butter was formulated due to its efficacy in preserving skin hydration, improving softness, and protecting against environmental stressors. SPF value measurements were conducted using spectrophotometric methods. The evaluation results of sunscreen body butter from formulas 1, 2, and 3 were sequentially light green, strong green, and dark green in color; with a typical weak extract odor, homogeneous, pH 7, and a spreadability of 6- 6.5 cm. Stability testing with a cycling test showed that all three preparation formulas were stable. The SPF values of sunscreen body butter containing ethanol extract of soursop leaves for F1 extract 1% were 7.07, categorized as extra protection; F2 extract 2% was 10.51, categorized as maximum protection; and F3 extract 3% was categorized as ultra protection. The higher the concentration of extract in the preparation, the higher the SPF value it possesses.

Keywords: ***Annona muricata* L.; body butter; formulation; soursop leaf extract; sun protection factor (SPF); sunscreen.**

Introduction

Geographically, Indonesia is a tropical country located on the equator. Its position in the equatorial region allows for high-intensity sunlight exposure [1]. Sunlight exposure, while beneficial for health, also has side effects, particularly due to ultraviolet (UV) radiation in the 240-400 nm wavelength range [2]. Prolonged UV exposure can lead to acute skin damage such as tanning, redness or erythema, and sunburn [3].

Excessive UV exposure requires additional skin protection to prevent the negative effects of UV radiation. This additional protection can be in the form of substances that reduce the transmission of UV rays to the skin, known as sunscreen agents [4]. The ability of a sunscreen to protect the skin by delaying erythema is expressed by the Sun Protection Factor [5]. The Sun Protection Factor value is a universal indicator to describe the effectiveness of sunscreen products. The higher the SPF value of a sunscreen, the better its ability to protect against sunlight and the negative effects of UV radiation [6].

One of the compounds that exhibit protective activity from natural materials is the phenolic compound group [5]. Phenolic compounds, particularly flavonoid groups, have the potential as sunscreens due to the presence of chromophore groups (conjugated double bond) that can absorb UV rays effectively (both UV A and UV B), thus reducing their intensity on the skin [7]. Previous research has shown that the phenolic content in soursop leaf ethanol extract can be used to protect the body from pathogens and enhance antioxidant activity [8]. Soursop leaf ethanol extract is reported to have antioxidant activity with an inhibitory concentration 50 (IC50) value of 14,48 µg/mL [9].

Body butter is a cosmetic preparation that can protect the skin from sunlight exposure [10]. Compared to other topical preparations such as lotions and creams, which have weaknesses in maintaining skin hydration status, softening ability, and protecting against external influences, body

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butter has these advantages [11]. Body butter generally contains high levels of fatty oils, thus it has better ability to nourish and maintain skin moisture compared to lotion preparations [12]. In the production of body butter, various concentrations of extracts are used to obtain formulas with good SPF and optimal physical stability.

Based on the above description, it is necessary to conduct research to determine the activity and stability of sunscreen ingredients to be incorporated into body butter preparations with variations of the active ingredient, soursop leaf ethanol extract, which has a protective effect against UV rays.

Methods

Materials

Soursop leaves (*Annona muricata* L.) (Bogor, Indonesia), ethanol (Estu Jaya, Indonesia), cetyl alcohol (Akoma International, UK), stearic acid (Brataco, Indonesia), liquid paraffin (Asian Oil, India), glycerin (P & G Chemicals, Singapore), triethanolamine (Emplura®, Germany), methylparaben (Med Champ Express, USA), propylparaben (Alpha Chemika, India), distilled water (Brataco, Indonesia).

Maceration Extraction

A total of 500 g of soursop leaf powder was weighed using an analytical balance (OHAUS, USA) and macerated using 3 L of 70% ethanol solvent. The maceration process lasted for 24 hours with occasional stirring. The filtrate was then filtered and separated from the residue. The residue was subsequently remacerated 3 times using fresh 70% ethanol solvent in the same quantity. The combained filtrates were concentrated using a rotary evaporator at 50 ˚C under reduced pressure until a thick extract was obtained (IKA, Germany).

Formulation of Soursop Leaf Extract Sunscreen Body Butter

The body butter formula is presented in Table 1. All materials required for the formulation were accurately weighed using an analytical balance (OHAUS, USA). The preparation process began by dividing the ingredients into two parts: those soluble in the oil phase and those soluble in the aqueous phase. The oil phase components (cetyl alcohol, stearic acid, liquid paraffin) together with nipasol were placed into a glass beaker and heated using a hot plate (VELP® SCIENTIFICA, Italy). up to 70ºC until fused. The aqueous phase (triethanolamine, glycerin, methylparaben, and a portion of distilled water) was dissolved in a separate beaker and heated to the same temperature until completely solubilized. The aqueous phase was the added to the oil phase, homogenized, and stirred vigorously. While stirring, the remaining distilled water was added, follow follow b thhe soursop leaf extract (*Annona muricata* L.) and the mixture was stirred until homogeneous. Stirring was continued until the preparation cooled and formed a thick body butter mass.

Evaluation of Sunscreen Body Butter Preparation

The evaluation of the body butter preparation includes organoleptic testing (appearance, color, and odor), homogeneity testing, pH measurement, spreadability testing, irritation testing, and stability testing. Organoleptic observations are conducted by examining changes in the appearance, color, and odor of the preparations containing

Table 1. Sunscreen body butter preparation with soursop leaf extract.

Ingredients	Formula (%)		
	F1	F2	F3
Ethanol extract of soursop leaves	1	2	3
Cetyl alcohol	8.2	8,2	8,2
Stearic acid	8	8	8
Triethanolamine	5	5	5
Glycerin	2	2	2
Liquid paraffin	11.6	11.6	11.6
Methylparaben	0.3	0.3	0.3
Propylparaben	0.1	0.1	0.1
Distillated water	Ad 100 %	Ad 100%	Ad 100 %

Table 2. EE x I Values at wavelengths 290 – 320 nm.

Wavelength (nm)	EE × I
290	0.0150
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0839
320	0.018
Total	1

various concentrations of soursop leaf extract (*Annona muricata* L.) [13]. Homogeneity testing is performed by taking 1 g of body butter from the top, middle, and bottom parts, then applied onto a transparent glass. The presence of particles is observed if there is separation of two phases [14]. The pH of the body butter formulations was determined using universal Ph indicator strips (MQuant®, Germany). A small portion of the formulation was taken, and the pH strip was directly immersed into te sample until the indicator area was fully moistened. Let it stand for a while in the body butter solution until a color appears. The resulting color is compared with the standard color provided on the packaging of the universal pH indicator [10]. Spreadability testing is performed by weighing 0.5 g of the body butter preparation. The sample is placed in the center of a glass slide. Another glass slide is placed on top of the preparation, then weights of 50, 100, 150 g are placed on it for 1 minute, and the spread diameter is recorded [15]. The skin irritation test was conducted on 11 healthy volunteers (aged 18 – 35 years) consisting of 1 male ad 10 females who met the inclusion criteria. Prior to participation, all voluteers were informed about the study objectives and procedures, and written informed consent was obtained from each participant. Irritation testing is conducted by applying body butter on the lower arm and leaving it exposed for 5 minutes, then observed. Positive irritation reactions are characterized by the presence of redness (erythema) and edema on the treated skin [12]. Stability evaluation of the body butter is conducted using the cycling test method by storing the samples at 4°C for 24 hours, then transferring them to an oven (Memmert, Germany), at 40°C for 24 hours in one cycle. Each test is observed before and after 6 cycles of accelerated storage (1 cycle = the preparation is stored at 4°C and 40°C alternately for 24 hours each) [16]. Physical stability evaluation of the body butter includes organoleptic, pH, homogeneity, and spreadability testing [17].

Determining the SPF Value of the Preparation In Vitro

The SPF value of the preparation is determined by weighing 0.1 g of the sunscreen preparation, then dissolving it in 10 mL of 96% ethanol. The test solution is then examined for its absorbance using a UV-Vis spectrophotometer HALO DB-20S UV-Vis Double Beam (Dynamica, England) at wavelengths ranging from 290 to 320 nm, with ethanol used as the blank. Absorbance values are recorded at 5 nm intervals [18]. The SPF value is calculated using the formula based on the research development by Mansyur [19], as follows:

$$SPF = CF \times \sum_{290}^{320} EE(\lambda) \times I(\lambda) \times |(\lambda)|$$

Explanation:

CF = Correlation factor (10)
EE = Erythema efficiency
I = Solar simulation spectrum
Abs = Absorbance value read

The EE x I value is a constant value across the wavelength range of 290 – 320 nm with 5 nm intervals. The EE x I value can be found in Table 2.

Methods of Data Analysis

The data obtained in this study are primary data obtained from absorbance measurements for determining the SPF value of sunscreen body butter preparations. Statistical analysis will be conducted using the Kolmogorov-

Smirnov test to determine whether the obtained data are normally distributed or not. If the data are normally distributed, a linearity test will be performed to assess whether a set of data can form a linear line to predict its dependent variable. The data will then be analyzed using simple regression analysis with a significance level of 0.05 to examine the effect of soursop leaf extract (*Annona muricata* L.) concentration on the SPF value of sunscreen body butter preparations.

Result and Discussion

In this study, the samples used are soursop leaves sourced from the Research Institute for Spices and Medicinal Plants under the Ministry of Agriculture, located in Bogor City. Prior determination was conducted to ascertain the identity of the plant used. The determination results confirmed that the samples indeed belong to the soursop plant (*Annona muricata* L.) from the *Annonaceae* family.

The extraction method utilized in this study is maceration. Maceration is an extraction method involving the soaking of crude drugs in a solvent suitable for the polarity level of the active compounds desired [20]. The extraction process of soursop leaf powder was conducted through maceration using 70% ethanol solvent. According to Listiawati, 2022, the higher the ethanol concentration, the lower its polarity level; thus, it can be said that 70% ethanol is more polar compared to 96% ethanol, making it more effective in extracting the desired compounds [21].

The obtained soursop leaf thick extract amounted to 26.7 g with a yield of 5.34%. This result was obtained by comparing the amount of thick extract produced to the weight of the crude drug weighed. Determining the yield aims to ascertain the maximum capability of the solvent to extract compounds from the crude drug and to estimate the approximate amount of crude drug needed to produce a specific quantity of extract [22]. Based on the Indonesian Herbal Pharmacopoeia literature, the yield of soursop leaf thick extract should not be less than 11.4% when using *ethanol P* as the solvent [23]. The yield can vary depending on the particle size of the crude drug, extraction duration, conditions, and storage duration [24]. The results of soursop leaf powder maceration are shown in Table 3.

The results of the organoleptic test are presented in Table 4, showing differences in color among the formulations due to variations in extract concentration. An increase in extract concentration resulted in a darker green color, primarily attributed to the chlorophyll and polyphenolic compounds present in soursop leaves. In the context of topical application, particularly during daytime use, the green coloration of the preparation requires further consideration in terms of aesthetics and consumer acceptance. A dark green color may be less desirable, as it could leave a visible hue on the skin, potentially reducing user comfort. In contrast, a lighter or more translucent green shade is generally more acceptable for sunscreen cosmetic products. Therefore, determining the extract concentration in the formulation should not only be based on its biological activity but also take into account aesthetic aspects and consumer preferences to ensure broader acceptability. As a practical recommendation, adjustment of extract concentration may be required to achieve a balance between sunscreen activity and aesthetic appearance. Additionally, the use of supplementary agents such as color stabilizers or whitening excipients may help reduce the intensity of the green color, resulting in a more uniform, appealing, and user-friendly preparation suitable for daytime application. These results indicate that differences in extract concentration affect the color of the body butter preparations (Figure 1). The scent produced by the body butter preparations is characteristic of body butter derived from the base and added extract. All three formula preparations showed no significant differences in scent; they all had a mild characteristic scent. The mild scent in the formula preparations may be attributed to the presence of soursop leaf extract. Thus, this extract can be used as an active ingredient in body butter preparations.

In Formula 1, with a 1% extract concentration, the consistency is the firmest. Formula 2, with a 2% extract concentration, has a sufficiently firm consistency, and Formula 3, with a 3% extract concentration, has a semi-solid consistency. As the extract concentration decreases, the consistency of the preparation becomes firmer. From the results of this study, it was found that Formula 3 met the consistency standards for body butter preparations.

Table 3. Results of ethanol extract maceration of soursop leaves (*Annona muricata* L.).

Solvent	Extract Color	Sample Weight (gr)	Weight of Concentrated Extract (gr)	Yield (%)
70% Ethanol	Dark brownish	500	26.7	5.34

Table 4. Results of organoleptic test of sunscreen body butter preparation.

Formula	Consistency	Warna	Odor
1	Firmer	Light green	Weak typical extract odor
2	Solid	Dark green	Weak typical extract odor
3	Semi-solid	Deep green	Weak typical extract odor

In this study, the consistency of the formulations was evaluated organoleptically through visual inspection and manual comparison among formulas. Although quantitative viscosity testing using a rotational viscometer is the standard method for assessing the consistency of semisolid preparations, this study could not conduct such testing due to limitations in time and resources. Organoleptic evaluation, however, is still frequently employed in the early stages of formulation development to provide practical insights into spreadability and thickness [36,37]. Therefore, the description of consistency in Formulas 1–3 was based on direct qualitative parameters. Nevertheless, it is acknowledged that quantitative viscosity measurements would greatly strengthen the validity of the findings and are thus recommended for future studies.

In the body butter preparations, an evaluation of homogeneity was also conducted. Homogeneity testing aims to observe the presence of coarse particles on the glass slide [25]. The results of homogeneity testing for all three formulas indicated evenly distributed homogeneity, with no lumps or coarse particles found on the glass slide. This homogeneity ensures that the active ingredients are dispersed or dissolved perfectly in the carrier to provide maximum effect upon application. A homogeneous preparation indicates uniform distribution of active ingredients within the base [26].

The testing of the pH value of the preparation aims to determine whether the preparation meets the standard pH value for sunscreen preparations according to SNI 16-4399-1996, which is between 4.5 and 8.0 [12]. The suitability of the pH value affects the skin's acceptance of the preparation. A preparation with pH that is too acidic can cause irritation to the skin, while a preparation with pH that is too basic can lead to dry skin upon application [27]. The pH testing results for all three formulas showed a value of 7, indicating that the preparations meet the standard requirements for sunscreen preparations.

The spreadability test on the body butter preparations aims to assess the ability of the preparation to spread on the skin upon application [17]. The requirement for good spreadability of a preparation is between 5-7 cm, making it easy to apply [28]. The results of the spreadability test are shown in Table 5. The spreadability results indicate that F1, F2, and F3 meet the standards for good spreadability of preparations. Good spreadability ensures wide contact between the medication and the skin, facilitating rapid absorption into the skin [29]. Furthermore, the consistency of the formulation is closely related to its spreadability. Preparations with higher consistency (denser texture) generally exhibit lower spreadability, as greater force is required to distribute them evenly on the skin. Conversely, formulations with lower consistency or semi-solid texture

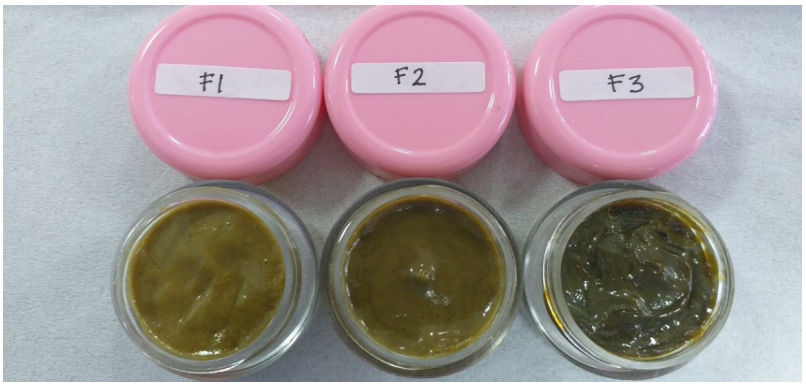

Figure 1. Sunscreen body butter preparation with soursop leaf extract. (Image description: F1= Formula 1, F2= Formula 2, F3= Formula 3).

Table 5. Results of physical evaluation of sunscreen body butter preparation.

Formula	Homogeneity	pH	Spreadability Diameter (cm)
1	Homogeneous	7	6
2	Homogeneous	7	6.2
3	Homogeneous	7	6.5
Mean	-	7.00	6.23
SD	-	0.00	0.25

tend to spread more easily, providing better user comfort upon application [37,38]. Hence, the variations in extract concentration that influence the consistency of the formulations also contribute to their spreadability, although all tested formulations in this study remained within the acceptable range of spreadability standards.

Efforts to evaluate the safety of topical preparations include irritation testing. Irritation is a symptom of inflammation on the skin or mucous membranes immediately after prolonged or repeated exposure, which can be caused by a substance such as solvent, emulsifier, acid, alkali, and detergent [30]. In the irritation test, a positive irritation reaction is characterized by the presence of redness (erythema) and edema on the treated skin [12]. From the results of the irritation testing, no irritation symptoms were found in any of the respondents, demonstrating that the preparation is safe for use on the skin. The preparation did not cause irritation in the respondents because all formulas had a pH within the range specified by SNI 16-4399-1996 as a quality requirement for topical preparations (4.5-8.0) and a pH that is suitable for the skin, namely between 4.5-7.5 [31].

Stability refers to a preparation's ability to maintain its quality during the period of use and storage [32]. Physical stability testing of the preparation ensures that it is made and still meets the criteria parameters during storage [16]. Testing with the cycling test method aims to obtain an overview of the stability of the sunscreen preparation throughout the storage and usage period [33]. Organoleptic observations during the 6 cycles, including the form, color, and scent of the preparation, showed no changes. Similarly, the homogeneity test results, one of the parameters of preparation stability, indicated that the preparation remained evenly distributed throughout the 6 cycles, with no lumps or coarse particles, color changes, or phase separation. Testing on other parameters such as pH showed no difference in pH during the 6 cycles of the cycling test, indicating that all three preparation formulas had stable pH values.

Another parameter to determine preparation stability in the cycling test is spreadability. The spreadability test results after the cycling test for Formula 1 and Formula 3 showed a decrease compared to before the cycling test, whereas Formula 2 showed an increase after the cycling test. The average spreadability value before the cycling test for all three formulas was 6.2 cm, while the average spreadability value after the cycling test was 6.1 cm. The data were then subjected to hypothesis testing using the Friedman test, and the analysis results showed a significance value of 0.069 (<0.05), indicating that there was no significant difference in spreadability among the formulas.

Based on the test results, it can be observed that both before and after the cycling test, all formulas did not experience a decrease in stability. Therefore, it can be

Table 6. Effectiveness of sunscreen preparations based on SPF values [19].

SPF Value	Kategori Proteksi Tabir Surya
2 – 4	Minimal Protection
4 – 6	Moderate Protection
6 – 8	Extra Protection
8 – 15	Maximum Protection
> 15	Ultra Protection

Table 7. Results of in vitro SPF testing of sunscreen body butter with ethanol extract of soursop leaves with variations of 1%, 2%, and 3% concentrations.

Formula	Extract Concentration (%)	SPF Value	Protection Category
Formula 1	1	7.07	Extra Protection
Formula 2	2	10.51	Maximum Protection
Formula 3	3	17.23 ± 5.17	Ultra Protection

concluded that the formulation of sunscreen body butter with soursop leaf extract (*Annona muricata* L.) in all three formulas demonstrates good evaluation and stability.

The determination of SPF refers to the regulations of the Food and Drug Administration (FDA), which categorizes the effectiveness of sunscreen formulations based on their SPF values [42]. The FDA recommends that sunscreen preparations should contain an SPF value. Commercially available sunscreen products generally exhibit SPF values ranging from 2 to 60; however, dermatologists recommend the use of sunscreen with SPF values between 15 and 30 [43]. Sunscreens with very high SPF values (>50) have a greater potential to cause allergic reactions, as they tend to contain higher concentrations of allergenic compounds such as avobenzene and oxybenzone [44]. It is important to note that SPF values only measure protection against UVB radiation. The classification of SPF levels is presented in Table 6. The required SPF level for a specific individual is influenced by knowledge of UV climatology, outdoor behavioral patterns, and individual susceptibility to sunburn [45].

The testing of the SPF value of sunscreen preparations was conducted by determining the sunscreen absorption characteristics in vitro using spectrophotometric analysis of dilution solutions from the preparations [34]. The SPF value was calculated using the formula based on the research development by Mansyur [19]. The results of determining the SPF values are listed in Table 7. In formula 1 with a concentration of 1% extract, the SPF value is 7.07, indicating extra protection category; formula 2 with a concentration of 2% extract is 10.51, indicating maximum protection category; and in formula 3 with a concentration of 3% extract is 17.23, indicating ultra-protection category. This indicates that the body butter extract of soursop leaves has the potential for good sunscreen ability. The phenolic content of ethanol extract from soursop leaves is beneficial for the body in protecting against pathogens and enhancing antioxidant roles [8]. Phenolic compounds are compounds that have aromatic rings, in which there are one or more hydroxyl groups attached to carbon atoms. Hydroxyl groups in phenolic compounds directly contribute to antioxidant activity and play an important role in scavenging free radicals, as the hydroxyl groups of phenolic compounds can donate hydrogen atoms to stabilize free radicals [7]. Previous studies have reported that ethanol extract from soursop leaves has antioxidant activity with an inhibitory concentration of 50 (IC50) value of 14.48 µg/mL [9]. Phenolic compounds are characterized by an aromatic ring with one or more hydroxyl groups (–OH), which not only contribute to their antioxidant activity through hydrogen donation to neutralize free radicals but also enable absorption of ultraviolet (UV) radiation, thereby exhibiting potential as natural sunscreen agents. For instance, ferulic acid, cinnamic acid, and p-hydroxycinnamate derivatives have been identified as effective bio-based UV filters, combining UV-absorbing capacity with antioxidant properties [39]. Moreover, the total phenolic content of plant extracts has been shown to positively correlate with Sun Protection Factor (SPF) values, indicating that phenolic compounds play a significant role in UV protection [40]. Although specific SPF data for ethanol extract of soursop (*Annona muricata* L.) leaves are not yet available, reports on phenolic-rich extracts from guava (*Psidium guajava* L.) leaves, which demonstrated photoprotective activity with phenolic content directly linked to higher SPF values, support the hypothesis that soursop leaves may also serve as promising natural sunscreen ingredients [41]. Therefore, soursop leaves become a natural ingredient with sunscreen activity.

The SPF values found in each body butter extract from soursop leaves indicate that the higher the concentration of the extract, the higher the SPF value obtained. This is because the higher the concentration, the higher the absorbance results from the preparation. According to Lumantow [35], the higher the absorbance, the greater the ability of the preparation to absorb sunlight. The higher the desired SPF value, the higher the amount of active sunscreen agent (concentration) needed. The higher the SPF value, the better the protection against sunlight and

the adverse effects of UV rays [6].

The results of the normality test for the SPF values on the base and the three formulas show a significance value of 1.000 (≥ 0.050), indicating that all SPF values on the base and the three extracts have a normal data distribution, allowing parametric analysis to be conducted. The data were further analyzed using simple regression analysis with a significance level of 0.05 to examine the influence of soursop leaf extract concentration on the SPF values of sunscreen body butter preparations. The statistical analysis results of the extract concentration data on the SPF values yielded a significance value of 0.007 (<0.050), indicating that there is an influence of soursop leaf extract concentration on the SPF values of sunscreen body butter preparations. The statistical analysis results show a significant influence of extract concentration on the SPF values in formula 1, formula 2, and formula 3.

Conclusion

Ethanol extract of soursop leaves (*Annona muricata* L.) can be formulated into sunscreen body butter preparations with good physical characteristics and stability. The difference in concentration of ethanol extract of soursop leaves affects the SPF value, with higher concentrations resulting in higher SPF values. The testing results of the SPF values of body butter preparations containing soursop leaf extract with concentrations of 1%, 2%, and 3% respectively are 7.07, 10.51, and 17.23.

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