PHYSICAL CHARACTERIZATION AND SUNSCREEN ACTIVITY OF *SEA BUCKTHORN* OIL CREAM WITH TWEEN 80 AND SPAN 80 VARIATIONS

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Abstract

This study aimed to evaluate the physical properties and in vitro sunscreen activity (SPF) of sea buckthorn oil cream formulated with varying ratios of Tween 80 and Span 80. Sunscreen products derived from natural sources, such as sea buckthorn oil (Hippophae rhamnoides L.), offer photoprotection through UV-B absorption and antioxidant activity from bioactive carotenoids and polyphenols, serving as safer alternatives to synthetic UV filters. Four cream formulations (F1–F4) containing 7% sea buckthorn oil and varied Tween 80:Span 80 ratios (3:1, 2:1, 1:2, and 1:3) were prepared using the melting method and analyzed for physical stability (organoleptic, homogeneity, pH, spreadability, adhesion, viscosity) and SPF values via UV-Vis spectrophotometry using the Mansur equation. All formulations produced homogeneous, deep-yellow creams with safe skin pH (6.65–6.80), acceptable spreadability (4.50–5.10 cm), and consistent viscosity (29–54.66 dPas). Adhesion significantly varied (1.37–2.70 s, $p < 0.05$). Spectrophotometric testing demonstrated strong photoprotective activity across formulations, with Formula 3 (3:1 ratio) achieving the highest SPF value of 15.87 ± 0.61 (ultra protection) due to enhanced release of active chromophores from the hydrophilic matrix. In conclusion, sea buckthorn oil cream formulated with a 3:1 Tween 80:Span 80 ratio provides an effective natural sunscreen with favorable physical characteristics.

Keywords: *Cream, surfactant, oil, sunscreen.*

INTRODUCTION

Excessive exposure to sunlight on the skin can have effects such as sunburn and premature aging. This is caused by the presence of ultraviolet (UV) rays in sunlight, including UV-A and UV-B rays, which can have negative effects (BPOM., 2017). Efforts to prevent the harmful effects of UV radiation can be made by using sunscreen products (Minerva., 2019). Sunscreens available on the market can cause harmful side effects on the skin if used continuously (Yani & Dirmansyah., 2021). Currently, many sunscreen products containing PABA (p-aminobenzoic acid) and benzophenone have dangerous effects because they can increase the likelihood of skin cancer (Tamara., 2019).

One of the plants that is beneficial as a natural sunscreen is *sea buckthorn*. *Sea buckthorn* oil contains various vitamins and bioactive substances, including tocopherols, which act as antioxidants, minimize lipid oxidation, and help relieve pain (Kallio et al., 2002). Carotenoids as antioxidants and aiding in collagen synthesis and epithelialization (Andersson et al., 2009). *Sea buckthorn* (*Hippophae Rhamnoides* L.), more commonly known as seaberry, is a plant that belongs to the Oleaster family (*Elaeagnaceae*) (Wang et al., 2014). *Sea buckthorn* is a small thorny shrub, attached to plants or trees, with round fruits that are yellow to dark orange in color, soft and hairy in texture, very sour in taste with a slight bitterness, and have a faint aroma (Koskovac et al., 2017). *Sea buckthorn* oil can absorb UV radiation and convert it into vitamin A. *Sea buckthorn* oil can absorb UV-B radiation with wavelengths in the range of 290-320 nm, which can cause tanning and sunburn, making it suitable for use as a natural sunscreen. The increased use of oil for topical preparations can be achieved by forming a cream.

Cream is a thick emulsion that is basically half solid and half liquid. It is meant to be applied to the skin for external use. Anief (2005) says that cream comes in two different types: oil-in-water (O/W) cream and water-in-oil (W/O) cream. Some ingredients used to make creams affect the cream's physical properties and how stable it is (Manda., 2011). A lot of the time, Tween 80 and Span 80 are used together. It is hydrophilic and has a high HLB value. Span 80, on the other hand, is lipophilic and has a low HLB value. Span 80 is used in many pharmaceutical preparations, such as cosmetics. It can also be used as a lipophilic nonionic surfactant in pharmaceutical formulations. When you use more than one surfactant together, you can make an emulsion that is more solid

(Walter, 2002). Scientists think that mixing Tween 80 and Span 80 will make a cream that has good physical properties. The purpose of this study is to find out how sea buckthorn oil cream with different amounts of Tween 80 and Span 80 behaves as a sunscreen and what its physical properties are.

METHOD

Materials

The materials used in this study consist of *sea buckthorn* oil (PT. Darjeeling Sembrani Aroma) with COA (Certificate of Analysis), ethanol, liquid paraffin, cetyl alcohol, Tween 80, Span 80, glycerin, methyl paraben, propyl paraben, and aquadest (Medical and Laboratory Supplier), Kleveru *Sea Buckthorn* Day Cream SPF 15 PA ++ (Watsons Cosmetic Store Dp Mall Semarang).

Tools

The tools used include an analytical balance, spatula, mortar and pestle, Erlenmeyer (Pyrex®), beaker (Pyrex®), measuring cylinder (Pyrex®), dropper, metal spoon, filter paper, ruler, UV-Vis Spectrophotometer (Shimadzu®), stopwatch, magnetic stirrer (Scilogex®), pH meter (Hanna Type HI 8424), vortex, hom spoon, porcelain dish, a set of viscosity testing tools (Rion®), spreadability, and adhesion.

Formulation of *Sea Buckthorn* Oil Cream

The formula for the *sea buckthorn* oil cream can be seen in Table 1.

Table 1. *Sea buckthorn* oil cream formula with variations of Tween 80 and Span 80

Bahan	Formula (%) v/v				Fungsi Bahan
	F1	F2	F3	F4	
Sea Buckthorn Oil	7	7	7	7	Active Ingredient
Liquid Paraffin	29	29	29	29	Emollient
Cetyl Alcohol	15	15	15	15	Thickener
Tween 80	3	2	1	1	Emulsifier
Span 80	1	1	2	3	Emulsifier
Glycerin	10	10	10	10	Moisturizer
Methyl Paraben	0,2	0,2	0,2	0,2	Preservative
Propyl Paraben	0,1	0,1	0,1	0,1	Preservative
Aquadest	50	50	50	50	Solvent

Production of *Sea Buckthorn* Oil Cream

Sea buckthorn oil cream is made using the melting method. All the ingredients were prepared and weighed. The oil phase (liquid paraffin, span 80, propyl paraben, cetyl alcohol) and the water phase (tween 80, methyl paraben, glycerin, and aquades) were heated while stirred with a magnetic stirrer at a temperature of 30°C until a homogeneous solution was obtained. After that, *sea buckthorn* oil was added drop by drop into the system until a homogeneous solution was formed, and stirring was carried out at a speed of 700 rpm for 30 minutes (Shabrina et al., 2020).

Physical Characterization and SPF Value of *Sea Buckthorn* Oil Cream

a. Organoleptic Test

The organoleptic test is conducted by observing the smell, color, and texture of the cream (Ayuningrum., 2016).

b. Homogeneity Test

1 gram of cream is applied to a transparent glass slide. Then, the preparation is observed to ensure it shows a homogeneous composition and no visible coarse particles (Ayuningrum., 2016).

c. pH Test

The pH meter is adjusted with standard buffer solutions of 4, 7, and 9. Measure 0.5 grams of the cream formulation and dissolve it in 50 mL of distilled water into a glass beaker. The electrode is subsequently submerged in the glass beaker for a duration of 10 minutes until it displays a

stable reading (Depkes RI., 1995). The pH of cosmetic formulations ought to be calibrated to align with the skin's pH, which falls between 4.5 to 7.5 (SNI 16-4399-1996).

d. Spreadability Test

Measure 0.5 grams of the cream formulation, position the specimen at the center of a glass dish, and overlay it with an additional glass dish. Position it on a scale calibrated to 200 grams, allowing a one-minute interval after each weight increment, and subsequently document the diameter of the spread cream from many angles. The assessment concludes when the measurement outcomes are coherent (Fitria, 2015)..

e. Adhesion Test

Weigh 0.5 grams of the cream preparation, then apply it to a glass object, cover it with another glass object, and press it with a 0,5 kg weight for 5 minutes. Then, remove the weight and release the two adhered glass objects while recording the time it takes for them to separate (Fitria., 2015).

f. Viscosity Test

The tool used for viscosity testing is the RION viscometer, by installing the rotator on the viscometer and lock it counterclockwise, then fill the cup with the cream sample to be tested. After that, the rotator is placed exactly in the middle of the cup containing the cream, and then the device is turned on. Rotator number 1 will start to spin, and the viscosity indicator needle will move to the right. After the needle stops, the viscosity can be read on the scale located on rotator number 1. The unit used is dePascal-seconds (dPas) (Fitria., 2015).

g. Determination of Correction Factor (CF)

The Correction Factor (CF) value is obtained by measuring the absorbance of sunscreen preparations that are known to have an SPF value on the packaging label. In this study, a CF value of 10 was used (Rahmadany et al., 2021). The CF value is used to account for the use of spectrophotometer instruments and solvent materials, so the resulting CF value can maintain measurement accuracy according to the conditions that will be used in the research (Karina., 2015).

h. Determination of SPF (Sun Protection Factor) Value

The formulation of sea buckthorn oil cream was measured at 1 gram for each concentration and thereafter transferred into a 10 mL volumetric flask to be diluted with technical ethanol to the designated line. The solution was conveyed to a test tube and agitated using a vortex. The SPF value assessment was replicated three times for each formulation. Subsequently, the solution was quantified with a UV-Vis spectrophotometer at a wavelength range of 290 nm to 320 nm. Technical ethanol served as a control. Document the absorbance measurements at each 5 nm increment (Ismail et al., 2014). The absorbance results acquired are computed utilizing the Mansur equation, yielding the SPF value (Mansur et al., 1986).

Data Analysis

The statistical analysis of the physical property test values, encompassing pH, organoleptic characteristics, homogeneity, spreadability, adhesiveness, viscosity, and SPF value, was conducted using one-way ANOVA. The SPF value classifications are designated as sunscreen efficacy if they exceed 15 (ultra category), range from 8 to 15 (maximum category), fall between 6 and 8 (extra category), lie between 4 to 6 (medium category), and are between 1 and 4 (minimum category). All tests were conducted in duplicate.

RESULTS AND DISCUSSION

The results of the organoleptic tests F1 (3:1); F2 (2:1); F3 (1:2); and F4 (1:3) show that each formula produced a deep yellow color, a soft, thick cream texture, and the characteristic smell of *sea buckthorn* oil. The yellow color in *sea buckthorn* oil indicates a high level of carotenoids. The use of carotenoids before exposure to sunlight can reduce the risk of skin burns due to UV radiation. Cosmetic formulations containing carotenoids on the skin act as UV filters (Kalwat et al., 2012). In addition, carotenoids have strong antioxidant properties that are beneficial as free radical neutralizers, which are responsible for various types of skin damage (Sandmann, 2019). Organoleptic tests were conducted on four formulations, each with three replications. The testing was conducted by directly observing the color, smell, and properties of the preparation (Murrukhmihadi et al., 2017). The organoleptic test can be seen in Figure 1.


Formula I
(Replications 1-3)


Formula II
(Replications 1-3)


Formula III
(Replications 1-3)


Formula IV
(Replications 1-3)

Figure 1. Results of the organoleptic test of the cream preparation

Homogeneity testing of KMSB showed homogeneous results in F1 (3:1); F2 (2:1); F3 (1:2); and F4 (1:3), indicated by the uniform color in all parts of the preparation, with no formation or presence of coarse particles and air bubble clusters on the glass object. Homogeneous preparations yield good results because the active ingredients are evenly dispersed. This means that the difference in the amount of emulsifiers Tween 80 and Span 80 does not affect the homogeneity of the preparation (Pujiastuti & Kristiani, 2019). This is in accordance with what Ulaen et al. (2012) stated, that the requirement for cream as a topical preparation is the absence of coarse particles that clump when applied to an object glass. The results of the KMSB homogeneity test can be seen in Figure 2.

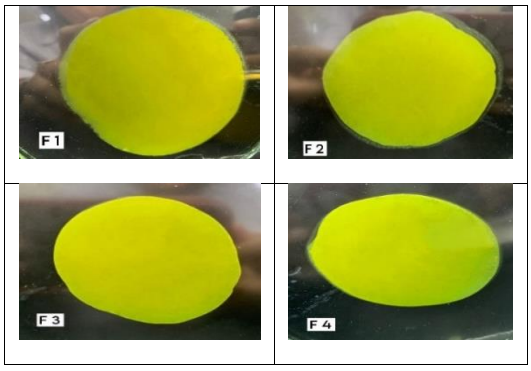


Figure 2. Results of the KMSB homogeneity test of the cream preparation

pH testing was conducted to determine the safety of the cream formulation when used, so it does not irritate the skin (Lumentut et al., 2020). The pH measurement results of KMSB F1 (3:1); F2 (2:1); F3 (1:2); and F4 (1:3) are in accordance with topical pH, which is in the range of 4-7.5 for skin (Gurning et al., 2016). The research conducted by Patihul et al. (2010) on the formulation of cream with ethanol extract of moringa leaves (*Moringa Oleifera* Lamk) shows that the use of nonionic emulsifiers Tween 80 and Span 80 produces a good cream in acidic, basic, and neutral pH conditions; thus, these emulsifiers will yield an optimal cream. The use of varying pH concentrations shows differences in pH for each formula, but still within safe usage limits. The pH test results can be seen in Table 2.

Table 2. Results of the physical characterization of *sea buckthorn* oil cream

Formula	Average pH ± SD	Average Adhesion ± SD	Average Spreadabilty ± SD	Average Viscosity (dPas) ± SD
F1	6.71 ± 0.14	1.37 ± 0.07	5.10 ± 0.07	29 ± 2.00
F2	6.80 ± 0.05	1.84 ± 0.25	4.90 ± 0.50	54.66 ± 1.52
F3	6.67 ± 0.08	2.70 ± 0.20	4.50 ± 0.08	50.33 ± 1.52
F4	6.65 ± 0.07	2.65 ± 0.28	4.60 ± 0.06	53.66 ± 5.43

The adhesion of topical preparations is no less than 4 seconds (Ulaen et al., 2021). The research conducted by Nining and Endah (2012) on the optimization of the composition of Tween 80 and Span 80 in a vanishing cream base showed that the adhesion profile with the addition of span 80 was greater than the adhesion of the cream with the addition of Tween 80. This is because the consistency of the cream with the addition of Tween 80 is relatively more liquid, as Tween 80 is easily soluble in water, making the solution more diluted and the adhesion smaller. On the other hand, if the cream is added with a combination of Tween 80 and Span 80, it results in the highest adhesion. This is due to the increased viscosity of the cream, making its consistency thicker and the adhesion greater. The statistical results of the adhesion test using one-way ANOVA showed a significance value of 0.001 (Appendix 11). Thus, there is a significant difference with a significance value of < 0.05, meaning it causes the adhesion strength of the KMSB preparation on the skin to be suboptimal. Next, a post hoc test was conducted to determine the variables that have significant differences. The results of the post hoc test on F1 (3:1); F2 (2:1); F3 (1:2); and F4 (1:3) showed significant differences, namely (F1 and F3); (F1 and F4); (F2 and F1) with a significance value of $p < 0.05$.

An effective cream requires little time for application and possesses a significant spreading value (Sulastri., 2016). The study by Devi et al. (2019) elucidates that an elevated ratio of Tween 80 to Span 80 signifies that a greater concentration of Tween 80 enhances spreadability. This occurs due to Tween 80's hydrophilic nature, which adheres to the aqueous phase, leading to an increased attraction of water molecules in the cream and enhancing its spreadability. The study by Sumana (2011) about the enhancement of cream formulation with ethanol extract from avocado and green betel leaves indicated that the incorporation of Tween 80 and Span 80 as emulsifiers yields a spreadability that satisfies the criteria of 5-7 cm. The study by Dina et al. (2016) regarding the development of an antioxidant cream utilizing ethanolic extract from avocado leaves (Persea americana Mill.) demonstrated that increased concentrations of Tween 80 and decreased concentrations of Span 80 resulted in elevated viscosity and adhesion values, whereas spreadability diminished. The dispersion range of topical formulations is 4-7 cm (Ulaen et al., 2012). The reduction in viscosity of the formulation influences the resultant spreadability; increased viscosity correlates with diminished spreadability, while decreased viscosity results in enhanced spreadability (Sulastri, 2016). The statistical findings from the sea buckthorn oil cream spreadability assessment via one-way ANOVA indicate a significance level of 0.120 (Appendix 10). Consequently, it can be asserted that there is no notable disparity in the formulation of the sea buckthorn oil cream, as the significance value exceeds 0.05.

The consistency of the formulation must be verified to achieve an ideal sea buckthorn oil cream. The study by Eva and Agatha (2019) elucidated that the ideal formulation for the creation of sunflower oil cream is determined by its physical characteristics, such as viscosity and spreadability. The analysis of the emulsifier composition curve in relation to the evaluated response indicates that an increase in tween 80 generally diminishes the viscosity response, while simultaneously enhancing the spreading response and viscosity variation. Typically, the amalgamation of tween 80 and span 80 as emulsifiers yields an effective emulsion system, whereby the roles of tween 80 and span 80 enhance one another. Creams with inadequate viscosity yield insufficient skin contact duration, resulting in diminished efficacy of the active components. Elevated viscosity prolongs the duration of retention at the application location while simultaneously diminishing spreadability (Garg et al., 2002). The disparity in viscosity measurements for each formulation is affected by the differing concentrations of tween 80 and span 80, specifically F1 (3:1); F2 (2:1); F3 (1:2); and F4 (1:3). Span

80 exerts a more significant influence on viscosity enhancement than tween 80 (Sumana, 2011). Optimal viscosity in cream formulations lies between 20-500 dPas (Erwiyanti et al., 2018 and Mailana et al., 2016). The study conducted by one-way ANOVA yielded a significance value of 0.055, which above the threshold of 0.05. It may be inferred that the viscosity measurements of each sea buckthorn oil cream formulation are not markedly different.

The determination of the correction factor serves to accommodate the use of spectrophotometers and solvents, thereby obtaining an accurate correction factor value according to the conditions to be used in the research. The correction factor value is determined using the absorbance data of sunscreen products that are known to have SPF values on their packaging labels (Karina, 2015).

The absorbance measurement was derived using UV-Vis spectrophotometric data within the wavelength range of 290 nm to 320 nm, thereafter utilized in the calculation by Mansur et al. (1986). The Kleveru Sea Buckthorn Day Cream SPF 15+ PA++ was selected as the reference for the correction factor due to its analogous cream formulation, yielding a CF value of 3.976 (Rahmadany et al., 2021). The calculation of the correction factor, valued at 3.976, was employed to ascertain the SPF value of the sea buckthorn oil cream formulation using variations of tween 80 and span 80. The assessment of SPF value may be affected by the utilization of unsuitable sunscreen product evaluation techniques, variations in solvent application, types of emulsions, concentrations of sunscreen formulations that lead to interactions among components or additives, including emollients and emulsifiers, as well as the interaction of active ingredients with the dermis. Moreover, pH, viscosity, and the rheological characteristics of emulsions are additional elements that may enhance or diminish the absorption of UV radiation from sunscreen (Mbanga et al., 2014).

The determination of the sunblock activity of *sea buckthorn* oil cream can be seen in Table 3.

Table 3. The SPF value results of *Sea Buckthorn* Oil Cream with variations of Tween 80 and Span 80

Formula	Average SPF ± SD	Category
F1	15.66 ± 0.79	Ultra Protection
F2	15.15 ± 1.35	
F3	15.87 ± 0.61	
F4	14.92 ± 0.12	

The sunscreen properties of this cream come from the variety of secondary metabolites found in sea buckthorn oil (*Hippophae rhamnoides* L.). There are two main ways that sea buckthorn oil protects against UV light: it absorbs UV photons (UV filtering) and gets rid of harmful radicals (ROS scavenging). Sea buckthorn oil is naturally orange because it contains a lot of carotenoids, such as β-carotene, zeaxanthin, and lycopene. Carotenoids are made up of molecules that are linked together by a long chain of double bonds (chromophore group). In the wavelength range of 290–320 nm, this conjugated chain can efficiently absorb UV-B photon radiation energy. It can then turn that energy into thermal energy that is safe for epidermal cells (Sandmann, 2019). Additionally, carotenoids protect cells from damage caused by photon radiation by stopping singlet oxygen molecules and protecting cell structures (Tudor et al., 2020). Sea buckthorn oil has a lot of phenolic and polyphenolic compounds, like quercetin, isorhamnetin, and kaempferol. These compounds have connected aromatic rings that make the UV radiation spectrum bigger. This group of phenolic compounds can also reduce inflammation, which stops redness or swelling on the skin's surface (Tudor et al., 2020).

The difference in SPF values between formulas is significantly influenced by the ratio of hydrophilic (Tween 80) and lipophilic (Span 80) emulsifier concentrations. Span 80 has a dominant lipophilic property with a low HLB value (4.3), while Tween 80 is hydrophilic with a high HLB value (15.0). *Sea buckthorn* oil and Span 80 are both lipophilic. In Formula III (1:2) and Formula IV (1:3) with a high proportion of Span 80, *sea buckthorn* oil is strongly bound within the internal phase

of the lipophilic oil/matrix. This strong entrapment inhibits the release of carotenoid and tocopherol components from the preparation matrix during spectrophotometric testing, resulting in relatively low measured absorbance values (Aghnia, 2022; Ais, 2022). Formula I (3:1) and Formula II (2:1) with a higher proportion of Tween 80 formed an oil-in-water (O/W) emulsion system that has high stability and facilitates the optimal release of active substances into the testing medium. This allows the chromophore groups of carotenoids and tocopherols to be maximally exposed to absorb UV-B radiation, resulting in a significantly higher SPF value (Sandhi et al., 2022).

CONCLUSION

The *sea buckthorn* oil cream formula (Hippophae rhamnoides L.) with variations of the emulsifiers Tween 80 and Span 80 has been proven to significantly affect the photoprotective activity of SPF values. Formula 3 with a Tween 80:Span 80 ratio of (3:1) produced the highest SPF value of 5.66 ± 0.79, which falls into the ultra protection. The sunscreen activity is supported by the high content of bioactive compounds such as carotenoids, tocopherols, flavonoids, and unsaturated fatty acids in *sea buckthorn* oil, which work synergistically to absorb UV-B radiation photons and neutralize free radicals. The increase in the ratio of the hydrophilic emulsifier Tween 80 enhances the release of active substances from the cream matrix, thereby maximizing the effectiveness of the sunscreen.

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