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Irritation, Hedonic, and Antioxidant Activity Testing of Sunkist Orange Peel (*Citrus sinensis* (L.) Osbeck) Peel-Off Gel Mask Formulation

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ABSTRACT

Sunkist orange peel is a rich source of antioxidants beneficial for skin protection, making it a promising ingredient in cosmetic products like peel-off gel masks. This study investigated the sensory profile, primary irritation index (PII), and antioxidant activity of peel-off gel mask formulations containing Sunkist orange peel extract (*Citrus sinensis* (L.) Osbeck). The extract was obtained through maceration using 96% ethanol, with a mean yield of 9.95 ± 1,2 %. Phytochemical analysis identified the presence of polyphenols, tannins, and flavonoids. The extract was incorporated into peel-off gel mask formulations and evaluated for quality parameters (organoleptic properties, pH, viscosity, and drying speed), sensory characteristics, PII, and antioxidant activity using the DPPH method. All formulations fulfilled the required quality standards. Sensory evaluation indicated that Formula III (FIII) was the most favored by respondents across all stages of application (before, during, and after use). The irritation index test on 25 volunteers revealed no irritation, with PII values ranging from 0 to 0.4, classifying the preparations as non-irritating. Antioxidant evaluation showed that the peel-off gel with 2% extract exhibited an IC-50 value of 23.38 ppm, categorizing it as a very strong antioxidant. These findings highlight the potential of Sunkist orange peel extract in peel-off gel masks, combining excellent antioxidant properties with favorable sensory and safety profiles. Further optimization may enhance its application in skincare products.

INTRODUCTION

The skin represents a focal point of concern among contemporary women. Facial skin, in particular, garners heightened attention, as it is considered a primary determinant of one's appearance for many women. Nevertheless, exposure to free radicals triggers oxidative processes in facial skin, giving rise to a multitude of dermatological issues.

Antioxidants represent a group of compounds capable of mitigating oxidative processes in the skin and are instrumental in skin rejuvenation. The topical application of antioxidants offers substantial benefits in averting premature aging attributable to free radicals (Burke, 2018). Natural sources of antioxidants can be found in various fruits and vegetables (Chang et al., 2016). One such fruit renowned for its antioxidant content is Sunkist oranges (Zou et al., 2016).

Sunkist orange (*Citrus sinensis* (L.) Osbeck) is a frequently utilized plant in traditional medicinal practices. It has health benefits such as

encompass the treatment of fevers, infections, immune system enhancement, cholesterol reduction, and the fortification of the spleen (Haitami et al., 2017). Sunkist oranges stand out as a high-antioxidant content fruit, comprising two distinct plant components responsible for antioxidant activity: phenolics and carotenoids (Rekha, 2012).

The peel of Sunkist oranges (*Citrus sinensis* (L.) Osbeck) contains lot of phenolic compound that have antidiabetic, antioxidant, and free radical scavenging effects. Alkaloids, tannins, saponins, and flavonoids have been identified through phytochemical screening of the ethanolic extract of Sunkist orange peels (Depari et al., 2021).

The utilization of orange peel in cosmetic formulations has been explored, particularly in the development of peel-off gel mask preparations. In previous study, the formulation of a peel-off face mask using Citrus *Aurantiifolia cortice* (lime peel) extract comply quality requirements based on organoleptic parameters, homogeneity testing, pH assessment, spreadability evaluation, drying characteristics, and irritation testing (Karnelo et al., 2021). Additionally, Previous study also demonstrated the robust antioxidant activity of Sunkist orange peel extract, with an IC-50 value of 38.33 ppm, confirming its potency in this regard (Long et al., 2021).

The topical application of cosmetics to counteract free radicals generated by environmental factors such as pollution and sunlight is currently of significant importance. One convenient and practical form of cosmetic preparation is facial masks.

Facial masks are a popular cosmetic formulation for addressing facial skin issues. However, the typical mask application process can be somewhat complex, leading to a demand for more user-friendly and practical mask products, such as peel-off gel masks. Peel-off gel masks represent a cosmetic skincare preparation in gel form. Once applied to the facial skin and left to dry for a specific duration, these formulations form a transparent and elastic film layer that can be peeled off (Santoso et al., 2020). The selection of peel-off gel masks is based on their ability to spread well on the skin, provide a cooling effect, and be easily removed, thus enhancing their practicality.

Irritation can occur with the use of cosmetic products, characterized by redness and the development of edema at the application site. In the process of cosmetic product development, irritation testing is essential to ensure the safety of the cosmetic formulation before it is used. Since 2013, the policy prohibiting the use of animals in cosmetic irritation testing has necessitated manufacturers to conduct in vitro or clinical irritation testing on human subjects, after a thorough review of the cosmetic ingredients based on existing literature, prior to testing (Kose et al., 2018).

Hedonic testing is a sensory organoleptic analysis used to assess the extent of quality differences among similar products by providing evaluations or scores for specific attributes of a product. It serves the purpose of determining the level of liking or preference for a given product. Hedonic testing aims to gauge panelists' preferences for the produced products concerning attributes such as aroma, color, and texture (Cahnia et al., 2022).

To create cosmetic products from Sunkist orange peel extract that meet quality, safety, and effectiveness criteria, a comprehensive research approach is required. This research process should commence with the formulation of peel-off gel preparations, followed by irritation testing and hedonic evaluation.

METHODS

Collection and Processing of Simplified Ingredients

The Sunkist orange peel (*Citrus sinensis* (L.) Osbeck) used in this study was obtained from a fruit vendor in Bandar Lampung city. The orange peel samples were bright orange and fresh in appearance after removing the outer peel. They were thoroughly washed with running water and drained. Subsequently, the Sunkist orange peel was dried by air-drying, and once dried, it was finely ground using a blender. The resulting powder was sifted to obtain a fine and uniform powder. Extraction of the Sunkist orange peel was carried out using the following method:

The extract was prepared using the maceration method with 96% ethanol as the solvent. Amount of Five hundred (500) grams of Sunkist orange peel simplicia powder was weighed and placed in a macerator, with the top covered with cotton. Then, 3 liters of 96%

ethanol solvent were added to the macerator to ensure complete submersion of the simplicia. The maceration process was conducted for 5 days, with solvent replacement on the 3rd and 5th days, each time with 3 liters of fresh solvent until the resulting filtrate became clear. The obtained extract was concentrated using a rotary evaporator at a temperature not more than 40°C to yield a thick extract, which was stored in bottles.

Phytochemical Screening

According to the research (Yasir et al., 2021), phytochemical screening was conducted using the following methods:

Alkaloids

A total of 0.5 mL of the extract sample was mixed with 5 drops of chloroform. After dissolving, 5 drops of Mayer's reagent (prepared by dissolving 1 g of KI in 20 mL of distilled water and adding 0.271 g of $HgCl_2$ until it dissolves) were added. A positive reaction was indicated by the formation of a precipitate or a solution that becomes cloudy.

Flavonoids

A total of 0.5 mL of the extract sample was introduced into a reaction tube, followed by the addition of 0.5 g of Mg powder and 5 mL of concentrated HCl (dropwise). The mixture was then stirred. A positive reaction was indicated by the change in the solution's color to red, yellow, or orange.

Polyphenols

A volume of 1 mL of the sample was placed into a reaction tube, then supplemented with 3 drops of 2% $FeCl_3$ solution. A positive result was indicated by the appearance of green, purple-red, blue, or black color.

Saponins

A total of 0.5 mL of the extract sample was mixed with 5 mL of distilled water, then shaken for 30 seconds. A positive result was indicated the presence of saponins if foam with a height of 1-3 cm persists for 15 minutes.

Tanins

A total of 1 mL of the extract sample was placed into a reaction tube, and 10% $FeCl_3$ solution was added. A positive reaction was indicated by the formation of blue, green, or black color.

Peel-Off Gel Mask Preparation

The formulations of the peel-off gel mask were presented in **Table 1**.The preparation of the peel-off gel mask was began by dissolving the extract. All ingredient were weighed according to the planned formula. Next, PVA was expanded using hot distilled water (four times the weight of PVA) in a glass beaker on a water bath at 80°C while stirring. After the polyvinyl alcohol had expanded, it was gradually added into a mortar and ground until homogeneous (M1).

In an evaporating dish, HPMC was expanded by adding hot water above 80°C, about one-third of the HPMC quantity. This was because HPMC easily dissolves in hot water. HPMC was evenly spread on the hot water surface. It was left until it fully expanded to form the gel base, then transferred into a mortar and stirred until homogeneous (M2). Propylene glycol, which had been weighed, was prepared in a glass beaker based on the planned formula (M3). The phenoxyethanol preservative, which had also been weighed, was prepared in a glass beaker (M4). In a dry mortar, M1 was added, then M2 was incorporated while continuously stirring. Next, M3 was added and stirred, followed by M4

Table 1. Gel Peel-off Mask Formula

Material	Concentration (%w/w)					Function
	K-	FI	FII	FIII	K+	
Sunkist orange peel extract	-	0.5	1	2	Commercial Peel-off Mask	Active Ingredient
PVA	15	15	15	15		Film Forming
HPMC	1	1	1	1		Gelling Agent
Propylene Glycol	12	12	12	12		Humectant
Phenoxyethanol	0.5	0.5	0.5	0.5		Preservative
Perfume	qs	qs	qs	qs		Perfume
Ethanol 96%	5	5	5	5		Cosolvent
Aqua Dest	*Ad* 100	*Ad* 100	*Ad* 100	*Ad* 100		Solvent

and stirred. Then, 96% ethanol was added and mixed. Finally, distilled water was added up to 100 grams to form a homogeneous gel mass, followed by the addition of fragrance. To complete the process, the weighed concentrated Sunkist orange peel extracts (F1, F2, and F3) were added into the base and grind until homogeneous.

Physical Evaluation

Organoleptic

Observations were made directly regarding the color, smell, and appearance of the Sunkist orange peel extract peel-off gel mask formulation.

Homogeneity

Homogeneity testing involves uniformity spreading the sample on glass slides and observing the homogeneity of the peel-off gel mask. If there were no visible grains or coarse particles, the sample is considered homogeneous.

pH

pH measurement of the peel-off gel mask formulation was conducted by a pH meter. A quantity of 1 gram of the formulation was dissolved in 10 mL of aquadest, and the pH was then measured using a pH meter. The formulation should meet the criteria for skin pH, which falls within the pH range of 4.5-8.0 according to the SNI 16-4399-1996 standard. If the formulation is alkaline (outside the skin pH range), it can cause the skin to feel slippery and dry. If the formulation is acidic with a pH below the skin pH range, it may lead to skin irritation (Athaillah et al., 2019).

Spreadibility

A quantity of 0.5 g of the peel-off gel mask was placed on the spreading power test device. The upper glass part was weighed first, then placed on top of the peel-off gel mask, and left for 1 minute. A weight of 50 g was added, and it was left for another 1 minute. Measure the spread of the gel mask within 1 minute Good spreadibility is within the range of 5-7 cm (Voigt, 1994).

Drying Time

A quantity of 0.5 grams of the peel-off gel mask formulation was applied to a glass object with an approximate thickness of 1 mm. It was then placed in an oven at a temperature of 36.5 ± 2°C, and the drying time of the formulation was measured using a stopwatch. The requirement for the drying time of the peel-off gel mask formulation is between 15-30 minutes (Yasir, 2021).

Viscosity

Viscosity testing was conducted to determine the level of thickness of the sample, and this test was performed using a Brookfield viscometer. The spindle size used was number 11, and it operated at a speed of 60 rpm. The sample was placed in a container, and the spindle was immersed in the container up to the marked limit. The value in cPs (centipoises) displayed on the monitor is then recorded as the viscosity (Ali et al., 2013). According to the Standard National Indonesia 16-4399-1996, the viscosity of a good gel formulation should fall within the range of 2,000-50,000 cPs.

Skin Irritation Test

This research was approved by Ethical Review Committee, Malahayati University regarding the Declaration of Helsinski. The aproval ethical number was 3808/EC/KEP-UNMAL/VII/2023. This research was conducted on 25 volunteers using a Completely Randomized Design (CRD), and they were divided into 5 samples, namely FI, FII, FIII, K-, and K+. In this experimental design using CRD, 25 volunteers were employed, and each volunteer underwent testing twice. It was possible that specific formula tests were not administered to certain subjects because each subject only had 2 trials. The purpose of this design was to minimize the number of subjects without reducing the number of repetitions for each formula, and it also helped minimize errors caused by subjects or the order of use. The criteria for volunteers included an age range of 18-25 years and their willingness to complete a questionnaire and provide informed consent.

The test was conducted by applying approximately 0.5 grams of the mask formulation to the back of the ear with a diameter of approximately 3 cm. Let it for 30 minutes, then the formulation was removed with water, and any signs of irritation that appear was observed in that area. Observations were made at 0, 24, 48, and 72 hours after removing the formulation. Typically, a positive irritation reaction on the skin was characterized by erythema and edema in the treated area.

Table 2. Erythema and Edema Score

Value	Erythema Formation	Edema Formation
0	No Erythema	No Edema (no swelling)
1	Very Slight Erythema (barely perceptible), edges of area not well defined	Very Slight Edema (mild swelling)
2	Slight erythema (pale red in color and edges definable)	Slight Edema
3	Moderate to severe erythema (defined in color and area well defined)	Moderate to severe Edema (severe swelling)
4	Severe erythema (beet to crimson red) to slight eschar formation (injuries in depth)	Severe edema (severe swelling)

Erythema and edema scores were obtained by comparing the observed area and the corresponding condition as described in **Table 2**.

The data obtained from the irritation test is then used to calculate the Primary Irritation Index (PII) in accordance with ISO 10993-23:2021(E). The data is analyzed to obtain the Primary Irritation Index (PII) for the skin, using **Equation 1.**

$$PII = \frac{\Sigma \text{ erythema grade at } 0/24/48/72h + \Sigma \text{ erythema grade at } 0/24/48/72h}{50} \quad \textbf{..(1)}$$

The PII value is used to determine the level of irritation. The obtained PII results are compared to reference criteria in the classification of irritation responses, as shown in **Table 3**.

Table 3. Irritation Classification Response (ISO 10993)

PII	Irritation Classification
0-0.4	No significant irritation observed.
0.5-1.9	Mild irritation with minimal impact.
2.0-4.9	Moderate irritation with noticeable effects.
5.0-8.0	Severe irritation with significant impact.

Hedonic Test

The hedonic test in the research is divided into 5 groups: FI, FII, FIII, K(-), and K(+). The hedonic test involves 10 volunteers for each sample. The criteria for volunteers include an age range of 18-25 years, their willingness to fill out a questionnaire in the form of a Google Form, and providing informed consent.

Volunteers provide scores within a rating range of 0-10 for the criteria related to the product's appearance, the experience during product application, and the sensation after the product is removed.

Antioxidant activity by DPPH assay

The DPPH solution was prepared by dissolving 3.94 mg of 2,2-diphenyl-1-picrylhydrazyl (DPPH) in 100 mL of analytical grade ethanol (96%) to obtain a 0.1 mM solution. The solution was stored in a light-resistant container at 4°C until further analysis. The maximum absorption wavelength was determined spectrophotometrically by scanning the DPPH solution in the range of 400-800 nm utilizing a UV-Visible spectrophotometer, with ethanol (96%) serving as the blank solution.

The sample stock solution was prepared by precisely weighing 100 mg of the sample and subsequently dissolving it in 96% ethanol in a 100 mL volumetric flask to achieve a concentration of 1000 ppm. Serial dilutions were then prepared from the stock solution to obtain working concentrations of 20, 40, 60, 80, and 100 ppm utilizing appropriate volumetric glassware.

The antioxidant activity assessment was conducted by combining equal volumes (2 mL) of each sample concentration with the DPPH solution. The reaction mixtures were incubated under dark conditions at ambient temperature for 30 minutes. Subsequently, the absorbance measurements were performed at 515 nm using a UV-Visible spectrophotometer. The radical scavenging activity was quantified as percentage inhibition utilizing the **Equation 2**. The half-maximal inhibitory concentration (IC50) was determined through linear regression analysis of the concentration-response relationship.

Table 4. Results of The Extraction and Phytochemical Test of Sunkist Orange Peel

Paramaters	Result
Extract Type	Concentrate extract
Solvent	Ethanol 96%
Sample Weight (g)	500
Extract Weight (g)	49.76
Yield (%)	9.95
Phytochemical content	
Polyphenol	+
Alkaloids	-
Saponin	-
Tanin	+
Flavonoid	+

Note: (+) sign indicates presence and (-) sign indicates absence of corresponding phytocomponents

$$\%\textbf{Inhibition} = \frac{\textbf{Control Abs} - \textbf{Sample Abs}}{\textbf{Control Abs}} \quad \text{.....(2)}$$

RESULT AND DISCUSSION

The method used for extracting Sunkist orange peel is the maceration method using 96% ethanol as the solvent. Maceration was chosen due to its ease of operation, the use of simple equipment, and suitability for heat-sensitive materials. The choice of 96% ethanol as the solvent is because it has a similar polarity to the compounds to be extracted. 96% ethanol is effective in extracting alkaloids, polyphenols, flavonoids, tannins, and saponins since it is a polar solvent.

Amount of 500 grams of Sunkist orange peel powder were weighed and macerated with 3 liters of 96% ethanol each. The evaporation process was conducted using a rotary evaporator, resulting in a dark yellowish-black, characteristic aroma of Sunkist orange peel extract. The extract had a weight of 49.76 grams, yielding 9.95% as shown in **Table 4**. These results are not significantly different from similar studies, indicating that the choice of solvent and extraction method is considered suitable (Saini et al., 2019).

Phytochemical screening was conducted to qualitatively assess the presence of secondary metabolites believed to have the ability to scavenge free radicals. Based on the phytochemical screening results, the positive extract of Sunkist orange peel contains polyphenols, tannins, and flavonoids (**Table 4**). Polyphenols, tannins, and flavonoids are natural antioxidants that play a role in neutralizing free radicals that can affect the skin. Their presence in the extract supports the research being conducted (Dewi et al., 2019; Andrade and Fasolo, 2014; Panche et al., 2016). The results of the phytochemical screening in this study differ from the research conducted, in which the extract of sunkist orange peel was found to contain saponins and alkaloids, whereas in this study, these metabolites were not detected (Long, 2021). This could be due to differences in the location where the Sunkist orange samples were collected. Variations in the growing environment can influence the secondary metabolites contained within them (Yang et al., 2018).

In the process of making peel-off gel mask formulations, three formulations were tested: Formulation I (0.5% extract concentration), Formulation II (1% extract concentration), and Formulation III (2% extract concentration). The gel was formed using PVA and HPMC, where PVA served as a film-forming agent and HPMC as a gelling agent. Propylene glycol was used as a humectant, and Phenoxyethanol was used as a preservative. Sweet Orange Essential Oil was included as a fragrance.

Organoleptic testing is performed to visually evaluate the appearance and aroma of the prepared formulations. Any discrepancies in this test can indicate incompatibility in the formula. In the organoleptic test from **Table 5**, FI, FII, FIII, which contain Sunkist orange peel extract, have an orange color due to the extract, while the K- formula, which does not contain Sunkist orange peel extract, appears transparent. All four formulations have the characteristic scent of the perfume and have a semi-solid texture similar to K-. This indicates that there is no indication of incompatibility reactions between the extract and the excipients used.

Testing for homogeneity, pH, spreadability, and drying time is conducted to ensure that the quality of the formula meets the specified requirements. The preparation is considered

Table 5. Organoleptic, Physical, and Chemical Evaluation

Formula	K-	FI	FII	FIII
Color	No Color	Pale Yellow	Dark Yellow	Orange
Aroma	Typical perfume	Typical perfume	Typical perfume	Typical perfume
Form	Semisolid	Semisolid	Semisolid	Semisolid
Homogeneity	Homogeneous	Homogeneous	Homogeneous	Homogeneous
pH ± SD	5.66 ± 0.23^{b}	5.26 ± 0.31^{a}	5.16 ± 0.08^{a}	5.16 ± 0.08^{a}
Spreadibilty ± SD (cm)	6.6 ± 0.24^{b}	6.3 ± 0.15^{b}	6.3 ± 0.18^{b}	5.2 ± 0.31^{a}
Drying time ± SD (minutes)	18.2 ± 1.5^{c}	16.5 ± 1.4^{b}	16.3 ± 0.3^{b}	15.3 ± 0.1^{a}
Viscosity (cPs ± SD)	$6,707.59 \pm 122.09^{a}$	$7,384.32 \pm 227.13^{a}$	$7,665.49 \pm 163.24^{a}$	$8,859.78 \pm 103.06^{b}$

$^{a-c}$ different letters in the same row indicate statistically significant different ($p<0.05$)

homogeneous when there are no longer visible granules or coarse particles in the sample. The drying time requirement for the peel-off gel mask preparation is 15-30 minutes (Saputra et al., 2019). The test results in **Table 5** indicate that all formulations meet the quality requirements for the peel-off preparation. pH in cosmetic formulations plays a crucial role in the physical, chemical, and microbiological functions of the skin (Schulte to Brinke et al., 2021). Therefore, we conducted an investigation into the pH of the prepared formulations. The tannin content in sunkist orange peel is acidic, which is why K- (**Table 5**), which does not contain sunkist orange peel extract, has the highest pH value compared to the other formulas ($P<0.05$) (Suseela, 2019). The all preparation meets the skin pH criteria within the pH range of 4.5-8.0 according to SNI 16-4399-1996.

Spreadability testing was conducted to compare the effect of extract concentration on the ease of product spreading during use. Good spreading ability falls within the range of 5-7 cm, and all the formulas meet the established criteria (Voigt, 1994). In the spreadability test, FIII has the lowest spreadability due to its higher extract content compared to the other formulas ($P<0.05$). Nevertheless, all the formulas still meet the specified criteria.

Peel-off preparations are formulations that, when applied and dried, can be easily peeled off. One of the parameters for consumer comfort in using them is the drying time of the peel-off preparation. The results of the drying time testing in **Table 5** indicate that FIII dries more quickly than the other formulas ($P < 0.05$). This could be due to the lower water content in FIII compared to the others. Higher water content leads to a longer time required for the water to evaporate. Nevertheless, all the formulas meet the specified drying time criteria.

Viscosity testing is conducted to determine the thickness of the formula produced. According to the SNI 16-4399-1996 standards, the ideal viscosity for gel preparations should range from 2,000 to 50,000 cps. The results of the testing in **Table 5** show that all the formulas meet the specified requirements. In general, the viscosity of a cosmetic product will affect its spreadability. Higher viscosity indicates a thicker, more resistant product, which can make it more challenging to spread evenly on the skin. Conversely, a lower viscosity product will be thinner and easier to spread (Chatziantoniou et al., 2015). This phenomenon is consistent with the results of the spreadability and viscosity tests, where FIII has the highest viscosity and the lowest spreadability ($P < 0.05$).

Table 6. *Primary* Irritation *Index* (PII)

Formula	PII	Irritation Classification
K-	0	Not irritating
FI	0	Not irritating
FII	0	Not irritating
FIII	0.05	Not irritating
K+	0	Not irritating

Irritation testing of the peel-off gel mask preparations is intended to identify any symptoms that may occur in case of irritation. If irritation occurs, it will be indicated by skin reactions after the product is applied to the skin. This testing is also conducted to assess and evaluate the characteristics of a substance when

exposed to the skin. The results of the Primary Irritation Index (PII) calculations, as seen in **Table 6**, show that none of the formulas caused irritation reactions up to 72 hours after the product was applied. Based on these results, it can be concluded that both the base formula and the sunkist orange peel extract do not trigger irritation in the volunteers who used the product. This is supported by similar research conducted by Prommaban (2022), which showed that the essential oil from orange peel did not cause skin irritation in the form of a microemulsion preparation (Prommaban and Chaiyana, 2022).

The appearance of a product is the first impression when consumers choose a product for use. Gel formulations with high brightness and transparency give a more elegant impression and are preferred by consumers (Simmonds et al., 2018). **Figure 1** illustrates the relationship between the scores provided by volunteers (x-axis) and the types of formulas under evaluation (y-axis). The data indicate that K+ has higher transparency and lower brightness compared to the other formulas ($P<0.05$). The inclusion of sunkist orange peel extract reduces the product's transparency but enhances the brightness of its color.

The evaluation during the application of the formulation is conducted to understand the sensory profile perceived by volunteers when using it. **Figure 2** illustrates the relationship between the average scores provided by volunteers (x-axis) and the types of formulas under evaluation (y-axis) with respect to the

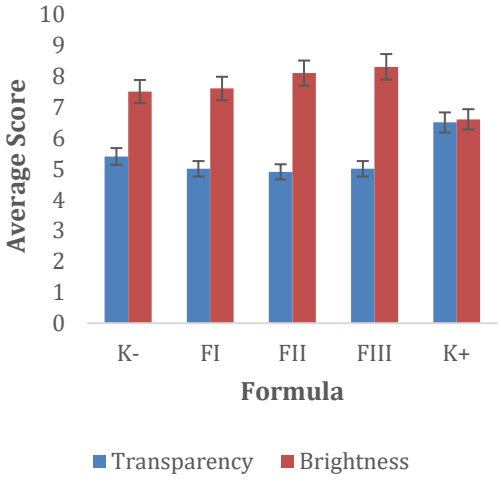

Figure 1. Average Score (±SD) of Product Appearance Profile

Table 7. Half maximal inhibition concentration (IC50, ppm) of Various Samples

Sample	IC_{50}
K-	286.08[c]
Extract	30.4[a]
FIII	23.38[a]
K+	167.04[b]

[a-c]different letters in the same column indicate statistically significant different ($P<0.05$)

sensory parameters of the product during application. The results shown in **Figure 2** indicate that FIII has the lowest ease of spreading on the skin and the highest skin tightening effect compared to the other formulas ($P<0.05$). This is consistent with the viscosity testing of FIII, which showed that this formula has the highest viscosity. The higher the viscosity, the lower the spreading ability of the gel formulation (Szulc-Musioł et al., 2017). The high skin tightening effect in FIII is suspected to be due to its high viscosity, making the skin adhere and resist returning to its original state upon application of the peel-off gel formulation due to its high density.

The penetration ability of FIII is lower compared to K-, FI, FII, and K+, as seen in **Figure 2** ($P<0.05$). This can also be attributed to the viscosity of FIII, which affects these parameters perceived by the volunteers. The higher the viscosity, the lower the skin penetration ability of the formulation (Binder et al., 2019). However, for the flowability and sliding ability parameters, FIII does not differ from the other formulas ($P>0.05$). This could be due to the thixotropic rheological properties of the gel formulation. The shear stress applied during the application of the formulation on the skin can reduce the viscosity of the gel, allowing it to spread more easily, even though it has higher viscosity when no force is applied to the formulation (Dănilă et al., 2020).

There is no difference in the cooling effect and foam form parameters between all formulas ($P>0.05$). From **Figure 2**, the cooling effect has an average value of 7.6, and foam form has 2.96. This indicates that all formulas have a cooling effect on the skin, which may be due to the ethanol content in the formula (Kurihara-Bergstrom et al., 1990). The absence of foam during application is because the

formula does not contain surfactants or similar substances that could emulsify air into the formulation.

formulas (P<0.05). This is due to the higher content of sunkist orange peel extract, which contains essential oils (Long, 2021). Additionally, FIII, as shown in **Figure 3**, exhibits

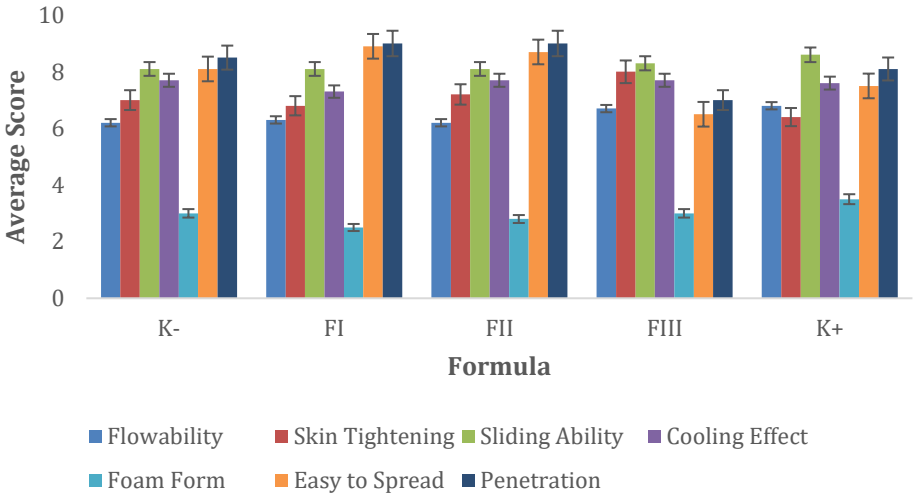

Figure 2. Average Score (±SD) of During Application Product Profile

In the development of cosmetic products, testing the sensation after cosmetic use is important to ensure that consumers have a pleasant experience before, during, and after using the product. Testing in this parameter measures the level of sensation of volunteers, including ungreasy, softens the skin, and unsticky sensations, as seen in **Figure 3**. **Figure 3** illustrates the relationship between the scores provided by volunteers (x-axis) and the types of formulas under evaluation (y-axis) with respect to the sensory parameters of the product after application. FIII provides a higher feeling of greasiness and stickiness compared to all

better skin softening activity than all formulas (P<0.05). This condition can be attributed to the ability of the metabolites present in sunkist orange peel extract (Guzmán and Lucia, 2021).

From **Table 7**, antioxidant activity testing was conducted on four formulas: K-, sunkist orange peel extract, FIII, and K+. Sunkist orange peel extract and FIII exhibit stronger antioxidant activity compared to K- and K+ (P<0.05). This is due to the presence of secondary metabolites in sunkist orange peel extract, as it contains polyphenols, flavonoids, and tannins, as observed in the phytochemical screening.

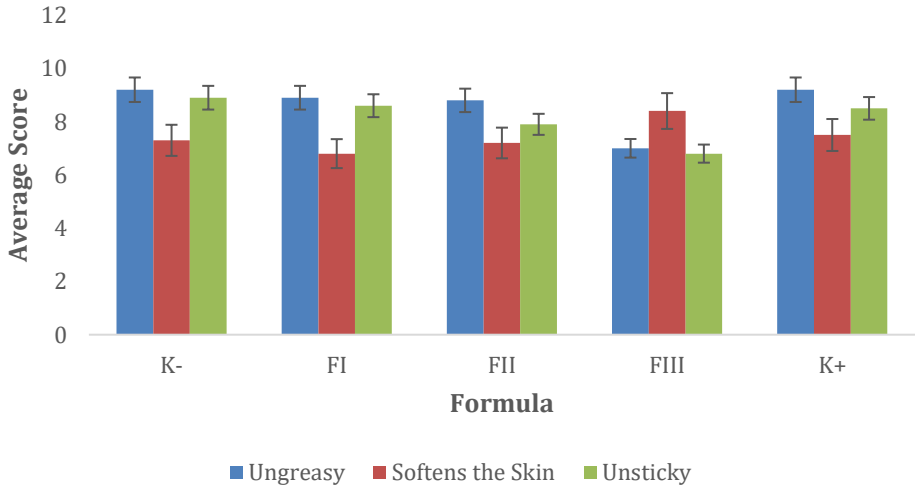

Figure 3. Average Score (±SD) of After Application Product Profile

Flavonoids are phenolic compounds commonly isolated from plants for their antioxidant benefits in scavenging free radicals that can damage body cells. The antioxidant activity of the sunkist orange peel mask gel peel-off in this study is higher than a similar study conducted by Anjani (2018), which showed that the antioxidant activity of mask gel peel-off from lemon fruit peel essential oil, belonging to the same genus as sunkist oranges (Citrus sp), had an IC-50 DPPH value of 139.188 ppm (Anjani, 2018). Based on these results, it can be concluded that sunkist orange peel extract and the sunkist orange peel extract mask gel peel-off exhibit very strong antioxidant activity.

CONCLUSIONS

Based on the results of the conducted research, it can be concluded that:

Sunkist orange peel extract (*Citrus sinensis* (L.) Osbeck) can be formulated into a peel-off gel mask preparation that meets various criteria, including homogeneity testing, pH testing, spreadability testing, drying time testing, and viscosity testing. Sensory evaluation shows that Formula FIII is preferred over FI and FII.

Formula FIII, with a concentration of 2% sunkist orange peel extract, has an IC-50 value of 23.38 ppm, indicating very strong antioxidant properties

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AUTHORS' CONTRIBUTIONS

N contributed to the experimental design, data collection, and drafting of the manuscript. SS participated in experimental process and data analysis. ASY supervised the project and revised the manuscript for intellectual content.

CONFLICT OF INTERESTS

The authors declare no conflict of interests regarding the publication of this article.

ETHICAL CONSIDERATION

All ethical guidelines were strictly adhered to during this research, including ensuring originality, avoiding data fabrication, and preventing double publication.

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