Hedonic Ratings and Physicochemical Stability of Antiaging Cream Formulas with Natural Active Ingredients of Nanophytosome from Combination of Merbau Wood-Gotu Kola Leaves Extracts and Essential Oils

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Abstract. Nanophytosome from the combination of Merbau wood (*Intsia sp.*) and Gotu Kola leaves (*Centella asiatica*) extracts (NMG) have the potential as natural active ingredients of antiaging creams. This study aims to analyze the preference level of creams with the active ingredient of 4% NMG and the additions of essential oils and to test the physicochemical stability of the most preferred cream. The cream added the essential oil of nutmeg leaf, kaffir lime peel, and lime peel at consentration of 0%, 0.5%, 1%, and 1.5% (w/w). The preference level was measured by hedonic rating tests on the scent, texture, and viscosity by 30 non-standard panelists aged ≥25 years. The most preferred formula was tested for physicochemical stability by storage at low temperature (±4 °C), room temperature (±27 °C), and extreme temperature (±40 °C) for 21 days. The results showed that the most preferred formula was F9, which used 1% kaffir lime peel essential oil. The higher the temperature, the spreadability of the cream will increase; conversely, the higher the storage temperature, the lower the pH value, viscosity and stickiness of the cream, but it still meets the physicochemical standard of cosmetics cream. So this antiaging cream can be used for cosmetic applications.

1 Introduction

Aging skin on the face is one of the problems that can reduce self-confidence. Skin aging is a progressive decrease in the function and capacity of the skin. Two factors play a role in the occurrence of skin aging, namely intrinsic and extrinsic factors. Intrinsic factors include genetics, cell metabolism, and hormones, while outside factors include ultraviolet (UV), infrared, and environmental carcinogens such as air pollution [1]. Long-term UV radiation is the main extrinsic factor causing skin aging [2]. Ecological conditions in Indonesia trigger premature skin aging faster, so the demand for antiaging products in Indonesia is very high. Unfortunately, about 99% of the active ingredients are imported and made from synthetics with dangerous side effects [3]. An antiaging cream formula with active natural ingredients from local resources has been scientifically proven for its antiaging effectiveness and safety [4].

One of the forest products that have the potential to be developed as a source of natural active ingredients in antiaging cream formulas is Merbau wood (*Intsia sp*) and Gotu Kola (*Centella asiatica* Linn.) (Indonesia: Pegagan). This is because the ethanol extract of Merbau wood has very high antioxidant activity [5]. Gotu Kola, a ground cover shrub, can be developed as a source of natural active ingredients in antiaging cream formulas. Gotu Kola leaves contain flavonoids, carotenes, tannins, vitamin C, and triterpenoids, which have antioxidant activity and play a role in repairing damaged skin cells and stimulating collagen synthesis, which is the essential ingredient for the formation of fibroblast fibers and skin rejuvenation [6]. Previous research reported that mice treated with an antiaging cream formula with an active ingredient of 4% nanophytosomes, a mixture of Merbau wood extract and gotu kola leaf extract with a ratio of 1:2 had higher levels of skin brightness and collagen percentage and had fewer wrinkles and skin irritation compared to commercial creams and creams with active mixtures of extracts without being made into nanophytosomes [3]. Nanophytosomes are nanotechnology that can increase the bioavailability and absorption of active ingredients into the skin by binding these active ingredients with phospholipids, which are similar to cell membranes [6].

Antiaging cream formulations can use an oil-in-water (O/W) type cream base. This type of cream base

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is non-sticky and easy to clean [7]. In addition, the base type of O/W cream with 10% vetiver essential oil repellent had better physical stability than the water-in-oil (W/O) type cream [8]. Adding essential oils to the antiaging cream formula can provide a fresher scent and add antiaging effects, such as the essential oils of nutmeg leaves, kaffir lime peels, and lime peels. Nutmeg leaf essential oil with the main compounds trans-β-cinema and α-pinene has the potential as an antioxidant [9]. Kaffir lime peel essential oil contains powerful antioxidants [10]. Lime peel essential oil contains active compounds such as vitamin C, tannins, and flavonoids, which function as antioxidants, anti-inflammatories, and antioxidants [11]. Adding an essential oil scent can increase the level of preference and physicochemical properties of the cream formula.

Cream preparations that are made basically must meet the stability test. The cream preparation is stable if the preparation is still within acceptable limits during the storage period and used with the same characteristics and properties as the conditions when the cream was made. The preparation's cream base and active substances will determine its stability [12]. The stability test of cream preparations is essential to determine whether the practices are still safe to use in a specific place or for a particular shelf life. Therefore, the physicochemical stability test of antiaging cream preparations with active ingredients of 4% nanophytosomes with the addition of the most preferred essential oils at different temperatures must be carried out.

2 Materials and Methods

2.1 Materials

The materials used for extraction are gotu kola leaves obtained from the Biopharmaca garden of IPB, Merbau wood from Papua, distilled water, and ethanol 96% (Merck, Darmstadt, Germany). The materials used to make nanophytosomes are gotu kola leaf extract, Merbau wood extract, soybean lecithin produced from subcritical water extraction and L-α-Phosphatidylcholine (soybean ≥99%, lyophilized powder) were used as an encapsulant or liposome without further modification were obtained from Lansida Yogyakarta, dichloromethane CH_2Cl_2 99,8% (Merck, Darmstadt, Germany), and n-Hexane $CH_3(CH_2)_4CH_3$ (Merck, Darmstadt, Germany) and distilled water were obtained from PT. Brataco Bogor, Indonesia. The materials used for the manufacture of antiaging creams are nanophytosomes of gotu kola-merbau wood, kaffir lime peel essential oil, nutmeg leaf essential oil, lime peel essential oil, and an oil-in-water (O/A) cream base. The materials used for the hedonic test were formula cream that had been made and panelist paper. The materials used for the physicochemical test of the cream are distilled water and cream pots.

The tools used were a wiley mill, 40-60 mesh sieve, filter paper (Whatman 42), beaker glass, erlenmeyer, oven (Memmert celsius 10.0, Memmert, Germany), water bath, reflux, desiccator, magnetic stirrer, rotary evaporator (Rotavapor, Buchi R–300, Switzerland), digital scales and ultra sonicator.

2.2 Methods

2.2.1 Raw Material Preparation

Extraction in this study refers to [3]. Simplicia powder from gotu kola leaves and Merbau wood is manufactured by conventional drying in the sun until it reaches air-dry moisture content. After drying, the raw materials are ground using a Wiley mill to become powder. The powder of each raw material is then sieved using a 40-60 mesh sieve. Maceration of gotu kola leaf powder using 70% ethanol concentration and maceration of Merbau wood powder using 50% ethanol concentration. Maceration of gotu kola leaves and Merbau sawdust using a powder-to-solvent ratio of 1:10. Raw material maceration was carried out with three repetitions.

2.2.2 Manufacturing of Nanophytosomes

The manufacture of phytosomes was carried out concerning [13]. The extract used was a combination of extracts of gotu kola leaves and merbau wood (2:1), which was reacted with soy lecithin with a ratio of 1:1. The combination of soy extract and listened was then put into a 500 mL round bottom flask and refluxed with 100 mL dichloromethane at 60 ℃ for 2 hours. The mixture was concentrated using a rotary evaporator until it reached a 5-10 mL volume. Furthermore, n-hexane (20 mL) was added with continuous stirring to obtain a residue. The precipitate was filtered and stored in a desiccator for 12 hours. The dried residue was crushed with a mortar into a powder, placed in a glass bottle, and stored at room temperature.

Furthermore, hydration was carried out on the thin layer of phytosomes using 20 mL of distilled water using a magnetic stirrer for 30 minutes to form nanophytosomes. The solution was transferred into a 50 mL beaker glass, and the particle size was reduced using an ultrasonication process for 30 minutes. Nanophytosome from the combination of merbau wood and gotu kola leaves extracts (NMG) was then made into an active ingredient in antiaging cream formulas.

2.2.3 Preparation of Antiaging Cream Formulas

The cream was made in ten formulas, as contained in Table 1. The cream was made from mixing O/W cream base, active ingredients nanophytosomes from the combination of gotu kola leaves and merbau wood extracts (2:1) (NMG), as well as essential oil of nutmeg leaves (NL), skin kaffir lime (KP), and lime peel (LP). The O/W cream base is made from the oil phase (stearic acid) and the water phase (aquades, glycerin, sodium tetraborate, and triethanolamine (TEA) with a specific composition made by the Pharmacy Laboratory, School of Veterinary Medicine and Biomedical, IPB. The cream is made by mixing the cream base, active ingredients with a specific concentration, and essential oils with a particular concentration according to a predetermined formulation. The homogeneous cream is then put into the cream pot.

Table 1 Antiaging Cream Formulas with an active ingredient of nanophytosome cream formula (NMG) with the addition of essential oils

Cream Formula	Cream base (%)	Nanophytosome (%)	Essential oil (%)
F1 (NMG0)	96.00	4	-
F2 (NMG-NL1)	95.50	4	NL 0.5
F3 (NMG-NL2)	95.00	4	NL 1.0
F4 (NMG-NL3)	94.50	4	NL 1.5
F5 (NMG-KP1)	95.50	4	KP 0.5
F6 (NMG-KP2)	95.00	4	KP 1.0
F7 (NMG-KP3)	94.50	4	KP 1.5
F8 (NMG-LP1)	95.50	4	LP 0.5
F9 (NMG-LP2)	95.00	4	LP 1.0
F10 (NMG-LP3)	94.50	4	LP 1.5

Notes: nutmeg leaves oil (NL), skin kaffir lime oil (KP), lime peel oil (LP).

2.2.4 Hedonic Test of Antiaging Cream Formulas

The hedonic test determined the preference level for the cream formulation made for consumers. The hedonic test in this study refers to SNI 01-2346-2006 [15]. The hedonic test was conducted by surveying by filling out forms by 30 non-standard female panelists aged 25 years and over. This test refers to Rachman's research [16], which states that consumers of antiaging creams are dominated by women aged 25-64 years. The hedonic test in the study uses a scale of 1-9, which shows the level of preference from immensely, very dislike to very, very like. The number 1 represents strongly dislike, 2 represents dislike very much, 3 represents dislike, 4 represents somewhat likes, 5 represents neutral, 6 represents rather appreciates, 7 represents likes, 8 represents likes very much, and 9 represents likes very much [17].

The data obtained from the scoring sheet is tabulated, and its quality value is determined by finding the average result for each panelist at the 95% confidence level. To calculate the average quality value interval of each panelist, the following formula is used:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

$$S^2 = \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n}$$

$$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n}}$$

with:
n = the number of panelists;
S^2 = variety of quality values;
$\bar{x}$ = average quality value;
x_i = the quality value of the i-th panelist, where i = 1,2,3,….,n;
s = standard deviation of quality value

2.3 Physicochemical Characterization of Antiaging Cream Formulas

The physicochemical stability test was carried out on the cream formula with the highest hedonic test value. In addition, there is also a negative control, which is an O/W cream base without active ingredients. Observation of the physical stability test of the cream was carried out for 21 days at different storage temperatures. Various storage conditions were carried out, including storage at low temperatures in the refrigerator (±4 °C), room temperature (±27 °C), and extreme temperatures (in the oven at ±40 °C). The physical stability test was obtained by comparing the condition of the samples on day one and day 21. Physical stability tests included pH, Viscosity, spreadability, adhesion, and color change tests.

2.3.1 Degree of Acidity (pH) Measurement

The cream preparation was weighed as much as 1 g and diluted with 10 mL of distilled water. Then, use a pH meter, the sensor part, and read the pH on the monitor part. The test was carried out by replication 5 times for each formula.

2.3.2 Viscosity Measurement

As much as 0.5 g of cream was put into the cup, spindle No. 6 was installed, and the rotor was run at 12 rpm. After the Brookfield viscometer shows a stable number, the results are recorded and multiplied by a factor (500). The test was carried out by replication 5 times for each formula.

2.3.3 Spreadability Measurement

The cream preparation was weighed as much as 0.5 g, then placed in the middle of the glass plate and left for 1 minute. After that, an additional load was given every 1 minute 50 g to 250 g, and then the diameter was measured to see the effect of the load on changes in the diameter of the spread. The test was carried out by replication 5 times for each formula.

2.3.4 Stickiness Measurement

The cream preparation was weighed 0.5 g and then smeared on a glass plate. The two glass plates were affixed until the vessels came together and were given a load of 250 g for 5 minutes. After that, they were released and then given a release load. Time is recorded until the two plates are removed from each other. The test was carried out by replication three 5 for each formula.

2.3.5 Discoloration Measurement

The color change test was carried out on the formula before being stored (day 0) on the 21st day at each storage place. Color testing uses a service scheme at the LDITP Food Lab, IPB, using a CR-400 Chromameter. Color testing was carried out using the CIELab method. The L*a*b* color space, also known as CIELab, is the complete color space defined by the International Commission on color illumination (French Commission Internationale de l'eclairage, CIE). This color space can describe all the colors that can be seen by the human eye and is often used as a reference color space [20].

The CIELab method states three parameters to measure changes or differences in the color of an object. The L* value is a brightness parameter that has a value of 0 (black) to 100 (white). The a* value is a mixture of green-red colors (+a with values from 0 to 80 is red; -a is with values -80 to 0 is green). The b* value represents a mixture of blue-yellow colors (+b represents a value from 0 to 70 for yellow; -b represents a value of -70 to 0 for blue). According to Sari [17], ΔL*, Δa*, and Δb* were calculated from the difference between the values before (0 days) and after being held for 21 days. ΔE* is the total color difference, which is obtained from the formula:

$$\Delta \mathbf{E} * = \sqrt{(\Delta \mathbf{L})^2 + (\Delta \mathbf{a})^2 + (\Delta \mathbf{b})^2}$$

2.4 Data Analysis

The physicochemical stability test data was analyzed descriptively, while the hedonic test analysis used a two-factor Completely Randomized Design (CRDF). Factors in the hedonic test were (1) the addition of essential oil types (nutmeg leaves, kaffir lime peels, and lime peels) and (2) the concentration of essential oils (0%, 0.5%, 1%, and 1.5%). Data were analyzed using variance (ANOVA). If the results of the analysis of variance show that there is a treatment that has a significant effect on each response, then a further Tukey test is performed. Data analysis using SPSS software.

3 Result and Discussion

3.1 The Hedonic Ratings

The hedonic test was conducted on 30 non-standard female panelists aged 25 years and over. Panelists gave values of preference (1-9) for scent, texture, and Viscosity (Viscosity) for ten formulas made with the appearance shown in Fig. 1. In general, the ten formulas had little difference in color appearance, namely bright ivory, yellow or beige.

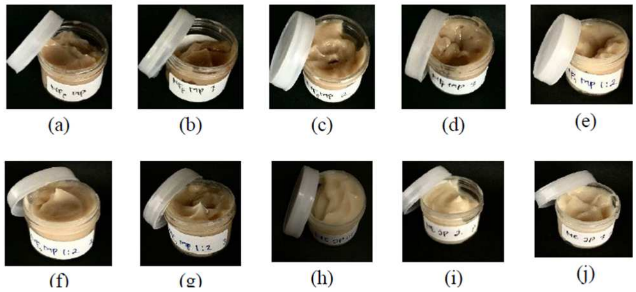

Fig. 1. Appearance of antiaging cream formulas with active nanophytosome from the combination of Merbau wood-Gotu kola leaves extracts with the addition of essential oils (a) F1, (b) F2, (c) F3, (d) F4, (e) F5, (f) F6, (g) F7, (h) F8, (i) F9, and (j) F10.

3.1.1 Scent

The panelists' preference level for the scent of various cream formulas is shown in Fig. 2. The analysis of variance showed that the interaction between the type of essential oil and its concentration did not affect the level of preference for the scent. The type of essential oil affects the level of appreciation for scent, so it is continued with Tukey's further test. Tukey's additional test results showed that cream formulas with lime peel essential oil were preferable to other essential oils or cream formulas without adding an essential oil scent. The value of the average preference for scent for each formula is shown in Fig. 2. The value of the preference level for scent is in the range of 4.9 to 6.9, which means like it. Based on the scent, the formula with the highest preference level is the cream formula F8 and F9 with a value of 7, meaning likes. Cream formulas F8 and F9 are cream formulas flavored with lime peel essential oil 0.5% (F8) and 1.0% (F9). The lowest level of preference is in the formula with the addition of KP essential oil. This matter is probably because the formula contains KP essential oil with a distinctive scent of kaffir lime peel which is rarely used in beauty products. Hence, panelists are unfamiliar with it when used in creams [10]. In contrast, the highest preference level was found in the cream formula with the addition of LP essential oil. Formulas with LP essential oil are preferred because many beauty products use this essential oil, so panelists are more familiar with this scent.

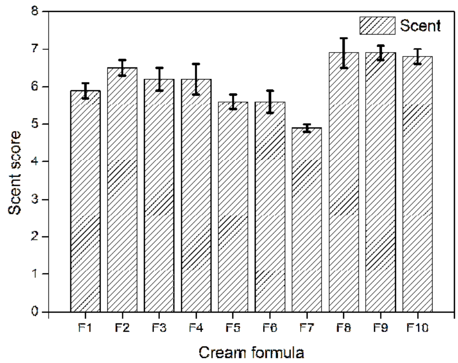

Fig. 2. The score of the panelist's preference level test value for the scent of the cream formulas ( )

3.1.2 Texture

The panelists' preference level for the texture of various cream formulas is shown in Fig. 3. The value of the texture preference ranged from 6.3 to 6.8, with the highest value in cream formula F9. Based on the analysis of variance, the type of essential oil, the concentration of essential oil, and the interaction between the two had no significant effect ($p>0.05$) on the texture preference of the formula. In general, the panelists quite liked the texture of all the cream formulations made. The addition of essential oils did not affect the preference level of the surface of the cream formula, possibly because the textures of all the formulas were similar due to the addition of the low concentration of active ingredients and essential oils.

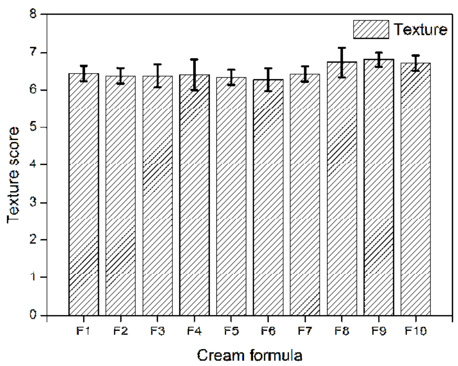

Fig. 3. The score of the test value for the level of preference for the texture of the cream formulas ( )

3.1.3 Viscosity

The panelists' preference level for the Viscosity (Viscosity) of various cream formulas is shown in Fig. 4. The analysis of variance showed that the type, concentration of essential oils and their interactions had no significant effect ($p>0.05$) on the level of preference for the thickness of the formulas. The value of the preferred level of Viscosity ranges from 6.2-6.8. The lowest level of preference value is in formula F1, while the highest is in cream formula F9. However, these results illustrate that the panelists rated that they liked quite a bit to appreciate the thickness of all the cream formulas tested.

The hedonic test results showed that the highest value based on the scent parameter was 6.9, the texture was 6.8, and the Viscosity was 6.8. In the scent parameter, the formulas F8 (LP 0.5%) and F9 (LP 1%) were not significantly different, but F9 had a higher concentration of essential oils, allowing for increased antioxidant activity. According to Pratiwi and Salimah's research, the percentage of 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical inhibition increased with increasing concentrations of lesson flower essential oil [18]. This is because, at higher concentrations, more active compounds make it more effective in counteracting DPPH radicals. Therefore, the F9 cream formula was chosen as the formula that was tested for physicochemical stability for 21 days.

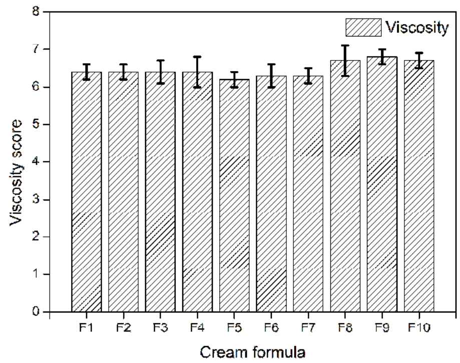

Fig. 4. The score of the test value for the level of preference for the viscosity of the cream formulas ( )

3.2 Physicochemical Stability of Cream Formula

A physicochemical stability test against storage conditions was carried out on the formula with the best preference F9 and cream base as a negative control. The treatment in the physicochemical stability test was temperature (at room temperature, room temperature, and extreme temperature for 21 days). Parameters measured in this physical stability test include pH, viscosity, spreadability, stickiness, and color change of the cream.

3.2.1 The degree of acidity (pH)

The degree of acidity or initial pH of the cream base is 7.32, while the pH of the F9 cream is 7.25. The pH of the F9 cream is slightly more acidic than the cream base due to adding the active ingredient nanophytosomes from Gotu kola leaves and Merbau wood, which contains acidic phenolic compounds [26]. The results obtained (Fig. 5) show that temperature lowers the pH value of the cream or F9 cream base. Storage at low temperatures lowered the pH of the cream base to 7.13, while the pH of the F9 cream became 7.08. Storage at room temperature lowered the pH of the cream base to 7.08, while the F9 cream became 7.06. The pH also decreases at extreme temperatures; the pH of the cream base drops to 7.05, while the pH of the F9 cream becomes 7.0. The most significant decrease in the pH of the cream base and F9 cream occurred when the cream was stored at extreme temperatures. This is in line with Sari's research [17]; the decrease in pH was caused by high temperatures, which resulted in oxidation, which lowered the pH value.

The decrease in pH at all temperatures between the cream base and F9 cream is not entirely different, although the decline in pH in F9 cream is slightly more significant. This shows that the stability of the pH is affected by the condition of the cream base. According to [19], the formulation of cream base preparations using stearic acid and triethanolamine (TEA) emulsifiers can affect the pH and thickness of the cream preparations. Even though there was a decrease in pH, the cream base and formula F9 had a pH value that was still safe and met the standard weight of Indonesian Standards (SNI 16-4399-1996) as a quality requirement for skin moisturizers (4.5−8.0). The pH of a care product is essential to note because it relates to the pH of skin acceptance. The pH of facial skin generally ranges from 5.0-6.5 and can adapt well when interacting with ingredients with a pH between 4.5-8.0. Topical preparations are expected to have a normal skin pH because if the pH is too alkaline, it will cause scaly skin, whereas if it is too acidic, it can trigger skin irritation [20].

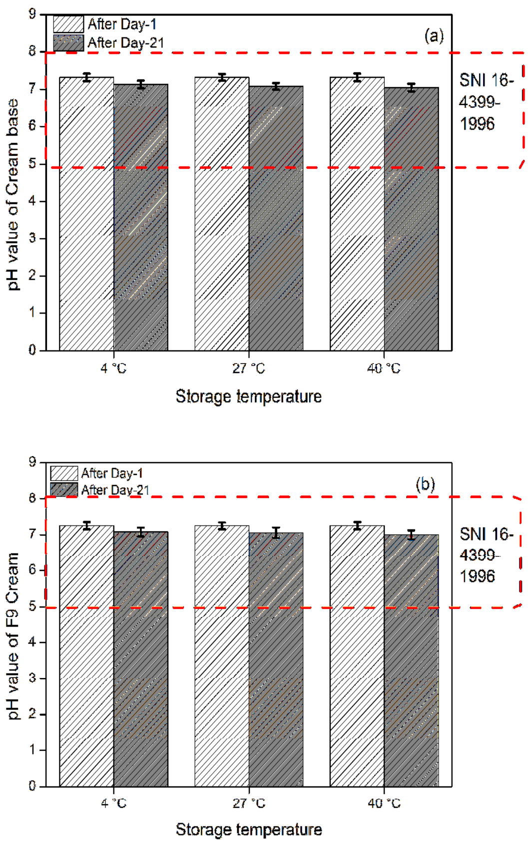

Fig. 5. Changes in pH value of cream formulas (a) only cream base and (b) F9 after *1* day of storage (▨) and after 21 days of storage (▨)

3.2.2 Viscosity

The initial Viscosity of the cream base was 27500 cP. In comparison, the initial Viscosity of cream F9 was 25000 cP at low temperature and 27833 cP at room temperature and extreme temperature (Fig. 6). Viscosity decreased at all temperatures, both on the cream base and F9 cream. The Viscosity of the cream base decreased to 26500 cP and that of the F9 cream to 24333 cP at low temperatures. Cream viscosity decreased at room temperature, cream base decreased to 26000 cP, while F9 cream decreased to 26833 cP. Cream viscosity also decreases at extreme temperatures. The cream base drops to 20500 cP, while the F9 cream is 22000 cP.

The results showed that the most significant decrease in the Viscosity of the cream base and F9 cream occurred when the cream was stored at extreme temperatures. The most significant reduction in Viscosity occurs at extreme temperatures because an increase in temperature can affect the stability of the preparation, where the emulsion resistance will be disturbed at high temperatures, which reduces the Viscosity and increases the dispersed phase motion. Increasing temperature will increase the movement and flexibility of molecules so that the Viscosity will decrease.

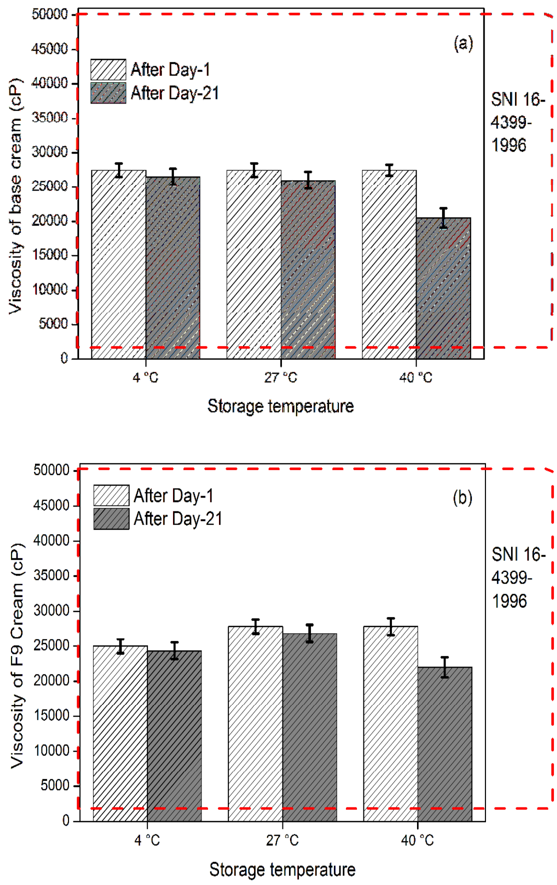

Fig. 6. Changes in viscosity values of cream formulas (a) only cream base and (b) F9 after 1 day of storage (▨) and after 21 days of storage (▨)

The difference in the decrease in Viscosity at all temperatures between the cream base and the F9 cream was not significant, even though the actual decrease in the Viscosity of the F9 cream was more significant than cream formula The difference in the decrease in Viscosity at all temperatures between the cream base and the F9 cream was not significantly different, even though the actual decrease in the Viscosity of the F9 cream was more significant than cream formula only cream base (without active ingredients). This shows that the stability of the Viscosity is affected by the condition of the cream base. Formulation of cream base preparations using stearic acid and triethanolamine (TEA) emulsifiers can affect the pH and thickness of the cream preparations made [19].

Changes in the viscosity values of all creams are still classified as safe and comply with SNI 16-4399-1996 standards for semisolid preparations viscosities of 2000−50000 cP. The cream should have neither too low nor too high Viscosity. Cream with a viscosity that is too high will be difficult to pour into the container. At the same time, cream with a viscosity that is too low will result in a runny cream that drips easily when applied so that it does not stay entirely on the skin's surface.

3.2.3 The initial spreadability

The initial spreadability of the cream base at low temperature, room temperature, and extreme temperatures was 4.35 cm, while the initial spreadability of F9 cream was 3.85 cm. The spreadability of the cream has increased at all temperatures. The spreadability of the cream base and F9 cream increased at all temperatures, with the highest increase at extreme temperatures. The spreadability of the cream base increased to 4.39 cm, while the F9 cream increased from 3.88 cm at low temperatures. Spreadability also increased at room temperature; the cream base increased to 4.43 cm, while the F9 cream increased to 3.96 cm.

The highest increase in spreadability occurred at extreme temperatures; the cream base increased to 4.51 cm, while the F9 cream increased to 4.03 cm. The increase in the spreadability of the cream probably occurred due to the temperature rise, which resulted in a decrease in the Viscosity of the cream. This is in line with the research of Elcistia and Zulkaranain [21]; a reduction in Viscosity will increase the spreadability of the cream because the cream will flow more easily and spread on the skin's surface.

The difference in the increase in spreadability at all temperatures between the cream base and the F9 cream could have been more significant, even though the rise in the spreadability on the base was slightly more significant. This shows that the condition of the cream base influences the stability to spreadability. Formulation of cream base preparations using stearic acid and triethanolamine (TEA) emulsifiers can affect the Viscosity, affecting the spreadability of the cream preparations made [19].

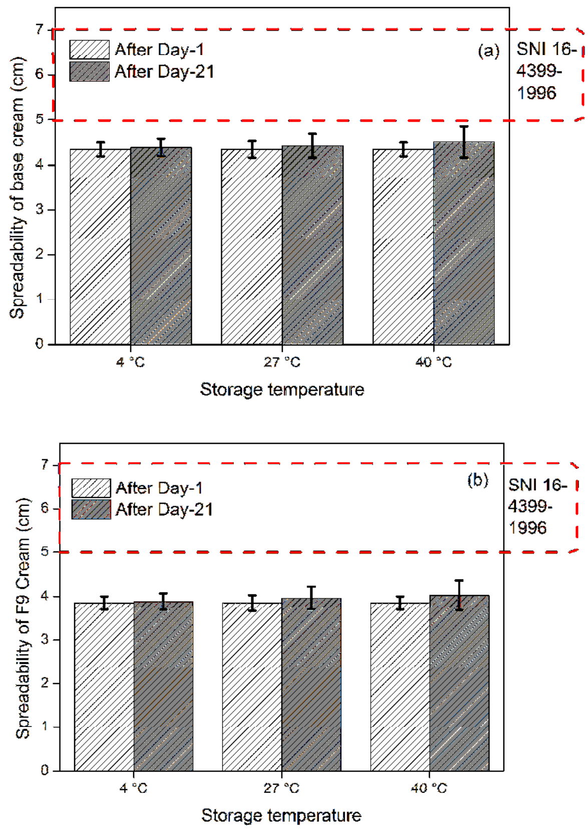

Fig. 7. Changes in spreadability values of cream formulas (a) only cream base and (b) F9 after 1 day of storage ( ) and after 21 days of storage ( )

3.2.4 The Initial Stickiness

The initial stickiness of the cream base at all temperatures was 225 seconds. In comparison, the initial stickiness of F9 cream at low temperature was 182 seconds, while at room temperature and low temperature was 181 seconds. The stickiness decreased in all creams (Fig. 8). The stickiness of the cream base dropped from 225 seconds to 97 seconds, while the F9 cream dropped from 182 seconds to 89 seconds at low temperatures. Stickiness also decreased at room temperature. The cream base decreased from 225 seconds to 87 seconds, while F9 cream decreased from 181 seconds to 65 seconds. The stickiness of the cream also drops at extreme temperatures, where the cream base drops from 225 seconds to 75 seconds, while the F9 cream drops from 181 seconds to 59 seconds. The spreadability of the cream decreased more when the cream base and F9 cream were stored at room and extreme temperatures. This viscosity is likely to occur due to a decrease in Viscosity. The lower the Viscosity of a preparation, the greater its spreading power, but its sticking power decreases.

The difference in the increase in stickiness at all temperatures between the cream base and the F9 cream could have been more significant. However, the decrease in the adhesive power on the cream base was slightly more significant. This stickiness shows that the

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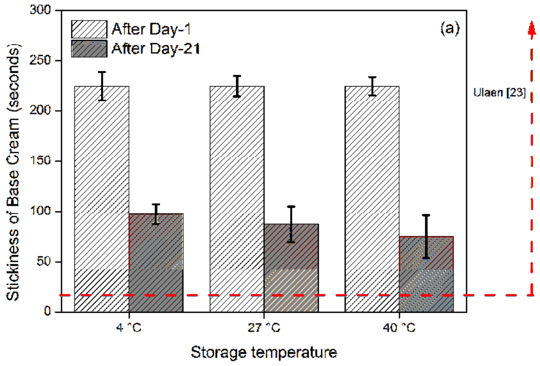
stability of the adhesive strength is affected by the condition of the cream base. Stickiness is closely related to the thickness of the cream preparation, which is also influenced by the use of stearic acid and triethanolamine (TEA) emulsifiers. The stickiness of the cream is closely related to the length of the cream's ability to stick to the skin. The stickiness of all the tested creams is quite good. This aligns with Ulaen [23], in which the sticking power standard should be at least 4 seconds. The longer the stickiness of the cream, the better because it allows the active substance to be absorbed entirely [33].



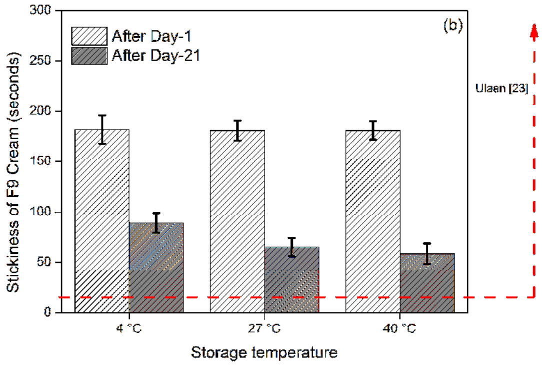


Fig. 8. Changes in the stickiness values of cream formulas (a) only cream base (b) F9 after 1 day of storage ( ) and after 21 days of storage ( )

3.2.5 Color

Visually, the cream base has a light white initial color (H° 241; L* 87), while the F9 cream base has a light beige color (H° 80; L* 82). In general, cream bases have a higher L* value than F9 creams, which means they have a higher brightness level. The higher the L* value, the lighter the preparation; conversely, the lower the L* value, the darker it is. Data on the importance of color change (ΔE*) on the cream base and F9 cream, which were stored for 21 days at different temperatures, are contained in Figure 9. The base cream and cream F9 color changes at low temperatures were 1.93 and 1.80, respectively. The difference in extreme temperature of the cream base was 5.47, while the F9 cream was 4.69. The biggest color change occurred when stored at room temperature. Namely, the cream base changed by 6.42 while the F9 cream was 4.81. The biggest color change occurred at room temperature. The temperature conditions are warmer at room temperature, and the light intensity is higher than extreme temperatures.

The increased discoloration of the cream base resulted in a darker color, while the F9 cream became more brown. The discoloration was probably caused by the condition of the cream base and the active compounds in the F9 cream, which were unstable to increasing temperature and light intensity, accelerating the chemical reactions in the cream. Flavonoids are unstable due to environmental factors such as temperature, pH, and light. The content of flavonoids in F9 cream is oxidized at high temperatures so that the active compounds, especially flavonoids, experience oxidation [24]. It is the oxidation of these flavonoids that causes the color of the cream to turn brown.

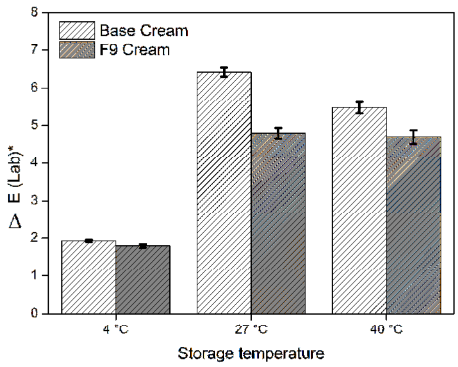


Fig. 9. Changes in the color of the cream formulas after 21 days of storage only cream base ( ) and F9 ( )

4 Conclusion

The interaction between the type and concentration of essential oils affects the panelists' preference level. The F9 cream formula has the highest total value for the preference level regarding scent, texture, and viscosity parameters. Storage temperature affects the physicochemical stability of F9 cream and cream base. Increasing temperature and availability of light will increase the color change of cream, which becomes darker and brown, so the most significant change occurs at room temperature. An increase in temperature also increases the value of the spreadability of the cream, but the deal does not meet the standard because it is less than 5–7 cm.

Conversely, increasing temperature decreases the pH value, Viscosity, and adhesion. However, the pH value, Viscosity, and stickiness of F9 cream still meet the quality standards of SNI 16-4399-1996. In addition, the condition of the cream base affects the physicochemical stability of the F9 cream.

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