FJIF Vol.15, No.2, December 2025, Page: 63-71, pISSN: 2549-9068, eISSN: 2622-755X

FITOFARMAKA: Jurnal Ilmiah Farmasi

(FJIF)

https://fitofarmaka-fmipa.unpak.ac.id

Research Article

Utilization of Teak Leaves (*Tectona grandis Linn.*) Ethanol Extract as a Natural Dye in Blush-On Cream

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https://doi.org/10.33751/jf.v15i2.43

Article info:
Submitted : 07-18-2025
Accepted : 12-20-2025
Published : 12-31-2025

Published by:
Universitas Pakuan

ABSTRACT

The leaves of the teak plant (*Tectona grandis L.*) contain anthocyanin compounds and have the potential as a natural dye. This study aims to develop a blush-on cream formulation containing ethanol extract of teak leaves as a natural dye and to evaluate the characteristics of the preparation. The color of the teak leaf extract remained stable during 28 days of storage at room temperature and was also stable following exposure to UV and polychromatic light. The blush-on cream was prepared using the fusion method with two types of bases: stearic acid–cetyl alcohol (F1) and beeswax–cetyl alcohol (F2), each containing 5 % extract. The formulations were evaluated for organoleptic properties, homogeneity, viscosity, spreadability, adhesion, cycling test stability, pH, and color stability. The F1 formulation exhibited a pink color, whereas F2 showed a brick-red color. The viscosities of the two creams differed, with F1 ranging from 12,100–16,466 cps and F2 from 6,466–7,766 cps, which influenced their adhesion and spreadability. Nevertheless, all parameters remained within acceptable limits for cosmetic applications. Measured parameters included pH values of 4.21–4.92 for F1 and 4.11–4.75 for F2; spreadability values of 5.46–5.83 cm for F1 and 7.43–7.67 cm for F2; and adhesion times of 173–184 s for F1 and 12.76–15.01 s for F2. After six cycles of the cycling stability test, globule sizes remained <50 µm. Color stability testing demonstrated no shift in the maximum wavelength of the teak leaf extract in either formulation. The extract color in the F2 cream was more stable than in F1, as indicated by the absence of significant changes in absorbance values; in contrast, F1 showed a slight decrease in absorbance after 28 days of storage at room temperature.

Keywords: blush-on cream; ethanol extract; natural dye; stability; teak leaves

INTRODUCTION

Every woman desire to appear beautiful and attractive, often by using cosmetics. One of the most commonly used cosmetic products is blush-on, a decorative cosmetic applied to give the cheeks a natural hue and artistic touch, making the face appear fresher, flushed, and radiant (Butar-Butar et al., 2022). Blush-on also helps enhance facial contours. Various types of blush-on are currently available on the market, including compact powder, liquid, cream, stick, and other forms (Tarigan et al., 2021).

The dye component is a key ingredient in blush-on and may originate from natural or synthetic sources. Some synthetic dyes can be harmful, potentially causing skin and eye irritation, allergic reactions, and even cancer. Therefore, there is a need for safe blush-on formulations that do not contain synthetic dyes. One natural dye source of interest is teak (*Tectona grandis* L.) leaves, which contain anthocyanin pigments that produce yellowish to reddish-brown coloration (Alfiyah et al., 2017). Under acidic conditions (pH < 4), anthocyanins primarily exist as flavylium cations, with the quinoidal base also present; at highly acidic pH (<1), the flavylium form predominates. In moderately acidic environments (pH 4–6), anthocyanins occur in both tautomeric forms—carbinol and chalcone—at ambient temperature (Oancea, 2021). Anthocyanins are more stable as red flavylium salts in acidic

conditions, but at higher pH values the color fades and may shift toward blue (Akmal et al., 2023).

Previous studies have formulated compact powder blush-on using teak leaf extract as a natural dye (Siwi et al., 2022). However, color changes occurred due to oxidation processes associated with the presence of zinc oxide in the formulations. Based on this background, the present study aims to develop and evaluate the color stability of blush-on formulations containing teak leaf extract as a natural dye in cream form. Cream formulations are easier to apply, convenient to use, non-sticky, and can be easily removed with water. Moreover, an oil-in-water (O/W) cream base can help improve skin moisture and softness (Husni et al., 2019).

In cream preparation, the selection of an appropriate emulsifying agent is crucial because it determines the stability of the final product (Hasniar et al., 2015). The emulsifying agents used in this study were the nonionic surfactants Tween 80 and Span 80, combined with different base components—stearic acid and beeswax—each mixed with cetyl alcohol. Because the formulation contains water, it may influence the stability of anthocyanins in the product.

METHODS

Materials

Teak leaves (*Tectona grandis* L.) were obtained from a plantation in Karangpawitan District, Garut Regency, West Java, in March 2024. Botanical identification was conducted at the Plant Taxonomy Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran, with specimen number 388/LBM/IT/III/2024. All cream formulation ingredients were pharmaceutical grade, and reagents used for chemical analysis were analytical grade.

Equipment

Analytical balance (Shimadzu), macerator, rotary evaporator (Heidolph G3), pH meter (Handheld Meat HI 99163), Brookfield viscometer (MYR VR 3000), UV–Visible spectrophotometer (Shimadzu UV-1800), hotplate magnetic stirrer (SH-2), centrifuge (BOAECO C-28A), water bath, oven (MEMMERT ON-01E), refrigerator, homogenizer (IKA RW 20), microscope slides, and standard laboratory glassware.

Methods

Preparation of Crude Extract

Teak leaves were first dry-sorted to remove dirt and pests, followed by wet sorting under running water to further clean the material. The leaves were then dried under sunlight filtered through a paranet to avoid direct exposure, which could degrade anthocyanins. The dried leaves were weighed, ground using a blender, and sieved through a 100 µm mesh to obtain a fine powder. Reducing particle size increases the surface area for solvent contact, enhancing extraction efficiency and maximizing the yield of active compounds (Diniatik, 2015).

The extract was prepared by maceration. A total of 36 L of 96 % ethanol was adjusted to pH 5 using citric acid. Then, 1200 g of teak leaf powder was macerated in 12 L of pH-adjusted ethanol (1:10 ratio) for 3 days, with daily solvent replacement. The filtrate was separated from the residue using filter cloth, concentrated using a rotary evaporator, and further evaporated in a water bath until a thick extract was obtained.

Phytochemical screening of teak leaves extract.

The teak leaf extract was qualitatively screened for the presence of alkaloids, flavonoids, tannins, polyphenols, saponins, quinones, monoterpenoids, triterpenoids, sesquiterpenoids, and steroids.

Color Stability Test of Teak Leaf Extract

A solution of teak leaf extract in ethanol was prepared at a concentration of 4000 µg/mL and analyzed using a UV–visible spectrophotometer within the wavelength range of 400–800 nm. The dye stability test was conducted at room temperature (27 °C) over a period of 28 days, with measurements taken weekly.

In addition, the color stability of the extract was evaluated under two light sources: polychromatic daylight (Philips, 15 W) and UV radiation at 365 nm. For UV exposure, measurements were taken after 1, 3, and 5 hours, whereas for polychromatic light, observations were made after 12, 24, and 48 hours. Following each exposure period, the absorbance of the extract was recorded using a spectrophotometer in the wavelength range of 400–800 nm.

Preparation of Blush-On Cream

The cream formulations were prepared using 5 % teak leaf extract. The ratios of stearic acid : cetyl alcohol and beeswax : cetyl alcohol were 2:1 in formulas F1 and F2, respectively. The composition of the blush-on cream formulas is presented in Table 1.

Preparation of blush on formula, the oil-phase components—stearic acid, beeswax, cetyl alcohol, isopropyl myristate, and Span 80—were melted at 70 °C, after which propyl paraben was added and stirred until completely dissolved. The water-phase components—Tween 80, glycerin, propylene glycol, and distilled water—were heated separately to 70 °C, followed by the addition of methyl paraben until dissolved.

The oil phase was then added to the water phase and homogenized at a constant speed while cooling. At 45 °C, sodium metabisulfite (antioxidant), teak leaf extract, and titanium dioxide (white pigment) were incorporated, and mixing was continued until a uniform cream was formed.

Evaluation of Blush-on cream.

Organoleptic Evaluation

Organoleptic evaluation was performed by observing the physical characteristics of the preparations, including color, texture, odor, and homogeneity. A small amount of cream from each formula was applied evenly on a glass slide and examined visually.

Viscosity Test

Viscosity was measured using a Brookfield viscometer with an appropriate spindle. The cream sample was placed into a container, the spindle was attached, and the rotor was operated at 50 rpm. According to SNI 16-4399-1996, acceptable viscosity values for cream preparations range from 2000 to 50000 cP (Azkiya et al., 2017).

Spreadability Test

Spreadability was determined by placing 1 g of sample in the center between two glass plates. A 50 g weight was placed on the upper plate for 15 minutes, after which the diameter of the spread cream was measured. The acceptable spreadability range for cream preparations is 5–7 cm (Pratasik et al., 2019).

Adhesion Time Test

The adhesion test use 500 mg of cream was placed at the center of a marked glass slide, covered with another slide, and pressed with a 50 g weight for 5 minutes. After removing the weight, the time required for the two slides to separate was recorded as the adhesion time. The acceptable adhesion time for cream preparations is 2–300 seconds (Tungadi et al., 2024).

The combination of Tween and Span surfactants was used to achieve the required mixed HLB (RHLB) value for the oil phase of the formulation. The amounts of each surfactant were calculated using the alligation method, with a total surfactant concentration of 10 %. For example, the mixed HLB value of the stearic acid, cetyl alcohol, and isopropyl myristate mixture was 14.78; therefore, the required amounts of Tween and Span were 9.79 % and 0.21 %, respectively. he combination of Tween and Span mixtures is used to achieved the mix RHLB value of the oil phase of preparation. The amount of each surfactant is calculated by using alligation method for total concentration of surfactants of 10 %. For example, the mix RHLB value of the mixtures of stearic acid, cetyl alcohol, and isopropyl myristate obtained was of 14.78, so the amount of Tween and Span added is 9.79 % and 0.21 % respectively.

pH Test

The pH of each formulation was measured using a calibrated pH meter. The acceptable pH range for topical preparations intended for the skin is 4–6 (Kusumawati et al., 2020).

Cycling Stability Test

This test evaluates the ability of the cream to withstand extreme temperature fluctuations that may occur during storage and transport. The cream was stored at 4 ± 2 °C for 24 hours, followed by storage at 40 ± 2 °C for the next 24 hours. The preparation was then kept at room temperature for 24 hours, after which changes in physical characteristics were assessed. This procedure constituted one cycle and was repeated for a total of six cycles (Hernández-Monzón & González-Bedia, 2021; Imanto et al., 2019).

Table 1. Formulation of teak leaves extract blush-on cream

Materials	Concentration (%w/w)	
	F1	F2
Teak leaves ethanol extract	5.00	5.00
Stearic acid	10.00	-
Beeswax	-	8.00
Cetyl alcohol	5.00	4.00
Tween 80	9.79	7.86
Span 80	0.21	2.14
Isopropyl Myristate	1.00	1.00
Propylene glycol	10.00	10.00
Glycerin	10.00	10.00
Methyl Paraben	0.18	0.18
Propyl Paraben	0.02	0.02
Titanium Dioxide	0.50	0.25
Sodium Metabisulfite	0,10	0.10
Rose oil	0.05	0.05
Aquadest	until 100	until 100

Color Stability Test

Color stability was assessed by storing the samples at room temperature (27 °C) for 28 days. On days 0, 7, 14, 21, and 28, the samples were analyzed using a UV–visible spectrophotometer at 400–800 nm. Approximately 8 g of cream was transferred into a 15 mL centrifuge tube and centrifuged at 50 rpm for 30 minutes to separate the oil and water phases. The aqueous phase was collected into a 100 mL volumetric flask. The remaining residue was mixed with 15 mL of ethanol and centrifuged again; the ethanol layer was collected and added to the volumetric flask. This extraction process was repeated three times. The combined extract was diluted with ethanol to the mark to obtain a final concentration of 4000 µg/mL, and the absorbance was measured spectrophotometrically.

RESULTS AND DISCUSSION

The characterization of the herbal material included macroscopic examination and determination of moisture and ash content. The moisture content of the dried teak leaf material was 9 %, and the total ash content was 6.29%, both of which met the established quality requirements.

Teak leaf ethanol extract was produced using the maceration method. Maceration is an extraction technique in which plant material is soaked in a suitable solvent to dissolve active constituents. It is commonly performed at 15–20 °C for 3–5 days in a light-protected environment and is particularly appropriate for herbal materials containing thermolabile or chemically unstable compounds (Chairunnisa et al., 2019). The target compounds in this extraction were anthocyanins, a class of flavonoids. Flavonoids are polar compounds that are heat-sensitive and readily undergo oxidation at elevated temperatures (Gloriana et al., 2023).

Anthocyanin extraction was optimize using 96 % ethanol acidified with citric acid to pH 5. This is consistent with Ramadhani (2024), who reported that 96 % ethanol yielded the highest anthocyanin content. The macerate was concentrated using a rotary evaporator at 60 °C and further evaporated in a water bath at 60 °C to obtain a thick extract. The resulting extract had a pH of 4.33, an appropriate value for anthocyanin stability. A total of 160 g of thick extract was obtained, corresponding to an extract yield of 13.33%.

Phytochemical screening of the ethanol extract revealed the presence of flavonoids, polyphenols, saponins, quinones, monoterpenoids–sesquiterpenoids, and steroid compounds. The extract also had a total ash content of 6.29 % and a moisture content of 9.4 %. These values met the required specifications: total ash <16 % and moisture content <10 % (Fitriyati et al., 2024; Kementerian Kesehatan Republik Indonesia, 2017).

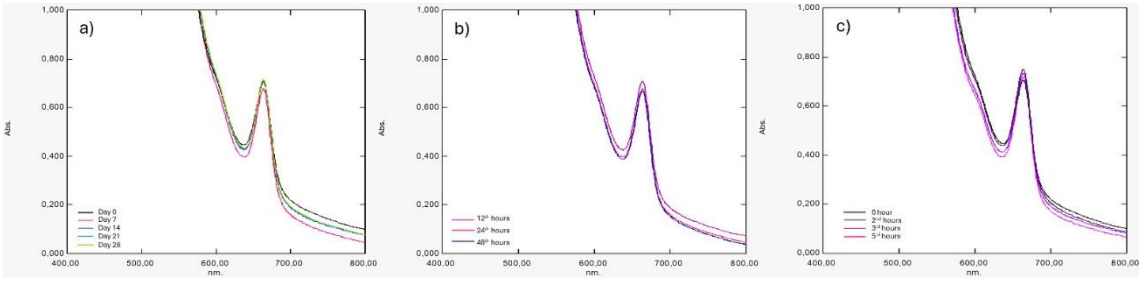

Figure 1. The spectrum of teak leaves extract: a) after storage at room temperature for 28 days, b) after irradiation with 365 nm UV light and c) after irradiation with polychromatic light.

The stability of the extract was evaluated by measuring its spectrum in the range of 400–800 nm after storage at room temperature (27 °C) for 28 days. Stability was also assessed under irradiation with UV light at 365 nm for 5 hours and under polychromatic lamp exposure for 48 hours. The difference in irradiation duration reflects the higher energy and stronger degrading effect of UV light compared with polychromatic light (Fatonah et al., 2016). The extract concentration used for analysis was 4000 µg/mL. The maximum wavelength (λ_max) of the teak leaf extract was found to be 663.5 nm. Spectra obtained at each sampling interval are shown in Figure 1.

Stability testing at room temperature showed no shift in λ_max, and changes in absorbance were negligible throughout the 28-day storage period. The extract also demonstrated good stability under both UV and polychromatic light exposure. This stability is likely attributable to the extract's acidic pH (4.33), which corresponds to the optimal stability range for anthocyanins, where they typically exhibit a dark red coloration. Initially, during the development of the cream formulation, a total thickener concentration of 10 % with a ratio of 2:1 was used for both formulas. However, the results showed that Formula F2 exhibited poor consistency, leading to uneven distribution and an uncomfortable feel upon application. Differences in physical properties and crystal rigidity between beeswax and stearic acid also contributed to this issue. Beeswax produces a higher viscosity than stearic acid, resulting in a thicker cream (Mutaharah et al., 2024). Therefore, in Formula F2, the concentration of beeswax was reduced to 8 % and cetyl alcohol to 4%, while maintaining the same 2:1 ratio. In contrast, Formula F1 contained 10 % stearic acid and 5% cetyl alcohol.

The difference in titanium dioxide concentration between the two formulas is due to the greater opacifying effect of beeswax compared to stearic acid. The structure and composition of beeswax impart a stronger opacity to the formulation, whereas stearic acid provides a weaker opacifying effect; therefore, a higher amount of titanium dioxide is required in the stearic acid–based formula.

The results of the organoleptic evaluation showed that both blush cream formulations were stable and did not exhibit any deformation from the time of preparation through 28 days of storage. Formula F1 had a pink color, whereas F2 exhibited a brick-red hue, and both formulations possessed a rose-scented fragrance. The homogeneity test indicated good quality, as the preparations displayed uniform color distribution throughout the base, ensuring that each sample contained an equal amount of teak leaf extract (Dominica & Handayani, 2019).

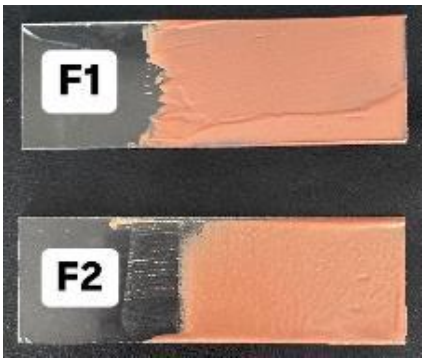

Figure 2. Physical appearance of teak blush-on cream

Tabel 2. Characteristics of teak leaves extract blush-on cream

Length of storage (days)	pH		Viscosity (cPs)		Spreadability (cm)		Adhesion time (s)	
	F1	F2	F1	F2	F1	F2	F1	F2
0	4.21 ± 0.050	4.11 ± 0.050	12100 ± 461	6466 ± 550	5.83 ± 0.05	7.67 ± 0.15	179 ± 11.1	12.76 ± 0.89
7	4.41 ± 0.001	4.35 ± 0.001	17233 ± 602	7666 ± 404	5.46 ± 0.05	7.43 ± 0.15	183 ± 4.9	13.58 ± 0.16
14	4.45 ± 0.001	4.45 ± 0.020	17266 ± 351	7666 ± 416	5.46 ± 0.15	7.47 ± 0.05	184 ± 5.2	14.74 ± 0.92
21	4.97 ± 0.020	4.87 ± 0.020	17133 ± 472	7733 ± 305	5.70 ± 0.10	7.43 ± 0.05	178 ± 3.2	14.72 ± 0.47
28	4.92 ± 0.020	4.75 ± 0.030	16900 ± 435	7766 ± 152	5.47 ± 0.15	7.40 ± 0.20	173 ± 1.5	15.01 ± 0.97

The pH test results indicated that both cream formulations remained within the range of 4.0–5.0 during 28 days of storage. These values meet the skin pH requirements of 4–6 (Kusumawati et al., 2020). A slight increase in pH was observed between days 7 and 28, but the values still fall within the acceptable range for topical application. pH is an important factor in determining the safety of a formulation; overly acidic preparations can irritate the skin, whereas highly alkaline formulations may cause dryness and flaking (Iskandar et al., 2021).

Viscosity is a key parameter related to emulsion stability, as higher viscosity reduces the rate of phase separation (Armadany et al., 2019). Viscosity measurements of both formulations over 28 days were performed using a Brookfield viscometer. The initial viscosity on day 1 differed from subsequent measurements, likely because the emulsion had not yet fully stabilized. Elevated temperatures during cream preparation can also temporarily reduce viscosity (Akmal et al., 2023). Over time, the emulsion stabilizes, resulting in a gradual increase in viscosity. Formula F1 exhibited higher viscosity than F2 because the combined concentration of stearic acid and cetyl alcohol in F1 was 15%, compared to 12% of cera alba (beeswax) and cetyl alcohol in F2. Both formulations fall within the acceptable viscosity range for creams (2,000–50,000 cP) (Azkiya et al., 2017).

The spreadability test evaluates the ease with which the cream can be applied to the skin. A cream is considered to have good spreadability if it can be applied evenly without significant finger pressure. F2 exhibited greater spreadability than F1. While F1 met the standard range of 5–7 cm, F2 slightly exceeded this range (Pratasik et al., 2019). These results are consistent with the viscosity measurements, as spreadability is inversely proportional to viscosity: higher spreadability corresponds to lower viscosity (Mardikasari et al., 2017).

The adhesion test assesses the duration that the cream remains in contact with the skin. High adhesion prolongs contact time and can enhance the formulation's efficacy (Megantara et al., 2017). Both formulations met the minimum topical adhesion requirements, with Formula F1 exhibiting longer adhesion than F2. This observation aligns with the viscosity results, as lower viscosity is generally associated with reduced adhesion (Akmal et al., 2023).

The cycling stability test evaluates the physical stability of the cream under extreme temperature fluctuations. Six cycles were performed, each consisting of 24 hours at 4 °C followed by 24 hours at 40 °C. No phase separation was observed in either formulation after six cycles, indicating that both creams are physically stable under extreme temperature variations. Globule sizes in all formulations remained below 50 µm (Hernández-Monzón & González-Bedia, 2021; Niazi, 2020).

Table 3. Results of cycling stability test of teak leaves extract blush on cream

Cycle	Globule Diameter (µm)	
	F1	F2
1	17.63 ± 0.85	14.36 ± 1.41
2	23.96 ± 3.75	19.16 ± 2.40
3	29.43 ± 2.83	29.00 ± 0.26
4	33.66 ± 1.49	34.10 ± 1.17
5	39.63 ± 0.63	37.23 ± 2.25
6	43.76 ± 1.53	40.00 ± 0.871

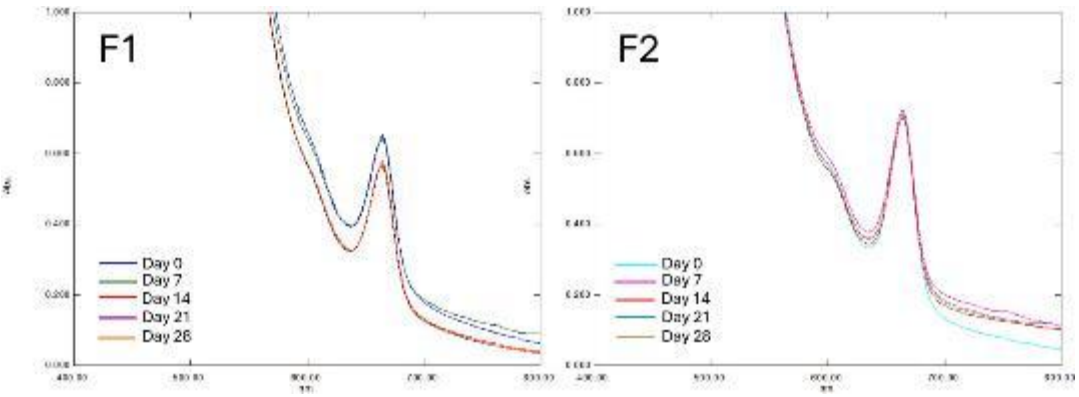

Figure 3: The spectrum of teak leaves extract in blush-on cream after 28 days of storage at room temperature

The cream preparations were stored at room temperature for 28 days, with samples taken every 7 days. For analysis, 8 g of each sample was weighed and centrifuged at 50 rpm for 30 minutes to separate the oil and water phases. The aqueous phase was then pipetted into a 100 mL volumetric flask. The residue was extracted with 5 mL of ethanol and centrifuged again; this procedure was repeated three times until the residue was colorless. The combined extract was then diluted with ethanol to a final concentration of 4000 µg/mL. The absorbance of this solution was measured using a UV–Vis spectrophotometer at 663.5 nm.

The aim of this study was to qualitatively assess the stability of the blush-on cream formulations by monitoring shifts in maximum wavelength and significant changes in absorbance at 663.5 nm. No shift in the maximum wavelength was observed in either formulation. Formula F2 was considered stable, as the absorbance measured on day 0 and day 28 showed no significant difference. Formula F1 exhibited a slight decrease in absorbance over the 28-day period, which may be attributed to minor variations in the base formulation affecting the pH of the cream. The results are presented in Figure 3.

The stability of the cream color during 28 days of storage at room temperature may be attributed to the pH of the preparation, which ranged from 4 to 5. Within this pH range, anthocyanins remain in a stable form. Additionally, the color stability of the blush-on creams is supported by the presence of sodium metabisulfite in the formulation, which helps prevent oxidation of the anthocyanins.

CONCLUSION

The ethanol extract of *Tectona grandis* leaves exhibited relatively stable color during 28 days of storage at room temperature, as well as after exposure to 365 nm UV light and polychromatic lamp light. Both blush-on cream formulations containing teak leaf extract demonstrated desirable characteristics and met the standard requirements for cream preparations. Differences in viscosity between the two formulations affected their spreadability and adhesion. Formula F1 appeared pink, whereas F2 was brick red. The color of the teak leaf extract in F2 cream was more stable than in F1, showing no significant change in absorbance, while F1 exhibited a slight decrease in absorbance after 28 days of storage at room temperature.

ACKNOWLEDGMENT

We would like to thank LPPM University of Jenderal Achmad Yani for funding of this study.

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