

The Effect Of Triethanolamine Variations On The Evaluation Of Physical Properties Of Papaya Leaf Ethanol Extract Lotion (*Carica Papaya L.*)

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ABSTRACT

Background: Papaya leaves (*Carica papaya L.*) contain papain, flavonoids, and vitamin C, which have antioxidant potential. **Objective:** This study aimed to formulate papaya leaf ethanol extract as a lotion and to determine the effect of triethanolamine (TEA) concentration on its physical properties. **Methods:** This experimental study used 96% ethanol for maceration. Papaya leaf extract was incorporated at a concentration of 15%, while TEA concentrations were varied at 2% (F1), 3% (F2), and 4% (F3). The formulations were evaluated for organoleptic properties, pH, homogeneity, spreadability, adhesion, protective ability, lotion type, physical stability, preference, and viscosity. **Results:** The extract yield was 8.79% w/w. F1 and F2 were medium-viscosity liquids, whereas F3 was a low-viscosity liquid. All formulations were bright brownish-green, had a rose fragrance, were homogeneous, had a pH of 6, and formed oil-in-water (O/W) lotions. The highest mean spreadability under a 100 g load was 25.53 cm² in F2 and F3, whereas F1 showed the lowest value of 18.10 cm². The mean adhesion times were 1.56 s, 1.66 s, and 1.88 s for F1, F2, and F3, respectively. F3 was the most preferred formula, selected by 45% of respondents. All formulas remained stable during four weeks of storage. One-way ANOVA showed that TEA concentration significantly affected spreadability ($p = 0.000$) but did not significantly affect adhesion ($p = 0.788$). **Conclusion:** Papaya leaf ethanol extract can be formulated into a stable O/W lotion. Increasing the TEA concentration reduced viscosity and increased spreadability; however, the difference in adhesion was not statistically significant.

Keywords: *Carica papaya L.*, lotion, triethanolamine, physical properties test, physical stability test

INTRODUCTION

Indonesia is a tropical country with excessive exposure to sunlight, so it is at high risk of various skin damage (Setyani et al., 2024). Therefore, external protection is needed by using moisturizing cosmetics. Cosmetics are a human need, especially for women (Lovena et al., 2021). However, many cosmetic products on the market do not meet safety specifications, as some contain hazardous chemicals. Cosmetics are used only on the external parts of the body and are intended to cleanse, perfume, enhance appearance, mask body odor, and maintain and nourish the skin to improve its appearance (Iskandar et al., 2021).

Skin is the outermost layer of the body, both men and women. Sun exposure can cause collagen loss and lead to skin damage, such as darkening, dryness, scaliness, and even wrinkles if not properly cared for (Karim et al., 2022).

Based on data from the National Workshop on Medicinal Plants in 2010, out of a total of 40,000 plant species in the world, Indonesia has 30,000 plant species, of which 940 have medicinal properties, one of which is papaya (*Carica papaya L.*). One part of the papaya with medicinal properties is its leaves. Several studies have shown that papaya leaf extract is an alternative in accelerating the formation of wound epithelium, because papaya leaves contain saponin compounds that can stimulate collagen formation in the wound healing process. Papaya leaves contain vitamins C, E, and beta-carotene as antioxidants. 100% papaya leaf water extract contains an enzyme that can help accelerate the work of macrophages, by increasing the production of interleukin in the wound healing process (Januarti & Sholeh, 2023).

According to research (Bulla et al., 2020), papaya leaves have benefits for treating toothaches, acne, and antibacterial properties. In a study of Javanese papaya leaf extract conducted by (Leny et al., 2021), Javanese papaya leaves contain chemical compounds with antiseptic, anti-inflammatory, antifungal, and antibacterial properties. Antibacterial compounds found in Javanese papaya leaves include tannins, flavonoids, alkaloids, terpenoids, saponins, vitamins C and E. Several previous studies have revealed a number of active compounds found in papaya leaves that have uses, such as alkaloids, tannins, saponins, flavonoids, steroids, and papain. These compounds have been shown to have larvicidal, antibacterial, anti-inflammatory, and antioxidant properties (Melita et al., 2022).

Flavonoids are polyphenol compounds that act as antioxidants. The antioxidant properties of flavonoids stem primarily from their chemical structure, which contains a hydroxyl group (-OH), thus stopping harmful oxidative chain reactions in cells. Flavonoids can inhibit the activity of certain enzymes that produce free radicals, such as xanthine oxidase and NADPH oxidase, which are involved in the production of superoxide radicals. Flavonoids can reduce the formation of free radicals in the body (Purwati & Yanti, 2022).

Of the plant parts, papaya peel showed the highest antioxidant activity, with an IC₅₀ value of 13,769 µg/mL using ethanol extract as a solvent. Papaya plants can be utilized from the fruit flesh, leaves, and even the peel (Santi et al., 2021). Antioxidants are compounds that can neutralize free radicals. Free radicals can oxidize healthy cells and cause skin damage. Furthermore, antioxidants also have beneficial effects on skin health, such as reducing wrinkles caused by premature aging and promoting skin regeneration (Karim et al., 2022). Antioxidants can stop the formation of reactive oxygen species caused by ultraviolet rays, which then allows for anti-inflammatory and anti-aging activities (Rumi, 2025). Exposure to ultraviolet (UV) light, pollution and free radicals are also triggers for oxidative stress which can cause premature aging. A substance that has very strong antioxidant properties if the IC₅₀ value is less than 50 ppm, strong if the IC₅₀ value is between 50-100 ppm, while if the IC₅₀ value is around 100-200 ppm, weak 50-200 ppm and more than 200 ppm is an antioxidant in the very weak category (Sepriyani et al., 2020).

One cosmetic product used for skin care is lotion. Lotion is a cosmetic product that helps soften, brighten, and protect the skin from sun exposure. The main advantage of lotion is its high water content, which makes it easy to apply, increases spreadability and penetration, doesn't leave a greasy feeling on the skin, provides a cooling sensation, and is easy to rinse off with water. One benefit of lotion is that it helps maintain skin moisture (Iskandar et al., 2021). Healthy skin is skin that is smooth, soft, shiny and always kept moist, which can certainly increase self-confidence (Daswi et al., 2020). This research formula is adopted from research (Yuliana, 2021a) entitled formulation and physical stability test of traditional body scrub from the use of lime peel waste (*Citrus aurantifolia*) and coffee grounds (*Coffea* sp.)

Lotion is a semi-solid preparation in the form of an emulsion intended for external use (Rahma et al., 2025). Lotion is a liquid emulsion consisting of a mixture of oil and water phases stabilized by an emulsifier. Lotion is used as an alternative to sunscreen. O/W lotions have the advantage of being easily washed off with water and being non-sticky when applied. Lotion is a liquid emulsion containing several active ingredients consisting of oil and water phases, stabilized by an emulsifier, so they don't separate.

Based on the background of the problem that has been described, the purpose of this study is to formulate papaya leaf ethanol extract (*Carica papaya* L.) into a lotion preparation and to determine the effect of triethanolamine lotion base concentration on the physical properties of the preparation. The novelty of this study from previous studies, namely the difference in terms of dosage form. The lotion formulation was chosen because the preparation is in the form of an emulsion that is not difficult to wash with water and does not make it sticky, in addition to the appropriate water content, the lotion dosage form is easy to use, has strong spreadability and penetration power, does not feel oily, and provides a cooling effect, while in previous studies a cream scrub preparation was made.

This study used 96% ethanol as a solvent, while previous studies used 70% ethanol. The concentration of triethanolamine in F1 was 2%, F2 was 3%, and F3 was 4%. Triethanolamine functions as an alkalizing agent and emulsifier (Sari & Zulkarnain, 2024). When free fatty acids and

triethanolamine (TEA) combine, a highly stable O/W emulsion is obtained. The ideal free fatty acid to use with TEA is stearic acid.

The concentration of papaya leaf extract used in the formulation refers to a concentration of 15%, because in previous research, this concentration showed the most effective activity for moisturizing the skin (Leny et al., 2023). In previous research (Yuliana, 2021b), formula 2, with a 3% TEA concentration, was declared the best formula due to its good physical stability test for the scrub. Therefore, this formulation was then developed into lotion preparations with variations of 2%, 3%, and 4% TEA. The reason for choosing this concentration is because, according to the BPOM (Indonesian Food and Drug Authority), based on safety guidelines, the usual concentration required for a lotion to be stable, homogeneous, and safe for the skin (non-irritating) is between 1% and 4% .

MATERIALS AND METHODS

Materials

The equipment used in this study included a local oven, Sonic analytical balance, Miyako blender, local porcelain dish, Pyrex glass slides and cover slips, spatula, local horn spoon, Pyrex measuring cylinder, local mortar and pestle, local spreadability-test apparatus, Pyrex beaker glass, local stopwatch, universal pH indicator strips, local glass stirring rod, and local lotion containers.

The materials used were papaya leaves (*Carica papaya* L.), 96% ethanol (technical grade), stearic acid (technical grade), triethanolamine (technical grade), propylene glycol (technical grade), cetyl alcohol (technical grade), sodium lauryl sulfate (technical grade), liquid paraffin (technical grade), methyl paraben (technical grade), propyl paraben (technical grade), fragrance, and distilled water.

Methods

Papaya leaf samples were obtained in Ngaglik Hamlet, Sidorejo Village, Sukoharjo Regency, namely fresh papaya leaves, without defects, green in color, leaves that are not too young or too old, stems 3-6. The papaya leaves that have been taken are wet sorted, washed and weighed as wet weight. The leaves are then aired and oven-dried at a temperature of 50 0 C for 3 hours, weighed as dry weight.

Papaya leaf extraction using the maceration method with 96% ethanol solvent. The ratio of the amount of simplicia to the solvent of the maceration method is 1:5. 300 grams of dried papaya leaf simplicia and 1500 ml of 96% ethanol. The solvent is then divided into 2 parts. 300 grams of dried papaya leaf simplicia powder is weighed, dissolved in 750 ml of 96% ethanol, and the beaker glass is covered with plastic. The dissolution soaking process is left for 6 hours with several stirrings. The extract soak is covered with flannel cloth, put into another beaker glass and filtered with filter paper, squeezed, the resulting dregs are soaked with the remaining 750 ml of 96% ethanol, left for 18 hours, then filtered using flannel cloth. The filtrate is evaporated over a water bath to remove the solvent, so that a thick extract is obtained. The weight of the extract is weighed to calculate the yield obtained (Kardiansyah & Endrawati, 2023).

Table 1. Reference Formula

Material	Formulas 3
Lime Peel	5 g
Coffee Grounds	10 g
Stearic Acid	10 %
Triethanolamine	3 %
Cetyl Alcohol	2 %
Sodium Lauryl Sulfate	2,5 %
Propylene Glycol	15 %
Liquid Paraffin	0,005 %
Methyl Paraben	0,3 %
Propyl Paraben	0,01 %
Distilled water ad	50 g

The research formula is adopted in research (Yuliana, 2021a) entitled formulation and physical stability test of traditional body scrub from lime peel waste (*Citrus aurantifolia*) and coffee grounds (*Coffea sp.*). Formula data can be seen in table 1.

In the research on the formulation of papaya leaf extract cream scrub preparations according to research (Leny et al., 2023), Papaya leaves (*Carica papaya L.*) provide the best effect in increasing skin moisture at a concentration of 15% with 96% ethanol solvent. In this research, it will be developed into a papaya leaf lotion preparation with a concentration of 15% with different triethanolamine base concentrations, namely F1 (2%), F2 (3%) and F3 (4%). Data on the formulation design of the papaya leaf ethanol extract lotion preparation can be seen in Table 2.

Table 2. Lotion Formula Design

Material	Formulas 1	Formulas 2	Formulas 3
Papaya Leaf Extract	15 %	15 %	15 %
Stearic Acid	10 %	10 %	10 %
Triethanolamine	2 %	3 %	4 %
Cetyl Alcohol	2 %	2 %	2 %
Sodium Lauryl Sulfate	2,5 %	2,5 %	2,5 %
Propylene Glycol	15 %	15 %	15 %
Liquid Paraffin	0,005 %	0,005 %	0,005 %
Methyl Paraben	0,3 %	0,3 %	0,3 %
Propyl Paraben	0,01 %	0,01 %	0,01 %
Parfum	q.s	q.s	q.s
Distilled water ad	50 g	50 g	50 g

Preparation of lotion formulations using papaya leaf ethanol extract. Formulas 1, 2, and 3 were prepared to produce 50 ml of lotion. The weighing data for the lotion ingredients can be seen in Table 3.

Table 3. Weighing of Lotion Ingredients

Material	Formulas 1	Formulas 2	Formulas 3	Fungsi
Papaya Leaf Extract	7,5 g	7,5 g	7,5 g	Active substance
Stearic Acid	5 g	5 g	5 g	Emulgator
Triethanolamine	1 g	1,5 g	2 g	Emulgator
Cetyl Alcohol	1 g	1 g	1 g	Softener
Sodium Lauryl Sulfate	1,25 g	1,25 g	1,25 g	Wetting
Propylene Glycol	7,5 g	7,5 g	7,5 g	Solvent
Liquid Paraffin	0,0025 g	0,0025 g	0,0025 g	Moisturizer
Methyl Paraben	0,15 g	0,15 g	0,15 g	Preservative
Propyl Paraben	0,005 g	0,005 g	0,005 g	Preservative
Parfum	q.s	q.s	q.s	Fragrance
Distilled water	26.5925 g	26.0925 g	25.5925 g	Solvent

Lotion Preparation

All equipment and ingredients were prepared, and each ingredient was weighed according to the formula. Distilled water was heated in a water bath. The water phase was prepared by dissolving methyl paraben in approximately seven times its volume of hot distilled water, followed by the addition of propylene glycol, propyl paraben, sodium lauryl sulfate, and TEA in a warmed mortar. The oil phase was prepared by heating stearic acid, cetyl alcohol, and liquid paraffin in a warmed porcelain dish. The water phase was mixed with the oil phase while warm. Papaya leaf extract was added before the preparation thickened, and the mixture was stirred until homogeneous. The preparation was then allowed to cool and transferred to lotion containers.

Evaluation of the Lotion Preparation

Organoleptic evaluation was performed by observing the color, consistency, and aroma of each formula. Observations were made weekly in triplicate during weeks 1-4 (Thomas et al., 2021).

The pH was determined using universal pH indicator strips. Each formula was tested in triplicate. A pH range of 4.5-6.5 was considered acceptable because it is compatible with normal skin pH (Syaputri et al., 2023).

Homogeneity was evaluated by spreading a sample on a glass slide and observing the presence of coarse particles, lumps, or visible phase separation. A preparation was considered homogeneous when the color and dispersion were uniform. The test was performed in triplicate (Syaputri et al., 2023).

For the spreadability test, 0.5 g of lotion was placed on a glass slide with a diameter of 15 cm. A second glass slide was placed over the sample and allowed to stand for 1 min. Loads of 50 g and 100 g were then applied sequentially for 1 min. The spread area was calculated using the formula $L = \pi r^2$. Each measurement was performed in triplicate (Yuliana, 2021a).

For the adhesion test, 0.5 g of lotion was placed between two glass slides. The assembly was pressed with a 1 kg load for 5 min. It was then mounted on the adhesion apparatus, and an 80 g load was released. The time until the slides separated was recorded. The test was performed in triplicate (Yuliana, 2021a).

Protective ability was evaluated using 10 cm × 10 cm filter paper moistened with phenolphthalein indicator and dried. A total of 0.5 g of lotion was applied to the filter paper. The paper was covered with a 2.5 cm × 2.5 cm paraffin-coated filter paper, followed by one drop of 0.1 N KOH. The appearance of pink or red staining was observed after 15, 30, 45, and 60 s and after 3 and 5 min. Each test was performed in triplicate (Atmaja et al., 2022).

For the lotion-type test, a sample was placed on a glass slide, mixed with methylene blue, and observed under a microscope. A blue continuous phase with transparent droplets indicated an O/W lotion, whereas a transparent continuous phase with dispersed droplets indicated a W/O lotion. The test was conducted in triplicate (Wahdaningsih & Rahmasari, 2020).

Physical stability was observed during storage at approximately 30°C for four weeks. The organoleptic characteristics, pH, and homogeneity were recorded weekly (Nurfita et al., 2021).

The preference test involved 20 panelists, who assessed their liking of the formula based on its consistency, color, and aroma. Positive responses were scored as 1 and negative responses as 0 (Yuhara & Rawar, 2022; Daswi et al., 2020).

Viscosity was measured using an Ostwald viscometer. The flow time through the capillary tube from the upper to lower mark was recorded in triplicate using a stopwatch.

Data Analysis

Drying loss was calculated as: $\text{Drying loss (\%)} = \frac{[(\text{wet weight} - \text{dry weight}) / \text{wet weight}] \times 100\%}{100\%}$. Maceration yield was calculated as: $\text{Yield (\% w/w)} = \frac{(\text{extract weight} / \text{dried simplicia weight}) \times 100\%}{100\%}$.

Spreadability and adhesion data were tested for normality using the one-sample Kolmogorov-Smirnov test and subsequently analyzed by one-way ANOVA using SPSS for Windows. The null hypothesis was accepted when $p > 0.05$, indicating no significant effect of TEA concentration on the evaluated physical property. The alternative hypothesis was accepted when $p < 0.05$, indicating a significant effect.

RESULTS AND DISCUSSION

RESULTS

Extraction Yield

The maceration of papaya leaves produced a thick, dark-green extract with an aromatic odor. The drying loss and extract yield are shown below.

$\text{Drying loss} = \frac{(2,000 \text{ g} - 760 \text{ g}) / 2,000 \text{ g}}{100\%} \times 100\% = 62\% \text{ w/w}$.

$\text{Maceration yield} = \frac{(26.37 \text{ g} / 300 \text{ g}) \times 100\%}{100\%} = 8.79\% \text{ w/w}$.

Organoleptic Characteristics

Table 4. Organoleptic Characteristics of Papaya Leaf Ethanol Extract Lotion

Organoleptic	Formulas 1	Formulas 2	Formulas 3
Liquid	Medium viscosity liquid	Medium viscosity liquid	Low viscosity liquid
Color	Bright brownish green	Bright brownish green	Bright brownish green
Odor	Rose	Rose	Rose

pH and Homogeneity

Table 5. pH Values of Papaya Leaf Ethanol Extract Lotion

Replication	Formulas 1	Formulas 2	Formulas 3
1	6	6	6
2	6	6	6
3	6	6	6
average	6	6	6

Table 6. Homogeneity Results of Papaya Leaf Ethanol Extract Lotion

Replication	Formulas 1	Formula 2	Formula 3
1	Homogeneous	Homogeneous	Homogeneous
2	Homogeneous	Homogeneous	Homogeneous
3	Homogeneous	Homogeneous	Homogeneous

Spreadability

Table 7. Spreadability Area of Papaya Leaf Ethanol Extract Lotion (cm²)

Formula	Replication	No load	50 g load	100 g load
F1	1	12.56	15.19	16.61
F1	2	13.84	14.51	19.62
F1	3	13.84	15.19	18.08
F1	Mean	13.41	14.96	18.10
F2	1	19.62	22.89	23.74
F2	2	18.08	23.74	24.61
F2	3	19.62	23.74	28.26
F2	Mean	19.10	23.45	25.53
F3	1	19.62	21.22	24.61
F3	2	19.62	22.05	23.74
F3	3	18.08	23.74	28.26
F3	Mean	19.10	22.33	25.53

Adhesion

Table 8. Adhesion Time of Papaya Leaf Ethanol Extract Lotion

Replication	Formulas 1 (s)	Formulas 2 (s)	Formulas 3 (s)
1	1,23	2,20	1,25
2	1,20	1,28	2,49
3	2,25	1,50	1,90
Mean	1,56	1,66	1,88

Protective Ability and Lotion Type

Table 9. Protective Ability of Papaya Leaf Ethanol Extract Lotion

Formulas	Time					
	15''	30''	45''	60''	3'	5'
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-

Description :

✓ : Produces a pink color on filter paper

- : Does not produce a pink color on filter paper

Table 10. Lotion Type of Papaya Leaf Ethanol Extract Lotion

Formulas	Lotion Type
1	M/A (oil in water)
2	M/A (oil in water)
3	M/A (oil in water)

Physical Stability

Table 11. Organoleptic Stability of the Formulations During 4 Weeks of Storage

Parameter	Form ula	Week 1	Week 2	Week 3	Week 4
Consistency	F1	Medium-viscosity liquid	Medium-viscosity liquid	Medium-viscosity liquid	Medium-viscosity liquid
Consistency	F2	Medium-viscosity liquid	Medium-viscosity liquid	Medium-viscosity liquid	Medium-viscosity liquid
Consistency	F3	Low-viscosity liquid	Low-viscosity liquid	Low-viscosity liquid	Low-viscosity liquid
Color	F1	Bright brownish-green	Bright brownish-green	Bright brownish-green	Bright brownish-green
Color	F2	Bright brownish-green	Bright brownish-green	Bright brownish-green	Bright brownish-green
Color	F3	Bright brownish-green	Bright brownish-green	Bright brownish-green	Bright brownish-green
Odor	F1	Rose	Rose	Rose	Rose
Odor	F2	Rose	Rose	Rose	Rose
Odor	F3	Rose	Rose	Rose	Rose

Table 12. pH Stability During 4 Weeks of Storage

Week	Formulas 1	Formulas 2	Formulas 3
1	6	6	6
2	6	6	6
3	6	6	6
4	6	6	6

Table 13. Homogeneity Stability During 4 Weeks of Storage

Week	Formulas 1	Formulas 2	Formulas 3
1	Homogeneous	Homogeneous	Homogeneous
2	Homogeneous	Homogeneous	Homogeneous
3	Homogeneous	Homogeneous	Homogeneous
4	Homogeneous	Homogeneous	Homogeneous

Preference and Viscosity

Table 14. Panelist Preference for Papaya Leaf Ethanol Extract Lotion

Formulas	Favorite	Percentage (%)
1	7	35
2	4	20
3	9	45
Total	20	100

Table 15. Viscosity of Papaya Leaf Ethanol Extract Lotion

Formula	Viscosity (cP)
F1	3,126
F2	3,033
F3	2,810

Statistical Analysis

Table 16. Summary of Statistical Analysis

Parameter	Normality p-value	Homogeneity p-value	ANOVA p-value	Interpretation
Spreadability	0.200	0.853	0.000	TEA concentration significantly affected spreadability.
Adhesion	0.150	0.892	0.788	TEA concentration did not significantly affect adhesion.

All formulas met the observed physical evaluation criteria. F2 and F3 showed the highest mean spreadability under a 100 g load (25.53 cm²), F3 showed the longest mean adhesion time (1.88 s), and F3 was the most preferred formula (45%).

DISCUSSION

Extract Characteristics and Formulation Feasibility

The 8.79% w/w maceration yield indicates that the 96% ethanol extraction procedure produced a measurable quantity of papaya leaf extract suitable for incorporation into a lotion. The resulting extract was thick, dark green, and aromatic, which is consistent with the presence of plant-derived constituents in the extract. The 15% extract concentration was selected based on previous work that reported favorable skin-moisturizing activity for papaya leaf extract at this concentration (Leny et al., 2023).

All three formulas could be prepared as homogeneous O/W lotions. The O/W system is consistent with the use of stearic acid and TEA, which can form an anionic emulsifying system that facilitates dispersion of the oil phase in the water phase (Sari & Zulkarnain, 2024; Wahdaningsih & Rahmasari, 2020). This type of lotion is desirable because it is easier to spread and wash from the skin than a water-in-oil system.

Organoleptic Characteristics, pH, and Homogeneity

F1 and F2 had medium-viscosity liquid consistency, while F3 had low-viscosity liquid consistency. All formulations had a bright brownish-green color and rose fragrance. The lower viscosity in F3 is consistent with its higher TEA concentration. The color and aroma did not change across the formulas, indicating that TEA variation did not produce a visible organoleptic difference under the conditions of this study.

The pH of all formulas was 6, which falls within the acceptable skin-compatible range of 4.5-6.5 (Syaputri et al., 2023). Maintaining a pH close to normal skin pH is important for user comfort and may reduce the risk of irritation. TEA likely contributed to pH adjustment through neutralization of stearic acid in the formulation.

All formulations were homogeneous in each replication and remained homogeneous throughout the four-week storage period. The absence of coarse particles, lumps, and visible separation suggests that the formulation process and emulsifier system were adequate to maintain physical uniformity during the observation period.

Spreadability, Viscosity, and Adhesion

Spreadability increased as the TEA concentration increased. Under a 100 g load, F2 and F3 reached the highest mean spread area of 25.53 cm², whereas F1 produced the lowest mean area of 18.10 cm². This trend agrees with the viscosity results, where F1 had the highest viscosity (3,126 cP) and F3 had the lowest viscosity (2,810 cP). In general, a lower-viscosity lotion spreads more easily because it offers less resistance to flow (Agustin et al., 2023).

The one-way ANOVA result for spreadability was significant ($p = 0.000$), confirming that the observed difference among formulas was statistically associated with TEA concentration. The practical implication is that TEA concentration can be adjusted to obtain a lotion with a more easily spreadable consistency while maintaining the other measured properties.

The mean adhesion time increased numerically from 1.56 s in F1 to 1.88 s in F3. However, the ANOVA result was not significant ($p = 0.788$). Therefore, although F3 had the highest mean adhesion time, the study does not provide statistical evidence that TEA concentration affected adhesion. This interpretation is more appropriate than concluding that increasing TEA concentration improves adhesion.

Protective Ability and Physical Stability

No pink staining was observed in the protective-ability test for any formula throughout the observation times. This result indicates that the tested lotions delayed the contact of the alkaline solution with the phenolphthalein-treated filter paper under the test conditions. All formulas were categorized as O/W, which was also maintained during the study period.

The organoleptic properties, pH, and homogeneity remained unchanged during four weeks of storage at approximately 30°C. The formulations therefore met the observed physical stability criteria. The original viscosity assessment also reported a slight decrease after 28 days of storage; however, the document did not provide serial viscosity data. Future studies should report viscosity values at each storage interval to support a more complete stability assessment.

Panelist Preference

F3 was preferred by 45% of the 20 panelists, followed by F1 (35%) and F2 (20%). The higher preference for F3 may be related to its lower-viscosity consistency, which likely made it easier to apply. Because all formulas had the same color and aroma, consistency was the most plausible differentiating characteristic in the panelists' preferences.

CONCLUSION

Ethanol extract of papaya leaves can be formulated into a lotion preparation, providing protection, in an O/W lotion form. The concentration of TEA affected the spreadability test (ANOVA test ($0.000 < 0.05$), but did not affect the organoleptic test, pH, homogeneity, lotion type, adhesion, or protective power (ANOVA test ($0.788 > 0.05$)).

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