FORMULATION AND EFFICACY TEST OF STICK-HEEL MOISTURIZER MADE FROM 96% ETHANOL EXTRACT OF PAPAYA (*Carica papaya* L.) LEAVES

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ABSTRACT

Papaya leaves contain phytochemicals including alkaloids, phenols, flavonoids, tannins, saponins, and steroids, which can function as natural moisturizers to maintain healthy heels. Papaya leaves were extracted using the maceration method with 96% ethanol solvent and evaporated on a rotary evaporator to obtain a thick extract. The yield was 10.2%. It was subsequently combined at concentrations of 5 %, 10 %, and 15% to create a moisturizing heel stick preparation. The physical quality of the stick heel moisturizer preparations was assessed using tests for homogeneity, spreadability, adhesion, pH, organoleptic properties, and moisturizing properties. The mixture produces a brownish-green stick, a semi-solid texture, a distinctive odor of papaya leaves, a pH of 6, good homogeneity, good adherence, and qualified spreadability. The moisturizing test results for FI 5%, FII 10%, and FIII 15% had average values of 2.23%, 1.56%, and 1.15%, respectively. The results of SPSS testing also showed various average values that were significant ($p<0.05$). From the obtained data, FIII was determined to be the most effective moisturizing formula.

Keywords: Papaya leaf, stick heel, moisturizer.

INTRODUCTION

The skin is the first layer of the body exposed to environmental pollutants. The skin also covers the entire body and serves as a barrier against various external disturbances There are several types of human skin, including oily, combination, normal, and dry skin. Many people frequently struggle with dry skin, which can lead to discomfort and psychological stress (Ervianingsih, 2016). Dry skin is an indication of anomalies in the stratum corneum and outermost layer of the epidermis. Due to indiscernible water loss from evaporation, factors such as dry air, sunshine, aging, and skin conditions can cause the skin to appear more scaly, dry, and wrinkled. When the stratum corneum's (SC) water content drops by as much as 10%, dry skin results. Under normal conditions, the stratum corneum contains approximately 30% water (Herawan *et al*. 2022).

Healthy foot skin is odorless, smooth, aromatic, clean, crack-free, dry, and molded. Nevertheless, poor foot care frequently leads to issues such as fungus and odor on the feet, dry or scaly skin, and cracked heels. This can interfere with the appearance of a lack of confidence when wearing flat shoes and is tipically painful (Handayani *et al*., 2021). The skin has a natural moisturizer called natural moisturizing factor (NMF). NMF is a natural substance that helps keep the skin hydrated and shields it from peeling, drying, and splitting. During the winter, various factors such as atopic dermatitis and detergent sensitivity can make the skin become dehydrated; therefore, additional protection—moisturizing makeup—is required to keep the skin healthy (Ervianingsih, 2016).

The market offers a variety of moisturizing and cleaning treatments for heels such as foot scrubs, foot sanitizer sprays, and foot lotion. Foot lotion is a semi-solid preparation that is applied to the body, whereas foot sanitizers contain 70%—95% ethanol, softeners, and moisturizers (Handayani *et al.*, 2021). Papaya leaf is an ingredient that can be utilized as a moisturizing cosmetic. Flavonoids, tannins, terpenoids, saponins, and alkaloids are among the phytochemical substances found in papaya leaves (Nilna *et al.*, 2021).

Leny *et al.* (2023) demonstrated that papaya leaf-based cream scrub formulations with 70% ethanol extract could bind moisture to the skin. According to another study by Ervianingsih (2016), the production of foot lotions with papaya sap powder helps to repair cracked heels without irritating them. The sticks were prepared as solid. Sticks are designed in the form of archery, such as threads or spirals used to roll in or out of containers. This form has the advantage of being easy to use—applicators are used instead of fingers—and are both aesthetically pleasing and comfortable, which might pique the attention of potential customers (Febriani 2015). The stick preparation is made from a composition of active substances, humectants, hardening agents, solvents, and preservatives. Cera alba, carnauba wax, cetaceum, and stearic acid are bases that can be used to prepare sticks. Examples of stick preparations include lipsticks, deodorant sticks, lip balms, and balsam sticks (Monisca 2022).

Based on this description, the researcher intended to create a stick-shaped preparation that was formulated using a 96% ethanol extract of papaya leaves. Physical quality evaluation, such as homogeneity, pH, adhesion, spreadability, and moisturizing effectiveness, is conducted to ascertain how effectively heel stick preparations work to treat xerosis on feet heels.

RESEARCH METHOD

Tools and Materials

The tools and materials in this study included analytical digital scale (Kenko), maceration container, rotary evaporator (Buchi), filter paper, universal pH paper, glassware, waterbath, blender, hotplate (Thermo Scientific), stick container, papaya leaves, 96% ethanol, candelilla wax, beeswax, stearic acid, Dragendorff reagent, castor oil, sorbitan stearate, glycerin, KOH, nipagin, nipasol, BHT, VCO, 2N HCI, cetyl alcohol, Mayer reagent, concentrated sulfuric acid, anhydrous acetic acid, and $FeCl_3$ solution.

Research Procedure

1. Plant Determination

   Determinations were carried out at the Herbarium Bandungense, Sekolah Ilmu dan Teknologi Hayati (SITH) at Institut Teknologi Bandung (ITB), Jatinangor, Sumedang, West Java.

2. Sample Preparation

   Papaya leaves were collected from Undisan Village, Tembuku, Bangli. The papaya leaf cultivars that were employed had green leaves on stalks 2–5 from the shoots, tapered leaf edges, a round, rayed bone contour, and striped leaflets that were approximately 25–27 cm in length. After removing the contaminants, the papaya leaves were rinsed under running water. Subsequently, papaya leaves were chopped and air-dried. Dried papaya leaves were blended into a powder. The resulting powder was stored in a tightly sealed container (Leny *et al*., 2023).

3. Preparation of Papaya Leaf Extract

   A maceration procedure was used for the extraction. A total of 500 g of dried simplicia powder from papaya leaves was weighed and macerated with 2500 mL of 96% ethanol (1:5) at room temperature for three days, stirred once daily, and then filtered. Afterward, it was remacerated with 96% ethanol for a day at room temperature, remacerated once more for a day at room temperature, and finally filtered. The filtrate was evaporated using a rotary evaporator (Leny *et al.* 2023). After obtaining a concentrated extract, the yield was calculated using the following formula:

$$\%\text{yield} = \frac{\text{extract weight obtained}}{\text{weight of papaya leaf simplicia}} \times 100\%$$

4. Phytochemical Screening of Papaya Leaf Extract
   a. Alkaloid Test
      A small amount of extract was added with 1% HCl and then added to 1 mL of Mayer reagent; the presence of a white precipitate or turbidity indicates the existence of alkaloid compounds (Listiani, 2023).
   b. Fenol Test
      A total of 1 mg of the extract was added to a few drops of 1% $FeCl_3$ reagent. If the hue changes from blue to reddish or blackish-green, the reaction is considered positive (Oktavia, 2021).
   c. Flavonoid Test
      A total of 1 mg of the extract was added to a few drops of 10% NaOH. If the hue changes to orange, the reaction is considered positive (Listiani, 2023).
   d. Tannin Test
      When 10% $FeCl_3$ reacts with the test solution of 1 mL, the presence of tannin was indicated if the reaction turned blackish-green (Mahatriny *et al*., 2014).
   e. Steroid/Terpenoid Test
      A total of 2 mL of the sample was heated in a cup until evaporation. After chloroform (0.5 mL) was added to the residual solution, anhydrous acetic acid (0.5 mL) was added. Then, 2 mL H_2SO_4 was added dropwise. The presence of terpenoids is indicated by the appearance of brownish or violet rings between solutions, whereas the presence of steroids is indicated by the appearance of a greenish-blue ring (Mahatriny *et al*., 2014).
   f. Saponin Test
      The samples were added to 10 mL of warm water and shaken vigorously for 10 seconds. Saponins are identified by the presence of foam that is 1–10 cm high and remains in that way for at least 10 minutes; the foam is not eliminated by adding 1 drop of HCl 2N (Mahatriny *et al*., 2014).
5. Formulation of Heel Stick

   The heel stick moisturizer formula in this study refers to the research of Monisca (2022), who created a moisturizing heel stick using pineapple (*Ananas comosus* L.) fruit juice. The concentration of the extract used was based on the method described by Ervianingsih (2016). Based on the findings of both investigations, this study attempted to compare the concentrations of each extract and determine the most effective formula for skin hydration.

Table I. Formulation of Heel Stick

No	Materials	Quantity% (b/b)			
		F0	FI	FII	FIII
1	Papaya leaf extract	-	5	10	15
2	Candelila wax	20	20	20	20
3	*Beeswax*	20	20	20	20
4	Stearic acid	15	15	15	15
5	Cetyl alcohol	10	10	10	10
6	Castor oil	10	10	10	10
7	Sorbitan stearate	1,5	1,5	1,5	1,5
8	Glycerin	1	1	1	1
9	KOH	1	1	1	1
10	Nipagin	0,1	0,1	0,1	0,1
11	Nipasol	0,1	0,1	0,1	0,1
12	Ethanol 96%	Qs	Qs	qs	qs
13	VCO	ad 100	ad 100	ad 100	ad 100

6. Procedure for Making Heel Stick

   First, nipagin and nipasol were dissolved in a small amount of ethanol to obtain a mass of 1. The second step was to prepare mass 2 by dissolving KOH in distilled water. The third step was to make mass 3 by melting candelilla wax, beeswax, and stearic acid in a water bath at 60—85°C. After combining candelilla wax, beeswax, and stearic acid in a vaporizer cup and swirling until the stearic acid completely melted, mass 3 was mixed with cetyl alcohol and BHT. Mass 3 was then mixed with glycerin and agitated until it was homogenous. Subsequently, mass 1 was combined with mass 3 and mixed until uniform. Mass 2 was then added to mass 3 and mixed until it was homogenous. The extract was then added in accordance with the concentration and mixed until uniform. Subsequently, VCO was added and stirred until homogeneity was achieved. The mixture was cooled to a temperature of 55ºC, while stirring and poured into the mold. After cooling, the solution was allowed to solidify at room temperature.

7. Effectiveness Testing of Moisturizing Heel Stick

   a. Preparation of Spangler Membrane

      The membrane used was Whatman Paper No. 1, which was soaked in a Spangler liquid. The process of making the membrane involves mixing and diluting all the Spangler liquid ingredients in a water bath at 80ºC, followed by stirring until homogeneity. After weighing, Whatman Paper No. 1 was transferred into the Spangler liquid and placed between two sheets of filter paper to allow absorption of the liquid. The amount of liquid absorbed by the synthetic membrane was determined based on its weight. The quantity of absorbed liquid was calculated using the following formula:

      Percentage of spangler liquid absorbed = $\frac{(W1 - W0)}{W0} \times 100\%$

      Description :

      W0: weight of the membrane before soaking (g).

      W1: weight of the membrane after soaking (g).

      The membrane passes the uniformity test if the percentage of Spangler liquid absorbed is in the range of 102.19% to 131.22%. (Liandari, 2015).

   b. Production and Preparation of Air Humidity

      Using a 33.09% H_2SO_4 solution, a desiccator's air humidity was produced and prepared to reach atmospheric conditions with 70% air humidity. The 150 mL solution was prepared by injuring 50 mL concentrated H_2SO_4, then adding distilled water until it reached 150 mL, placed in a container, and placed in a desiccator (Liandari, 2015).

   c. Moisturizing Power Test

      A desiccator was used for moisturizing power tests. After applying 1 g of the test preparation, comparator, and positive control (HIH Vaseline original moisturizing lotion stick anti-drying hand foot heel) to the Spangler membrane, the initial weight was measured. The membrane was then placed in a desiccator for 15 minutes, and the weight was recorded once more. Weighing was repeated for 30, 45, and 60 minutes. The percentage reduction in evaporated water was calculated. Each mixture was tested three times, and the decrease in evaporated water signified a decrease in moisturizing capacity. The percentage of evaporated water was calculated using the following formula:

      $\%X = \frac{b}{a} x\ 100\%$

      Description :

      a: water evaporated before being placed in the desiccator (g).

      b: water evaporated after being placed in a desiccator (g).

      %x : weight percentage of evaporated water (i.e. the percentage of reduced moisturizing power of a preparation).

Data on the percentage of evaporated water weight were statistically analyzed using the Repeated Measures ANOVA method. Statistical analysis was performed using the Statistical Product and Service Solution (SPSS) program.

Data Analysis

Data processing was used for descriptive and quantitative analyses. Organoleptic and homogeneity observations provided descriptive data, whereas assessments of spreadability, pH, adhesiveness, and moisturizing efficacy provided quantitative data. Statistical analysis was performed based on the pH assessment data, adhesion, spreadability, and moisturizing effectiveness values to compare the F0, FI, FII, and FIII group results with a 95% confidence level (=0.05). Prior to testing for data variance, the normality of the data was assessed, and the Shapiro-Wilk test calculation results were viewed. The data can be examined using repeated-measures ANOVA if it satisfies the criterion of equal variance and normal distribution with a significance value of $p>0.05$.

RESULTS AND DISCUSSION

Plant Determination

Determination was carried out with the aim of obtaining certainty of plant identity (Listiani & Indraswari, 2021). Papaya plants were collected at Herbariuum Bandungense, Sekolah Ilmu dan Teknologi Hayati (SITH) di Institut Teknologi Bandung (ITB), Sumedang, West Java, stating that the plant samples identified were true papaya plants (*Carica papaya* L.) of the *family Caricaceae*.

Papaya Leaf Extraction

Papaya leaves were extracted using the maceration method. A rotary evaporator set at 50°C was used to concentrate 500 mg of powdered simplicia that had been macerated for five days with re-aeration. This produced a thick extract weighing fifty-two grams with a yield of 10.2%. The yield of the leaf ethanol extract of papaya in this study was lower than that reported by Leny *et al.* (2023), which produced 17.16% yield. The disparity in outcomes is thought to derive from variances in the geographic location of the collection, which may lead to variations in compound content that impact the rendition of the results (Sunnah *et al.*, 2022).

Phytochemical Screening Papaya Leaf Extract

Phytochemical screening aims to understand which compounds in papaya leaf extract contain chemical compounds that are moisturizing.

Table II. Phytochemical Screening Result

Compound group	Reagents	Result	Conclusion
Alkaloid	Mayer	Cream precipitate	+
Fenol	$FeCl_3$ 1%	Blackish green	+
Flavonoid	HCl	Orange	+
Tanin	$FeCl_3$ 10%	Blackish green	+
Steroid	Sulfuric acid	Blue green color	+
Saponin	Aquadest, HCl 2N	Stable foam	+

The screening results contrast with the test conducted by Mahatriny *et al.* (2014), which showed that the ethanol extract of papaya leaves with 96% ethanol solvent was positive for alkaloids, flavonoids, glycosides, and tannin component groups. The differences in results can be influenced by the extraction method, solvents used, and variations in the growing environment, which can lead to variations in secondary metabolite compounds.

Organoleptic Test

Organoleptic examination of the preparation was performed, and based on the observations, it was found to be semi-solid, brownish green, and had a distinctive papaya leaf scent.

Table III. Organoleptic Test Result

Formula		Test Parameters		
		Color	Texture	Aroma
F0	1	Brownish-White	Semi solid	Typical of candelilla wax
	2	Brownish-White	Semi solid	Typical of candelilla wax
	3	Brownish-White	Semi solid	Typical of candelilla wax
FI	1	Brownish-Green	Semi solid	Typical of papaya leaves
	2	Brownish-Green	Semi solid	Typical of papaya leaves
	3	Brownish-Green	Semi solid	Typical of papaya leaves
FII	1	Brownish-Green	Semi solid	Typical of papaya leaves
	2	Brownish-Green	Semi solid	Typical of papaya leaves
	3	Brownish-Green	Semi solid	Typical of papaya leaves
FIII	1	Brownish-Green	Semi solid	Typical of papaya leaves
	2	Brownish-Green	Semi solid	Typical of papaya leaves
	3	Brownish-Green	Semi solid	Typical of papaya leaves

Homogeneity Test

The test was carried out by applying the preparation to the object glass and then observing with a microscope, and the preparation must have a homogeneous arrangement (Listiani & Indraswari, 2023). Homogeneity examination revealed that all preparations were homogeneous.

Table IV. Homogeneity Test Result

Formula		Result
F0	1	Homogeneous
	2	Homogeneous
	3	Homogeneous
FI	1	Homogeneous
	2	Homogeneous
	3	Homogeneous
FII	1	Homogeneous
	2	Homogeneous
	3	Homogeneous
FIII	1	Homogeneous
	2	Homogeneous
	3	Homogeneous

pH Test

pH testing was performed to ensure that the active ingredients were stable and appropriate for use in the preparations. The standard pH of topical preparations is 4.5–6.5 (Listiani, 2023). The pH should not be excessively acidic, as this can lead to skin irritation. Conversely, if the pH is too high, scaly skin may result. The test results indicate that the heel stick preparation is relatively safe for application to the skin (Mizolla, 2020).

Table V. pH Test

Formula		pH Test	
		pH	Average ± SD
F0	1	6	6 ± 0.00
	2	6	
	3	6	
FI	1	6	6 ± 0.00
	2	6	
	3	6	
FII	1	6	6 ± 0.00
	2	6	
	3	6	
FIII	1	6	6 ± 0.00
	2	6	
	3	6	

Spreadability Test

The test was performed by adding 50 g of additives and leaving it for 1 minute before recording (Monisca, 2022). The semistiff spreadability test requires 3–5 cm (Jumriani *et al.*, 2022).

Table VI. Spreadability Test

Formula		Result			Average (cm) ± SD
		50 g	100 g	150 g	
F0	1	3 cm	3.4 cm	3 cm	3.34 ± 0.81
	2	3 cm	3.5 cm	3.9 cm	
	3	3 cm	3.4 cm	3.9 cm	
FI	1	3.8 cm	3.4 cm	3 cm	3.41 ± 0.82
	2	3.7 cm	3.4 cm	3.9 cm	
	3	3 cm	3.4 cm	3.1 cm	
FII	1	3 cm	3.4 cm	3.6 cm	3.41 ± 0.81
	2	3 cm	3.3 cm	3.7 cm	
	3	3.8 cm	3.2 cm	3.7 cm	
FIII	1	3.6 cm	3 cm	3.4 cm	3.48 ± 0.83
	2	3.5 cm	3.8 cm	3.3 cm	
	3	3.6 cm	3.8 cm	3.4 cm	

The table shows that each formula satisfies the spreadability criterion. With an average spreadability value of 3, all formulas satisfy the criteria for semi-fluid spreadability. This is because the concentration of the extract influences the viscosity and lowers the water content, resulting in a lower spreadability rating (Sari *et al.*, 2021).

Adhesion Test

The adhesion test results demonstrate the capacity of the preparation to adhere to the skin and provide the best possible results. Preparations that adhere perfectly to the skin maximize their use and prevent reapplication (Pratiwi & Wahdaningsih, 2018). The adhesion test was carried out by attaching a preparation between 2 glass plates that were loaded with 150 g for 5 minutes. The glass plate was placed on a test device with a load of 80 g. The number of seconds that the glass plate was detached was recorded.

Table VII. Adhesion Test

Formula		Result (Seconds)	
		Adhesion	Average ± SD
F0	1	18.08	18.19 ± 0.33
	2	18.56	
	3	17.92	
FI	1	30.67	30.44 ± 0.39
	2	30	
	3	30.67	
FII	1	32.33	32.33 ± 0.33
	2	32.66	
	3	32	
FIII	1	35.33	35.22 ± 0,19
	2	35	
	3	35.33	

The adhesion test results showed that the preparation had good adhesion, because it was longer than 1 second. Adhesion to semi-stiff preparations is good between 1 and 300 seconds (Widnyana *et al.*, 2021).

Moisturizing Test

The moisturizing effectiveness test yielded the following results.

1. Spangler membranes met the uniformity requirements are 12 membranes (102.19%–131.22%).
2. The results of the moisturizing effectiveness test were used to obtain the average percentage of evaporated water reduction at 15, 30, 45, and 60 minute successively for each formula:

Table VIII. Moisturizing Test Result

Formula		Percentage of Evaporated Water Loss	
		15, 30, 45, dan 60 minutes	Average ± SD
F0	1	0,39; 1,86; 1,90 ;3,86	2,25 ± 1,10
	2	1,14; 1,17; 1,61; 1,61	
	3	0; 1,15; 1,16; 3,41	
FI	1	2,29; 2,40; 1,21; 1,25	2,23 ± 0,45
	2	2,13; 2,23; 1,51; 1,30	
	3	1,89; 1,89; 1,96; 2,41	
FII	1	1,10; 1,13; 0,85; 0,77	1,56 ± 0,43
	2	1,47; 1,52, 0,77; 0,74	
	3	1,90; 1,98; 1,02, 0,98	
FIII	1	0,77; 1,18; 0,72; 0,78	1,15 ± 0,23
	2	0,74; 1,14; 0,51; 0,60	
	3	1,10; 1,13; 0,82; 0,66	
Positive Control	1	0,37; 0,47; 076; 0,76	0,56 ± 0,16
	2	0,37; 0,76, 0,65, 0,54	
	3	0,36; 0,74; 0,58, 0,51	

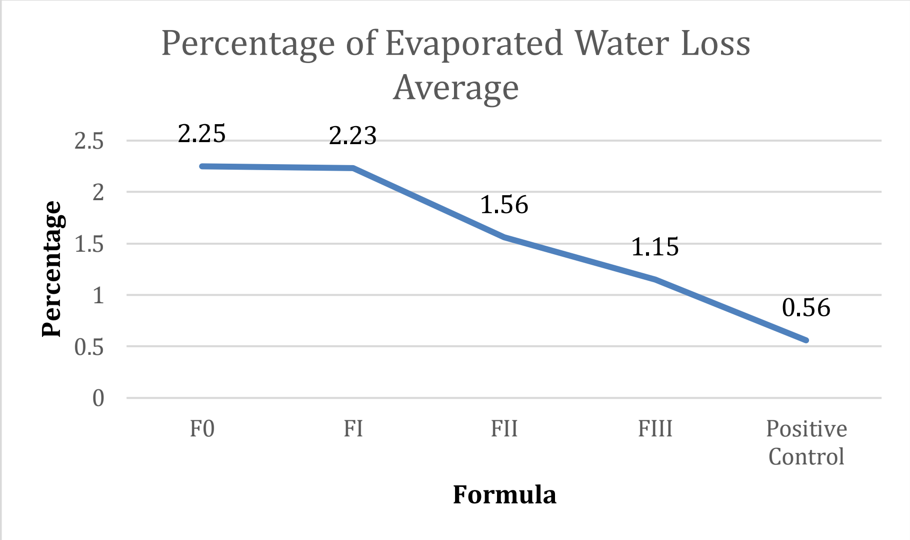

Figure 1. Percentage of evaporated water loss

The moisturizing power test on F0, which is a formulation that does not contain extracts or only a base, has an average percentage of evaporated water loss of 2.25%; F1, which is a formula with 5% extract added, has an average percentage of evaporated water loss of 2.23%; FII, which is a formula with 10% extract added and has an average percentage of water loss of 1.56%; FIII, which is a formula with 15% extract added, has an average percentage of water loss of 1.15%; and the positive control, namely the original HIH Vaseline brand, has an average percentage of evaporated water loss of 0.56%. Compared to FII, F1, and F0, FIII had the lowest proportion of water loss evaporating from the Spangler membrane, as indicated in Table VIII and Figure 1. While the moisturizing power of FIII was not superior to that of the positive control, the lower the average value of the percentage of evaporated water loss, the better the moisture retention.

SPSS Test Result

Pairwise Comparisons

Measure: sediaan

(I) formula	(J) formula	Mean Difference (I-J)	Std. Error	Sig.b	95% Confidence Interval for Differenceb Lower Bound	95% Confidence Interval for Differenceb Upper Bound
1	2	1.118*	.071	.000	.845	1.392
	3	1.770*	.172	.000	1.111	2.429
	4	2.200*	.120	.000	1.739	2.660
	5	2.633*	.121	.000	2.168	3.098
2	1	-1.118*	.071	.000	-1.392	-.845
	3	.652*	.154	.029	.060	1.244
	4	1.081*	.095	.000	.717	1.446

	5	1.514*	.089	.000	1.174	1.854
3	1	-1.770*	.172	.000	-2.429	-1.111
	2	-.652*	.154	.029	-1.244	-.060
	4	.429*	.109	.042	.013	.845
	5	.863*	.127	.001	.374	1.351
4	1	-2.200*	.120	.000	-2.660	-1.739
	2	-1.081*	.095	.000	-1.446	-.717
	3	-.429*	.109	.042	-.845	-.013
	5	.433*	.039	.000	.286	.581
5	1	-2.633*	.121	.000	-3.098	-2.168
	2	-1.514*	.089	.000	-1.854	-1.174
	3	-.863*	.127	.001	-1.351	-.374
	4	-.433*	.039	.000	-.581	-.286

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

The fact that F0's average evaporated water loss was higher than that of FI, FII, FIII, and the positive control suggests that F0 is not able to tolerate weight loss from evaporated water for an extended period of time. This is supported by the SPSS value, which shows that F0 was significantly different from FI, FII, FIII, and the positive control ($p<0.05$).Compared to FII, FIII, and the positive control, FI showed a greater percentage of evaporated water loss. This demonstrates FI's reduced capacity of the FI to tolerate the loss of evaporated water, which reduces its ability to retain moisture. This was evidenced by the SPSS value, which showed a significant difference from FII, FIII, and the positive control ($p<0.05$).FII had a greater percentage of evaporated water loss than FIII and the positive control did. This shows that FII was less able to retain moisture and resist the loss of evaporated water. This is evidenced by the SPSS value, which showed a significant difference between FIII and the positive control ($p<0.05$).

According to the SPSS value of $p<0.05$, FIII had the lowest average percentage of evaporated water loss compared to F0, I, and II, but it was still not less than that of the positive control. This was because FIII had the highest extract concentration. F0 had the highest average because F0 did not add extracts, but the base contained moisturizers. The positive control contained vitamin E, besswax, and squalane, which have a molecular structure similar to that of the skin's natural lipids and are therefore readily absorbed into the deepest layers of the skin; it has the lowest average evaporated water loss. Additionally, the antioxidant qualities of squalene shield the skin from free radical damage. Formula III is the best of all formulas because there is a significant difference between FII, FI and F0 as evidenced by the SPSS results ($p<0.05$). According to Sunnah *et al.* (2021), flavonoids help keep the skin hydrated and break down protein connections, change cell permeability, and potentially prevent the growth of bacteria and cells. Alkaloid compounds also have strong antioxidant activity, which can help protect the skin from free radicals that can harm cells and impair their ability to retain moisture and boost the production of collagen, which keeps the skin strong and supple, repairs the skin barrier, keeps water from escaping the skin, and improves the skin's capacity to absorb and hold onto water (Bulla *et al*., 2019).

CONCLUSION

According to the research results, formula FIII is more effective at moisturizing because the average percentage of water lost through evaporation is the lowest and closest to the value of 0. Statistical analysis showed a significant difference in the heel stick formula ($p<0.05$).

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