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Extract Tamarillo (*Solanum Betaceum*) as Natural Dye for Formulation of Moisturizing Lip

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Abstract *– The cosmetics industry is experiencing rapid growth, offering a diverse array of products designed to enhance appearance and promote skin health. Among these products, lip moisturizers are particularly important, serving to maintain lip moisture and health while enhancing attractiveness. The trend toward natural ingredients in cosmetics is on the rise due to their perceived safety and environmental benefits compared to synthetic alternatives. In this study, tamarillo (Solanum betaceum) extract is utilized as both a nutrient and a natural colorant in lip balm. Tamarillo is rich in anthocyanins, which provide natural coloration and antioxidant properties, helping to combat free radicals, hydrate, soften the skin, and reduce dryness. This research aims to develop a lip balm formulation incorporating tamarillo extract at varying concentrations. The study is conducted experimentally, with lip balm formulations prepared using tamarillo extract at 4% and 6% concentrations. The lip balm's quality is assessed through organoleptic testing, homogeneity, stability, melting point, pH, irritation potential, and moisturizing effectiveness over a two-week period. The resulting lip balm product is anticipated to be an innovative solution for addressing dry, chapped, and dull lips, with potential for further development.*

Keywords: *lip balm; natural coloring; extraction; tamarillo (Solanum betaceum)*

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INTRODUCTION

Lip moisturizers, or lip balms, are cosmetic products primarily composed of oils, waxes, fats, and natural extracts (Nurmi, 2019). These formulations are designed to prevent lip damage by enhancing moisture and protecting lips from various harmful environmental factors, such as dry air, wind, and UV exposure (Haryantio, 2020). The use of lip balm is particularly important for individuals with lips sensitive to low-humidity conditions, as lip skin is more susceptible to dryness and damage (Nara, 2019).

Lip balm products function by creating a protective layer on the lip surface, which locks in moisture and prevents fluid loss. Additionally, lip balms containing natural extracts often offer additional benefits, such as antioxidant and anti-inflammatory properties, which help maintain overall lip health. The trend towards using natural ingredients in lip balm formulations is growing due to their perceived safety and environmental friendliness, with Dutch eggplant (*Solanum betaceum*) being one such natural colorant (Kadu et al., 2015).

Tamarillo *(Solanum betaceum)* is rich in anthocyanins, compounds that can be used as natural colorants and possess antioxidant properties (Toh et al., 2013). Anthocyanins are beneficial for neutralizing free radicals, hydrating the skin, softening it, and reducing dryness. The potential of tamarillo ethanol extract as a natural colorant in lip balm formulations is worth exploring, as it not only provides

an attractive natural color but also offers additional health benefits for the skin of the lips (Marleni, 2018).

The maceration extraction method is a process of extracting plant materials using a solvent with occasional shaking or stirring at room temperature (Nara, 2019). This method is chosen for this research due to its effectiveness in extracting active compounds from plant materials. The process involves soaking the plant materials in a solvent at room temperature for a specified period, allowing the solvent to extract the active components. The maceration method offers advantages in terms of simplicity and cost efficiency (Putri et al., 2017).

This study aims to develop a lip balm formulation using tamarillo (*Solanum betaceum*) ethanol extract as a natural colorant through the maceration extraction method. The quality evaluation of the lip balm includes organoleptic tests, homogeneity, stability, melting point, pH, irritation tests, and moisturizing effectiveness over a specified period. This lip balm product is expected to be a safer and more natural alternative for consumers and contribute to the development of the natural ingredient-based cosmetic industry.

MATERIALS AND METHODS

Materials

Materials used in the manufacture of lip moisturizers are Dutch eggplant, ethanol 96%, olive oil, lanolin, cera alba, propylene glycol, butyl hydroxy toluene (BHT), and fragrance. The tools used in making lip balm are an oven, blender, knife, skin analyzer, rotary evaporator, pH meter, sieve, filter paper, analytical balance, beaker glass, watch glass, measuring cup, stirring rod, thermometer, lip balm pot, porcelain cup, vessel, water bath, and object glass. Lip balm formulations with variations of 4% and 6% Dutch eggplant extract, 2% and 4% olive oil concentration, and melting temperatures of 45°C and 55°C.

Table 1. Research design using factorial design

Run	Dutch Eggplant Extract (% in 100 ml)	Olive Oil (% in 100 mL)	Temperature (°C)
1	4	2	45
2	6	2	45
3	4	4	45
4	6	4	45
5	4	2	55
6	6	2	55
7	4	4	55
8	6	4	55

Preparation of Raw Materials

Preparation of raw materials includes preparing tools and materials to be used, washing the Dutch eggplant fruit using running water, cutting the Dutch eggplant fruit approximately 0.5 mm using a knife, drying the Dutch eggplant in the oven at 50 ° C until dry, the dried Dutch eggplant fruit is then blended until smooth, the blended Dutch eggplant is then filtered using a 30-mesh filter (Abadi et al., 2020).

Preparation of Dutch Eggplant Fruit Extract

Making Dutch eggplant fruit extract includes preparing the tools and materials to be used, 500 grams of Dutch eggplant powder that has been finely put into a jar with the addition of 96% ethanol 350 ml. The sample is stored in a closed container and placed in a place that is protected from sunlight for 5 days. As long as the sample is stored for 5 days and stirred once a day, the sample that has been stored for 5 days is then filtered using filter paper to separate the filtrate, the resulting filtrate is then evaporated using a rotary evaporator with a temperature of 40°C (Ambari et al., 2020).

Lip Balm Making

The preparation of lip balm includes preparing the tools and materials to be used; the preparation base, namely cera alba 4 grams and lanolin 4 grams, is put little by little into the cup while stirring and melting on a water bath with temperatures (45°C and 55°C), then mix the concentration of Dutch eggplant extract (4% and 6%) and stir until smooth. The preparation cup was removed from the water bath (without applying heat), then glycerine, olive oil, and 1 ml of fragrance were added while continuing to stir at each addition, after which it was put into the lip balm pot and left at room temperature until it froze or hardened (Haryantio, 2020).

Organoleptic Analysis

An organoleptic test was conducted visually on 10 panelists. Each panelist was asked to apply the preparation formula made on the panelist's wrist skin. Then, the panelists chose which formula variation they liked the most. Panelists wrote (1) if they strongly disliked, (2) if they disliked, (3) if normal, (4) if they liked, (5) if they strongly liked. The observation parameters in the organoleptic test are color, aroma, texture, and perceived preference on the skin, and the scoring test includes color, aroma, and texture (Marleni, 2018).

Homogeneity Analysis

Each preparation is checked for homogeneity by applying a certain amount of the preparation on a transparent glass object with a certain area (2 x 2 cm). The preparation should show a homogeneous composition, and no coarse grains should be visible (Nurmi, 2019).

Melt Temperature Analysis

The ideal melting temperature of lip balm is set to a temperature close to the temperature of the lips, varying between 36-38°C. But because it must pay attention to the resistance factor to the surrounding weather temperature, especially the temperature of the tropics, the lip balm melting temperature is made high, which ranges from 50-70°C.

The method of observing the melting temperature of lip balm used in the study is by putting as much as 1 gram of lip balm into the oven with an initial temperature of 50°C until it melts, then observing at what minute the lip balm began to melt (Sembiring, 2016).

Stability Analysis

The finished lip balm preparation was evaluated for 14 days (2 weeks), which included organoleptic observations (color, aroma, and texture) and whether changes occurred during storage at room temperature, namely 25°C, and out of reach of light (Simarmata, 2016).

pH Analysis

Measurement of the pH of the preparation was carried out using a pH meter. The sample was weighed at 1 gram and dissolved in 100 mL of distilled water, and then the electrode was dipped in the solution. Let the tool show the pH price until it is constant. The number shown by the pH meter is the pH of the preparation. The purpose of the pH test examination is to determine whether the lip balm preparation is in accordance with the physiological pH of the lip skin, which is 4.5-7 (Toh et al., 2017).

Moisture Effectiveness Analysis

This test was conducted by measuring skin moisture before and after applying lip balm using a skin analyzer to measure oil and moisture levels. The measurement is carried out by cleaning the forearm of the panelist until clean using water. Mark the box and code on the skin to be analyzed, turn on the skin analyzer tool, then attach it to the skin to be measured for moisture, and record the results aimed at the tool. Apply the lip balm preparation to the skin that has been measured for moisture and then measured again to get the results of moisture effectiveness (Toh et al., 2017).

RESULTS AND DISCUSSION

Organoleptic Test

Organoleptic tests were done visually on the 8 panelists. Every panelist requested to apply the prepared preparation formula to the skin wrist hand panelists. Then panelists choose which formula variation is most preferred. Panelists write (1) if it is very not like, (2) if not like, (3) if normal, (4) if like, (5) if really like. Observation parameters in organoleptic tests are color, aroma, texture, and perceived preference on the skin (Nazliniwaty et al., 2019).

- **Hedonic Test**

From 8 samples seen, that panelist more chose sample F5 with value 39, which uses extract eggplant Dutch 4% in 100 mL and olive oil 2% in 100 mL with a melting temperature of 45°C. Whereas the sample with the lowest choice from the panelist is sample F4 with a value of 27, it uses extract eggplant Dutch 6% in 100 mL olive oil 4% in 100 mL temp melting 45°C. According to 8 panelists who liked it, sample F5 is a lip balm that has color normal, whereas sample F4 is the lip balm that is color no like, according to panelists.

From Figure 2, it can be seen that panelists more often choose samples F1 and F2 with marks, namely 38. F1 samples use formulation extract eggplant Dutch 4% in 100 mL and olive oil 2% in 100 mL with a melting temperature of 45°; meanwhile, F2 samples use formulation extract eggplant Dutch 6% in 100 mL and olive oil 2% in 100 mL with a melting temperature of 45°C. Whereas the sample with the lowest choice from the panelists is sample F5 with a value of 27, it uses extract eggplant Dutch 4% in 100 mL and olive oil 2% in 100 mL with a melting temperature of 45°C. According to the 8 panelists who voted, samples F1 and F2 are lip balms that have a normal aroma; meanwhile, sample F5 is a lip balm that has no aroma, according to the panelists.

From Figure 3, samples show that panelists more choose sample F2 with value 39, which uses extract eggplant Dutch 6% in 100 mL and olive oil 2% in 100 mL with melting temperature 45°C. Whereas the sample with the lowest choice from the panelist is sample F4 with a value of 23, it uses extract eggplant Dutch 6% in 100 mL of olive oil 4% in 100 mL melting temperature 45°C. According to 8 panelists who liked it, sample F2 is a lip balm that has normal texture meanwhile, sample F4 is a lip balm that has no like texture, according to panelists (Nazliniwaty et al., 2019).

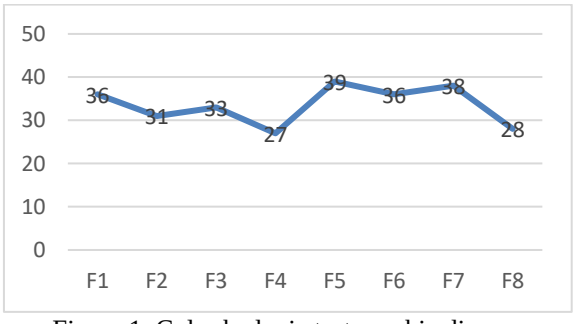

Figure 1. Color hedonic test graphic diagram

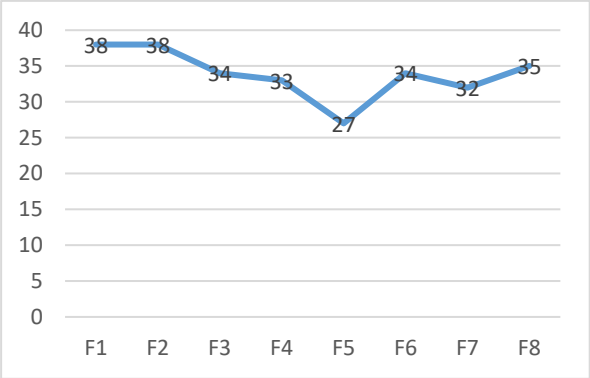

Figure 2. Graphic diagram of the hedonic aroma test

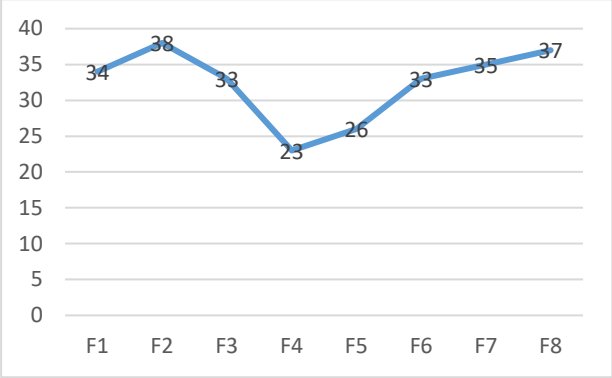

Figure 3. Graphic diagram of the hedonic texture test

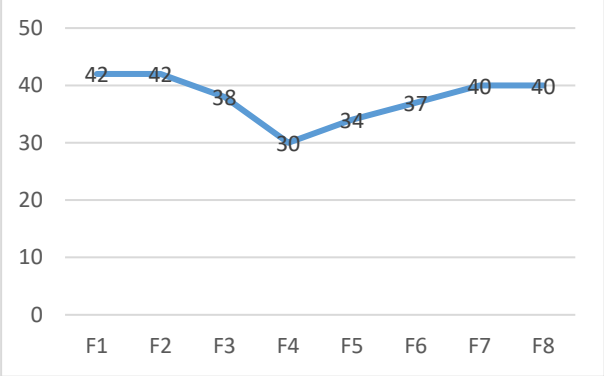

Figure 4. Graphic diagrams of the hedonic likeness test

From Figure 4, it can be seen that panelists more often choose samples F1 and F2 with marks. The same, namely 42. F1 samples use formulation extract eggplant Dutch 4% in 100 mL and olive oil 2% in 100 mL with a melting temperature of 45°C; meanwhile, F2 samples use formulation extract eggplant Dutch 6% in 100 mL and olive oil 2% in 100 mL with a melting temperature of 45°C. Whereas the sample with the lowest choice from panelists is sample F4 with a value of 30, it uses extract eggplant Dutch 6% in 100 mL of olive oil 4% in 100 mL temp melting 45°C. According to the 8 panelists who voted, samples F1 and F2 are lip balms that have a mark of favorite like samples F1 and F2; meanwhile, sample F4 is a lip balm that has a mark of favorite normal according to the panelists.

- **Scoring Test Texture**

From 8 samples seen, that panelist more chose sample F4 with value 29, which uses extract eggplant Dutch 6% in 100 mL olive oil 4% in 100 mL temp melting 45°C. Whereas the sample with the lowest choice from the panelist is samples F5 and F6 with a value of 12. Sample F5 uses extract eggplant Dutch 4% in 100 mL and olive oil 2% in 100 mL with a melting temperature of 55°C, while sample F6 uses extract eggplant Dutch 4% in 100 mL and olive oil 2% in 100 mL with a melting temperature of 55°C. According to 8 panelists who liked it, sample F4 is a lip balm that has a very soft texture, whereas samples F5 and F6 are lip balms that have a soft texture according to panelists (Nazliniwaty et al., 2019).

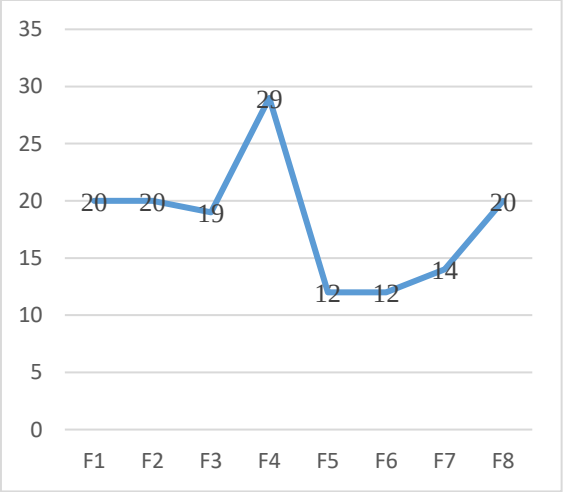

Figure 5. Graphic diagram of scoring test texture

Homogeneity Test

The samples were tested for homogeneity with the smear method, a number of certain preparations on a glass transparent object with wide certainty (2 x 2 cm). Preparation must show a homogeneous arrangement and not have rough details.

That all tested samples own the same homogeneity, although they own different variables. That thing can happen because all materials used can be mixed with good without existing details (Nazliniwaty et al., 2019).

Melting Temperature Test

The method used to observe the melting point of lip balm in this study involved placing 1 gram of lip balm into an oven at an initial temperature between 45-

55°C, according to the specified formulation. The melting process was then observed. The results showed that samples F4, F7, and F8 melted the fastest, taking approximately 5 minutes to melt in the oven. Meanwhile, sample F5 required 12 minutes of heating to melt. This difference in melting time may be attributed to the variations in the formulations used in the production of the lip balm (Nazliniwaty et al., 2019).

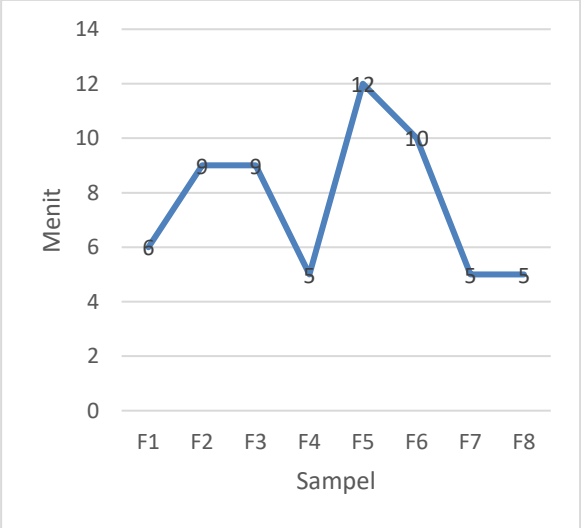

Figure 6. Graphic diagram of melting temperature test

Stability Test

During a 14-day stability test at room temperature of 25°C and protected from light, an evaluation was conducted on the organoleptic changes such as color, scent, and texture of the lip balm. The results showed that only two samples, F1 and F2, did not experience any changes in color, scent, or texture during this period (Nazliniwaty et al., 2019). Meanwhile, sample F3 only showed a change in scent on the 8th day, from strong to not strong.

Sample F4 showed changes in scent and texture on the 8th day, with the scent changing from strong to not strong and the texture from soft to very soft. Sample F5 showed a change in scent on the 11th day and texture on the 5th day, with the scent changing from strong to not strong and the texture from soft to not soft. Sample F6 showed changes in scent and texture on the 6th day, with the scent changing from strong to not strong and the texture from soft to not soft.

Sample F7 showed changes in scent and texture on the 9th day, with the scent changing from strong to not strong and the texture from soft to not soft. Sample F8 showed a change in scent on the 8th day and texture on the 9th day, with the scent changing from strong to not strong and the texture from soft to not soft. These changes occurred due to differences in the formulations of the samples (Nazliniwaty et al., 2019).

Sample Code	Parameter	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14
F1	Color	B	B	B	B	B	B	B	B	B	B	B	B	B	B
	Scent	S	S	S	S	S	S	S	S	S	S	S	S	S	S
	Texture	S	S	S	S	S	S	S	S	S	S	S	S	S	S
F2	Color	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB
	Scent	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Texture	S	S	S	S	S	S	S	S	S	S	S	S	S	S
F3	Color	B	B	B	B	B	B	B	B	B	B	B	B	B	B
	Scent	S	S	S	S	S	S	S	NS	NS	NS	NS	NS	NS	NS
	Texture	S	S	S	S	S	S	S	S	S	S	S	S	S	S
F4	Color	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB
	Scent	S	S	S	S	S	S	S	NS	NS	NS	NS	NS	NS	NS
	Texture	S	S	S	S	S	S	S	VS	VS	VS	VS	VS	VS	VS
F5	Color	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB
	Scent	S	S	S	S	S	S	S	S	S	S	NS	NS	NS	NS
	Texture	S	S	S	S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
F6	Color	B	B	B	B	B	B	B	B	B	B	B	B	B	B
	Scent	S	S	S	S	S	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Texture	S	S	S	S	S	NS	NS	NS	NS	NS	NS	NS	NS	NS
F7	Color	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB
	Scent	S	S	S	S	S	S	S	S	NS	NS	NS	NS	NS	NS
	Texture	S	S	S	S	S	S	S	S	NS	NS	NS	NS	NS	NS
F8	Color	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB	DB
	Scent	S	S	S	S	S	S	S	NS	NS	NS	NS	NS	NS	NS
	Texture	S	S	S	S	S	S	S	S	NS	NS	NS	NS	NS	NS

Figure 7. Stability test

Color (LM: Light Brown; B: Brown; DB: Dark Brown). Scent (NS: Not Strong;S: Strong; VS: Very Strong) Texture (N: Not Soft; S: Soft; VS: Very Soft).

pH Test

The pH measurement of the preparation was conducted using pH paper, where the sample was applied to the pH paper to determine if the lip balm matched the physiological pH of the lip skin, which ranges from 4.5 to 7 (Ambari et al., 2020). Based on Figure 3.7, it can be seen that the pH value of sample F1 reached pH 5, which is in line with the physiological pH of the lip skin. However, samples F2 to F8 showed pH values below the physiological pH of the lip skin, specifically pH 4 (Nazliniwaty et al., 2019).

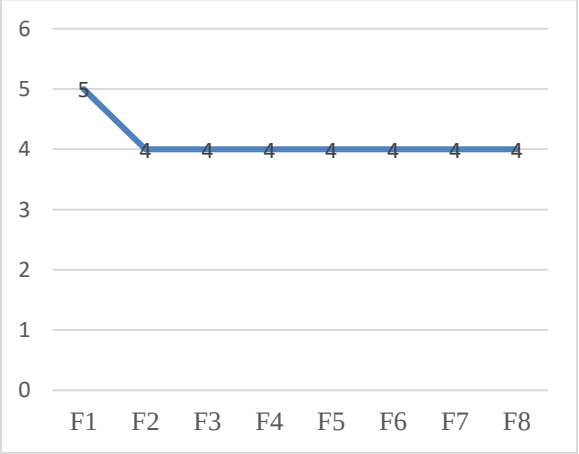

Figure 8. Graphic diagram of pH test

Humidity Effectiveness Test

• Oil Moisture Results

It can be seen in Figure 9. that sample F6 has the highest value of 12.1, which uses 6% tamarillo extract in 100 mL and 2% olive oil in 100 mL with a melting temperature of 55°C. On the other hand, sample F4 has the lowest value of 0.2, which uses 6% tamarillo extract in 100 mL and 4% olive oil in 100 mL with a melting temperature of 45°C. Therefore, the results indicate that sample F6 is the most effective at moisturizing the panelists' skin (Nazliniwaty et al., 2019).

Figure 9**.** Graphic diagram of oil moisture results

It can be seen in Figure 9. that sample F6 has the highest value of 12.1, which uses 6% tamarillo extract in 100 mL and 2% olive oil in 100 mL with a melting temperature of 55°C. On the other hand, sample F4 has the lowest value of 0.2, which uses 6% tamarillo extract in 100 mL and 4% olive oil in 100 mL with a melting temperature of 45°C. Therefore, the results indicate that sample F6 is the most effective at moisturizing the panelists' skin.

• Moisture Humidity Results

This test was conducted by measuring the skin's moisture before and after applying the lip balm using a skin analyzer to determine the moisture level. The measurement process involved cleaning the panelists' forearms thoroughly with water. Mark the area on the skin to be analyzed with a box and a code. Turn on the skin analyzer and place it on the marked skin area to measure the moisture, and record the results shown by the device. Apply the lip balm to the measured skin area, then measure again to obtain the effectiveness of the lip balm's moisturizing properties (Nazliniwaty et al., 2019).

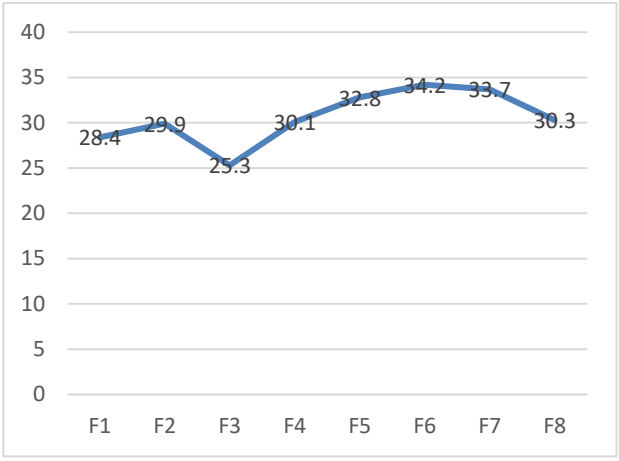

Figure 10. Graphic diagram of moisture humidity results

It can be seen in Figure 10. that sample F6 has the highest value of 12.1, which uses 6% tamarillo extract in 100 mL and 2% olive oil in 100 mL with a melting temperature of 55°C. On the other hand, sample F3 has the lowest value of 0.2, which uses 4% tamarillo extract in 100 mL and 4% olive oil in 100 mL with a melting temperature of 45°C. Therefore, the results indicate that sample F6 is the most effective at moisturizing the panelists' skin.

CONCLUSION

Based on the research conducted, the results from the organoleptic tests with 10 panelists can be summarized as follows: Two types of organoleptic tests were carried out: the hedonic test and the scoring test. In the color hedonic test, panelists preferred sample F5, scoring it 39. For the aroma hedonic test, samples F1 and F2 were preferred, both scoring 39. In the texture hedonic test, sample F2 was favored with a score of 39. For overall preference in the hedonic test, samples F1 and F2 scored 42.

In the homogeneity test, all samples exhibited the same level of homogeneity despite different variables. During the melting temperature test, samples F4, F7, and F8 melted the fastest, taking about 5 minutes in the oven. The stability test, conducted over 14 days at room temperature (25°C) and away from light, showed that samples F1 and F2 did not change in color, aroma, or texture. In the pH test, sample F1 had a pH value of 5, matching the physiological pH of lip skin, while samples F2 to F8 had a pH of 4, which is not in accordance with the physiological pH. The oil moisture effectiveness test revealed that sample F6 had the highest value of 12.1, utilizing 6% Dutch eggplant extract and 2% olive oil in 100 mL with a melting temperature of 55°C. The same sample, F6, also showed the highest value in the moisture effectiveness test under the same conditions.

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