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Analysis of the Physicochemical Properties of Lanolin-Based Lipstick from Sheep Wool with Addition of Dragon Fruit Exocarp Extract *(Hylocereus polyrhizus)*

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ABSTRACT

Lanolin (Adeps lanae), derived from sheep wool, is a complex lipid composed of fatty esters such as cholesterol, cetyl alcohol, and carnuba alcohol. It acts as an effective natural humectant that maintains moisture and enhances the stability of cosmetic formulations, including lipstick. This study aimed to study a lanolin-based lipstick incorporating dragon fruit (*Hylocereus polyrhizus*) exocarp extract as a natural colorant and antioxidant. The dragon fruit *exocarp* extract and lanolin were obtained using previously validated methods assisted by rotary evaporation. A completely randomized design (RAL) was implemented with four treatments: P0 (0%), P1 (20%), P2 (40%), and P3 (60%) exocarp extract concentrations in the lipstick formulation. Evaluated parameters included melting point, pH, spreadability, and homogeneity. Data were analyzed via ANOVA followed by Tukey's test at a 5% significance level. Results indicated that treatments had a significant effect ($P < 0.05$) on all evaluated properties. The highest melting point was observed in P0 (66.60 °C) and the lowest in P3 (60.60 °C), both within the SNI 16 4769 1998 standard range (50–70 °C). The highest pH was recorded in P0 (5.16 ± 0.07), while the lowest was in P3 (4.41 ± 0.02), nearing the physiological pH of the lips (3.8–4.7). The P1 formulation (20%) exhibited the best homogeneity and spreadability

Keywords: Dragon fruit exocarp extract, Homogeneity, Lanolin lipstick, Physicochemical

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1. Introduction

In today's modern era, the use of cosmetic products has become an important part of daily routines, especially for women. One of the most widely used types of cosmetics is lipstick. Lipstick not only serves to add colour to the lips but also plays a role in enhancing aesthetics and boosting the user's self-confidence [1]. The combination of these ingredients significantly determines the final quality of the lipstick, including its texture, viscosity, and melting point [2].

As public awareness of ingredient safety and environmental sustainability grows, the trend toward using natural ingredients in cosmetic formulations is also expanding. One natural ingredient that is increasingly being utilised is lanolin, an oily substance obtained as a by-product of sheep wool shearing (*Ovis aries*). Lanolin is known as a natural humectant and emollient that helps maintain moisture, improve texture, and provide a soft effect on the skin and lips [3]. Lanolin has the ability to form a protective barrier for sensitive skin and act as

an emollient for topical medications. Its ability to penetrate the skin and deliver active ingredients makes it a valuable component in various formulations.

Its ability to form a protective layer on the skin's surface makes lanolin a highly promising ingredient for use in cosmetic products, including natural-based lipsticks. Growing concerns about the negative impacts of synthetic dyes have driven the search for safer alternatives from natural sources. One promising natural colourant is dragon fruit skin, particularly the exocarp (outer skin), which is known to contain anthocyanin pigments. These pigments not only provide an attractive purple-red colour but also have antioxidant activity that contributes to maintaining skin health and extending product shelf life [4]. Dragon fruit (*Hylocereus polyrhizus*) is a plant that grows in areas with a dry tropical climate. This fruit is rich in various antioxidant compounds, such as vitamin C, flavonoids, and polyphenols. Dragon fruit also contains anthocyanin pigments that function as antioxidants.

Previous research conducted [5] attempted to utilise lanolin as a base material for lipstick with the addition of natural colourants. However, the results of this study did not fully meet expectations, particularly in terms of the stability and physicochemical quality of the lipstick meeting standards. Therefore, further development is needed to produce a lipstick formulation that is not only natural but also has physicochemical properties such as melting point, pH, homogeneity, and spreadability that meet cosmetic quality standards. This study aims to study a lanolin-based lipstick from sheep's wool with the addition of red dragon fruit exocarp extract as a lipstick with more optimal physicochemical characteristics.

2. Method

This research was conducted at the Livestock Production Laboratory of the Animal Science Study Program, the Biochemistry Laboratory of the Faculty of Mathematics and Natural Sciences, and the Cosmetology Laboratory of the Faculty of Pharmacy at USU. The research was conducted over a period of four months from January to April 2025.

2.1. Materials

The ingredients used include beeswax as a hardening agent, lanolin obtained from sheep's wool at a farm on Jl. Cempaka Dusun 19 Pasar 4 Kelambir 5 Kebun, Medan, which functions as a natural emollient, and red dragon fruit exocarp obtained from a dragon fruit supplier in Dairi Regency as a source of natural colouring. Additionally, supplementary ingredients such as rose oil as a fragrance, parabens as a preservative, 70% ethanol as a solvent, and cetyl alcohol to stabilise the emulsion are also used. For physical and chemical testing purposes, distilled water is used as a neutral solvent.

2.2. Tools

The tools used in this study included: Glass beakers, lipstick moulds, lipstick containers, stoves, pots, water baths, analytical scales, stirring rods, spatulas, thermometers, pipettes, porcelain dishes, refrigerators, electric ovens, centrifuges, and rotary evaporators.

2.3. Study design

This study used a completely randomized design (CRD) consisting of four treatments, each showing variations in the concentration of dragon fruit exocarp extract in lanolin-based lipstick formulations, with each treatment repeated five times, namely:

P0: no addition of dragon fruit exocarp extract
P1: addition of 20% dragon fruit exocarp extract
P2: addition of 40% dragon fruit exocarp extract
P3: addition of 60% dragon fruit exocarp extract

The research data will be analyzed using the Analysis of Variance (ANOVA) method to determine significant differences between treatments. If the analysis results show significant differences at the 95% confidence level, the testing will be continued with a Tukey post-hoc test to identify treatments that have significantly different effects.

Table 1. Lipstick formulation

Ingridients	Formulation			
	P0 (g)	P1 (g)	P2 (g)	P3 (g)
Lanolin	6.40	6.40	6.40	6.40
Beeswax	2.60	2.60	2.60	2.60
Dragon fruit exocarp extract	0.00	1.28	2.56	3.84

Oleum rosae	0.02	0.02	0.02	0.02
Paraben	0.40	0.40	0.40	0.40

Note : Concentrations of dragon fruit exocarp extract 0%, 20%, 40% and 60% by weight of modified lanolin [5].

2.3. Research Parameters

2.3.1 Physical Analysis

1. Melting Point

Melting point test used 0.5 grams of each lipstick sample was placed on a watch glass, then put into an oven with an initial temperature of 50°C. The sample is left for a few moments, then observed to see if it begins to melt. The temperature is then gradually increased by 1°C every minute, and observations are made to record the temperature at which the lipstick begins to melt [6].

2. Spreadability

A lipstick formulation is considered to have spreadability if the color adheres to the skin of the arm in a large and even manner [7]. The test is conducted on each formulation prepared and applied to the skin of the hand with five applications. This allows evaluation of how easily the lipstick is applied and to what extent it achieves the desired result on the skin surface.

3. Homogeneity

Homogeneity testing is performed by applying a small amount of lipstick formulation to a flat, transparent surface, such as glass [8]. The expected result shows an even distribution of color and texture without any coarse particles or unmixed ingredients.

2.3.2 Chemical Analysis

1. Potential of Hydrogen (pH)

This pH test was conducted using a pH meter is performed by dissolving 1 gram of lipstick sample in 10 ml of distilled water, forming a 1% concentration solution. Next, universal pH paper was dipped into the solution, and the color change was observed [1]. The color that appeared was compared to the standard color scale on the pH paper packaging to determine the pH value. Each sample was tested three times to obtain more accurate results.

3. Result and discussion

3.1. Melting Point

The melting point of a lipstick formulation is determined by gradually heating it in an oven, where the temperature is increased by 1°C every minute until the lipstick begins to melt or liquefy. The results of the melting point testing for a lanolin-based lipstick formulation derived from sheep's wool (*Ovis aries*), with the addition of red dragon fruit exocarp extract (*Hylocereus polyrhizus*) at various concentration levels, are presented in the Table 2.

Table 2. Melting point of lanolin-based lipstick with added dragon fruit exocarp extract (°C)

Treatment	Replication					Mean ± SD
	I	II	III	IV	V	
P0	66	66	68	65	68	$66,60^{a} \pm 1,34$
P1	62	63	62	62	63	$62,40^{bc} \pm 0,55$
P2	64	62	63	62	64	$63,00^{b} \pm 1,00$
P3	61	60	61	59	62	$60,60^{c} \pm 1,14$

Note: Different superscripts indicate significant differences between treatments ($P<0.05$).

The ANOVA results indicate that the addition of red dragon fruit exocarp extract has a significant effect ($P < 0.05$) on the melting point of lanolin lipstick preparations. The Tukey post hoc test at the 5% level shows that P0 is significantly different from P1, P2, and P3. However, treatment P1 was not significantly different from P2 and P3, while P3 was significantly different from P0. The highest melting point was recorded in P0 (66.60°C), while the lowest was in P3 (60.60°C). This decrease indicates that the addition of the extract began to affect the physical structure of the lipstick, making it easier to melt.

Treatment P2 showed an increase in the melting point to 63.00°C ± 1.00, which was likely due to the interaction between the extract and other ingredients in the formula, thereby providing a stabilizing effect, although not as high as the control treatment (P0). Meanwhile, in treatment P3, with the highest extract concentration, the melting point decreased significantly to 60.60°C ± 1.14. T The average melting point range of the four treatments was between 60.60°C and 66.60°C, which is within the standard melting point range for lipstick based on SNI 16-4769-1998, namely 50–70°C [9].

3.2. Spreadability

The data from the testing of the spreadability of lanolin-based lipstick formulations from sheep's wool with the addition of dragon fruit *(Hylocereus polyrhizus*) extract at different concentrations is presented in the Table 3.

Table 3. Spreadability lipstick score

Treatment	Replication					Mean^{tn} ± SD
	I	II	III	IV	V	
P0	1	1	1	1	1	10 ± 0,0
P1	1	2	1	1	1	1,2 ± 0,4
P2	2	2	2	2	1	1,8 ± 0,4
P3	3	2	3	2	3	2,6 ± 0,5

Note: 1 = Very easy to apply, 2 = Fairly easy to apply, 3 = Easy to apply, 4 = Somewhat difficult to apply, 5 = Difficult to apply

Based on the results of data, Treatment P0 showed excellent results with an average score of 1.0, which means that this lipstick is very easy to apply. A consistent score of 1 in each repetition of lipstick application shows that this lipstick has excellent spreadability, making it easy to use. Treatment P1 obtained an average score of 1.2, which means that this lipstick is still in the category of fairly easy to apply.

In the second repetition, there was a slight variation with a score of 2, which indicates that in that repetition, the spreadability of the lipstick was slightly different compared to P0. Overall, this lipstick still has fairly good spreadability, although not as ideal as P0. Treatment P2 received an average score of 1.8, indicating that the lipstick with a consistent score of 2 in each test shows that its spreadability is still fairly easy. Treatment P3 with an average score of 2.6 indicates that this treatment is more difficult to apply.

3.3. Homogeneity

Homogeneity testing in this study was conducted qualitatively by assigning ranking scores, which were then explained descriptively. Homogeneity is an important aspect in emulsion production, as it reflects the extent to which the oil and water phases in the preparation can be mixed evenly.

Table 4. Homogeneity score

Treatment	Replication					Mean^{tn} ± SD
	I	II	III	IV	V	
P0	1	1	1	1	1	1,0 ± 0,0
P1	1	2	1	2	2	1,6 ± 0,5
P2	3	2	3	2	3	2,6 ± 05
P3	4	3	3	3	3	3,2 ± 0,4

Note : 1 = Very homogeneous, 2 = Fairly homogeneous, 3 = Homogeneous, 4 = Less homogeneous 5 = Not homogeneous

Based on Table 4, four treatments were observed, namely P0, P1, P2, and P3, each with five replicates. The test results showed that treatment P0 had an average homogeneity score of 1 and was categorized as highly

homogeneous. This high level of homogeneity indicates that the mixing technique used in treatment P0 was quite effective and the proportions of the ingredients used were also appropriate. This is in line with the provisions of the Directorate General of POM (1979), which states that cosmetic preparations must have a homogeneous composition and not show coarse particles [10].

Treatment P1 showed an average homogeneity score of 1.6, which is classified as moderately homogeneous. Although the results are still good, there is a slight variation in values between replicates, indicating inconsistency during the mixing process. In treatment P2, the average homogeneity value was recorded at 2.6, while in P3 the value increased to 3.2. Although both are still in the homogeneous category, there are indications of a decrease in uniformity compared to the previous treatment. This decrease is thought to be related to the increase in the concentration of red dragon fruit exocarp extract, which affects the viscosity and mixing process of the ingredients in the formula.

3.4. Potential of Hydrogen (pH)

The pH test results of lanolin lipstick formulations from sheep wool (*Ovis aries*) with the addition of red dragon fruit exocarp extract (*Hylocereus polyrhizus*) at different concentrations are presented in the Table 5.

Table 5. The pH score

Treatment	Replication					Mean ± SD
	I	II	III	IV	V	
P0	5,20	5,05	5,22	5,14	5,18	5,16 ^{a} ± 0,07
P1	4,74	4,76	4,72	4,73	4,78	4,75 ^{b} ± 0,02
P2	4,64	4,61	4,66	4,60	4,67	4,64 ^{c} ± 0,03
P3	4,41	4,39	4,44	4,38	4,42	4,41^{d} ± 0,02

Note: Different superscripts indicate significant differences between treatments (P<0.05).

Based on the average results shown in the table, the highest pH value was recorded in treatment P0, which was 5.16 ± 0.07, while the lowest pH value was found in treatment P3, which was 4.41 ± 0.02. Based on the Tukey post-hoc test at the confidence level (P<0.05), it was found that there were significant differences between treatments P0, P1, P2, and P3, with a tendency for pH to decrease as the concentration of the extract increased. Treatment P0 showed the highest pH, indicating that the lipstick formulation was still neutral to weakly acidic. In treatment P1, with the addition of 20% red dragon fruit exocarp extract, the pH decreased to 4.75 ± 0.02, indicating that the extract began to influence the acidity of the formulation. In treatment P2, the pH decreased further to 4.64 ± 0.03, as the increased extract concentration further strengthened the acidic nature of the formulation. The most significant decrease occurred in treatment P3 (highest extract concentration), with a pH of 4.41 ± 0.02, the lowest value among all treatments. Overall, these results indicate that the higher the concentration of red dragon fruit exocarp extract added, the lower the pH value of the lipstick formulation [11].

4. Conclusion

This study proves that a lanolin-based lipstick formulation with the addition of red dragon fruit (*Hylocereus polyrhizus)* extract at a concentration of 20% produces good results in terms of the physical characteristics of the preparation. The treatment showed melting points and pH levels in accordance with SNI 16-4769-1998 standards and provided good results in terms of spreadability and homogeneity of the formulation.

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