
Natural Lipstick Formulation Based on *Monascus Purpureus* Extract: Variation of Beeswax–Candelilla Wax and Evaluation of Antioxidant Activity

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Abstract

*Lip colorants are cosmetic preparations used to color the lips with an artistic touch, thereby enhancing the aesthetic aspect of facial makeup. This study aims to formulate a lipstick using a natural dye derived from angkak (*Monascus purpureus*), with variations in the wax base using beeswax and candelilla wax, to produce a safe, comfortable, and long-lasting lipstick product. Methods: This experimental study was conducted in four stages: Stage one, Extraction of Natural Dye: The natural dye from *Monascus purpureus* was extracted using the maceration method with 96% ethanol as the solvent. Stage two, Lipstick Formulation: Three formulas were developed—F1, F2, and F3—with the following beeswax to candelilla wax ratios: F1 (2 : 3.57), F2 (3.57 : 2), F3 (2.78 : 2.78). Stage three, Physical Quality Evaluation: The formulations were evaluated for organoleptic properties, homogeneity, pH, melting point, spreadability, hardness, and stability. Stage four, Antioxidant Activity Test: To assess the antioxidant potential of the natural dye used. Results: All lipstick formulas exhibited good physical stability and met the required physical quality standards for organoleptic properties, homogeneity, pH, melting point, spreadability, and stability. However, a significant difference was found in the hardness test results, influenced by the varying concentrations of beeswax and candelilla wax. Conclusion: Variations in the concentration of beeswax and candelilla wax affect the physical quality, particularly the hardness of the lipstick. The best hardness result was obtained in Formula 1 (F1), with a beeswax concentration of 2% and candelilla wax concentration of 3.57%.*

Keywords: *Natural Lipstick, Monascus Purpureus Extract, Beeswax, Candelilla Wax, Antioxidant Activity.*

INTRODUCTION

Cosmetics are substances used to enhance the appearance of the human body, particularly among women, and the cosmetic industry is currently a rapidly growing sector that attracts significant public interest (Sunil et al., 2024). Decorative cosmetic preparations are a category of cosmetics that play an important role in improving, modifying, and concealing facial imperfections as part of makeup. These include products such as blush, eyeshadow, eyebrow products, and lip products (Abadi et al., 2022). Among beauty products, lipstick is one of the most frequently used items today. Many women consider lipstick an essential necessity and may experience a lack of confidence when going out without wearing it. This phenomenon has driven the cosmetic industry to compete in producing lipstick products that meet consumer preferences. Consequently, some lipstick manufacturers choose to incorporate synthetic colorants into their formulations to reduce production costs and enhance color attractiveness (Yuniarsih et al., 2023).

The use of synthetic colorants in lipstick is highly prone to ingestion along with saliva or food and beverages, which may pose health risks if the lipstick contains harmful substances derived from synthetic dyes. Several synthetic colorants used in lipsticks have been identified as potentially carcinogenic or capable of causing cancer. In addition, synthetic colorants may increase the risk of irritation, inflammation, and allergic reactions, particularly in individuals with high skin sensitivity (Monica et al., 2024). The use of natural colorants derived from natural sources has therefore emerged as an alternative to lipsticks containing synthetic dyes. Natural colorants possess advantages comparable to synthetic dyes, including lower color intensity, which produces a softer and more soothing visual effect when applied (Sutara, 2009).

Natural colorants can be obtained from plants, animals, and microorganisms (Aberoumand, 2011; Rymbai et al., 2011; Gupta et al., 2011; Visalakshi & Jawaharlal, 2013). Among microbial

sources capable of producing pigments with high yields are species of *Monascus* (Malik et al., 2012). *Monascus* sp. is a mold commonly utilized to produce red fermented rice (angkak), which generates pigments as secondary metabolites (Yuliana et al., 2016). Angkak is produced from rice fermented by *Monascus purpureus* and is characterized by its red appearance. The bioactive compounds present in angkak have been used for centuries as spices, colorants, and medicinal agents (Singgih, Permana, Maulidya, & Yuliana, 2019). Pigments from *Monascus* sp. are widely used as food colorants and flavoring agents in the food industry. Moreover, their applications are not limited to the food sector but also extend to the cosmetic and pharmaceutical industries (Seyedin et al., 2015). Currently, pigments produced by *Monascus* sp. include yellow (ankaflavin, monascin), orange (rubropunctatin, monascorubrin), and red (rubropunctamine, monascorubramine) pigments, which exhibit various biological activities (Wongjewboot & Kongruang, 2011).

Based on previous research conducted by Resmawati et al. (2024), angkak extract (*Monascus purpureus*) produced favorable coloration in eyeshadow, blush, and lip cream formulations, indicating its potential as a natural colorant in the development of decorative cosmetic products.

In lipstick formulations, the main components consist of butter, wax, and oil. The base of lip cosmetic preparations may be in the form of wax or butter, which can influence the melting point, texture, and application properties of the product (Kadu et al., 2017). A combination of candelilla wax and beeswax has been shown to be highly suitable for lipstick production. When candelilla wax is used in slightly higher proportions than beeswax, the resulting product tends to be softer and exhibits a glossy appearance (Mitha et al., 2000). Based on these considerations, this study aims to utilize *Monascus purpureus* as a natural colorant in lipstick formulations with variations in candelilla wax and beeswax as the wax base.

RESEARCH METHODS

Instruments and Materials

The instruments used in this study included an evaporating dish, analytical balance, mortar and pestle, mold tray, oven, water bath, dropper pipette, lipstick container, calibration weights, and other supporting laboratory equipment. The materials used were 96% ethanol, angkak (*Monascus purpureus*), beeswax, candelilla wax, castor oil (*Oleum ricini*), cetyl alcohol, methyl paraben, propylene glycol, petroleum jelly (vaseline), Tween 80, and butylated hydroxytoluene (BHT).

Preparation of Angkak Extract

The maceration method was employed in the extraction process of angkak powder. The dried angkak powder was extracted using 96% ethanol as the solvent for 72 hours. The filtrate was then filtered, and the resulting macerate was evaporated using a water bath until a concentrated extract was obtained.

Formulation of the Preparation

The formulation design of lipstick containing angkak extract (*Monascus purpureus*) is presented in Table 1.

Table 1. Formula Design

Composition	Formula (%)		
	F1	F2	F3
Red Yeast Extract	2	2	2
Vaselin alba	2	2	2
Cetyl alkohol	2,83	2,83	2,83
Oleum ricini	2	2	2
Beeswax	2	3,57	2,78
Candelilla wax	3,57	2	2,78
propilenglikol	2,5	2,5	2,5
BHT	0,05	0,05	0,05
Nipagin	0,05	0,05	0,05
Tween 80	3	3	3

Preparation and Formulation of the Lipstick

The first step in lipstick preparation was weighing each ingredient accurately. Subsequently, two masses were prepared. Mass A consisted of a mixture of methyl paraben (nipagin), propylene glycol, and Tween 80, which were dissolved in an evaporating dish. Angkak extract was then added and mixed until a homogeneous mixture was obtained. Mass B consisted of beeswax, candelilla wax, white petrolatum (vaselin alba), cetyl alcohol, castor oil (*Oleum ricini*), and butylated hydroxytoluene (BHT). These ingredients were weighed, placed in an evaporating dish, and melted using a water bath at a temperature of 60–80 °C. Mass A and Mass B were then gently triturated until a homogeneous mass was formed. The lipstick molds were lubricated with paraffin to prevent adhesion, after which the mixture was poured into lipstick containers (roll-up type) and allowed to cool until completely solidified.

Evaluation of the Lipstick Preparation

Organoleptic Test

Organoleptic evaluation was conducted on the prepared formulations through sensory observation to assess odor, color, and texture (Harmoni et al., 2021).

Homogeneity Test

The homogeneity test was performed to determine the uniformity of the lipstick preparation. A small amount of the lipstick was applied onto a glass slide and covered with a cover glass. The preparation was then observed for the presence of coarse particles. A formulation was considered homogeneous if no particle aggregation was observed and the active ingredient was uniformly dispersed within the base without lump formation (Suryanita et al., 2024).

pH Test

The pH of the formulation was determined using a pH meter. Prior to measurement, the instrument was calibrated using standard buffer solutions of neutral pH (pH 7.00) and acidic pH (pH 4.00) until stable readings were obtained. The electrode was rinsed with distilled water and dried with tissue paper. A 1% sample solution was prepared by dissolving 1 g of the lipstick formulation in 100 mL of heated distilled water. After cooling, the electrode was immersed in the solution and allowed to stabilize. The pH value displayed on the pH meter was recorded as the pH of the formulation (Rawlins, 2003).

Melting Point Test

The melting point was determined by placing the lipstick in a water bath maintained at 50 °C. The sample was observed until melting began, and the temperature at which melting occurred was recorded as the melting point (Santi, 2020).

Hardness Test

The hardness test was performed by placing the lipstick horizontally at approximately half the distance from the edge of the lipstick. A load was applied gradually in increments of 50 g at 30-second intervals until the lipstick fractured or deformed (Vishwakarma et al., 2011).

Spreadability Test

The spreadability test was conducted by applying the lipstick to the dorsal surface of the hand. The assessment was based on the intensity and uniformity of the color deposited on the skin. Each formulation was applied five times, and the test was repeated for six cycles (Rahmatunnisa et al., 2022).

Stability Test

Stability testing was carried out to evaluate changes in shape, color, and odor of the lipstick formulation during storage at room temperature. Observations were conducted weekly up to 30 days. Any changes in physical appearance, color, or odor were assessed by comparing the samples with their initial condition at the time of molding (Risnawati et al., 2012).

Data Analysis

Data obtained from the formulation study and the evaluation of pH, melting point, and hardness of lipstick containing *Monascus purpureus* extract were analyzed using the statistical software Jamovi. If the research data were normally distributed and homogeneous, a one-way Analysis of Variance (one-way ANOVA) was conducted to determine differences in mean values among the groups. When significant differences were identified, a Post Hoc Least Significant Difference (LSD) test was subsequently performed to examine differences between treatments. If the data were not normally distributed and/or not homogeneous, the analysis was continued using the Kruskal–Wallis test.

RESULTS AND DISCUSSION

Organoleptic Test Results

Table 2. Organoleptic Test Results for Lipstick Preparations

Characteristics	Formula 1	Formula 2	Formula 3
Odor	The Distinctive Smell of Red Yeast	The Distinctive Smell of Red Yeast	The Distinctive Smell of Red Yeast
Colour	Dark Red	Dark Red	Dark Red
Shape	Solid	Solid	Solid

Based on the observations presented in Table 2, the organoleptic test results for Formulations F1, F2, and F3 showed a dark red lipstick color, a characteristic angkak odor, and a solid form. After being stored for 30 days, organoleptic observations of all three formulations indicated no changes. Observations of the physical form revealed that Formulations F1, F2, and F3 maintained consistent shapes; the lipstick preparations remained firm, were not soft, and showed no signs of water separation or sliminess. Furthermore, color evaluation demonstrated no changes, with the dark red color remaining consistent both in physical appearance and in the color produced upon application. The odor observed in all three lipstick formulations remained characteristic of angkak. Therefore, it can be concluded that the lipstick preparations in all three formulations were stable.



Figure 1. Red yeast rice lipstick formulas F1, F2, and F3

Homogeneity Test Results

Table 3. Homogeneity Test Results for Lipstick Preparations

Formula	Homogeneity
F1	Homogen
F2	Homogen
F3	Homogen

The results of the homogeneity test observations for formulations F1, F2, and F3 indicated that the preparations were homogeneous. A preparation can be considered homogeneous when no coarse particles or signs of non-uniformity are observed. The homogeneity test results of the lipstick formulations demonstrated that the lipstick preparations were evenly dispersed.

pH Test Results

Table 4. pH Test Results

Formula	pH
F1	6.87±0,01
F2	6.77 ±0,04
F3	6,85± 0,10

Based on the pH observations of lipstick formulations containing angkak extract (*Monascus purpureus*), the results showed that Formulation F1 had a pH value of 6.87, Formulation F2 had a pH value of 6.77, and Formulation F3 had a pH value of 6.85. The one-way ANOVA conducted on the pH data produced a significance value of 0.241 (sig > 0.05), indicating that there was no statistically significant effect of variations in the concentrations of beeswax and candelilla wax on the pH of lipstick containing angkak extract (*Monascus purpureus*). According to SNI 16-4399-1996, a good lipstick preparation should have a pH that corresponds to the physiological pH of the skin, ranging from 4.5 to 8. A pH value lower than 4.5 may cause skin irritation, while a pH value higher than 8 may result in skin dryness or scaling (Lestari et al., 2021). Therefore, all three formulations met the criteria for physiological skin pH.

Melting Point Test Results

Table 5. Melting Point Test Results

Formula	Melting point
F1	58°C ±1,00
F2	59,3°C ± 2,52
F3	59,3 °C ± 1,15

Based on the observations presented in Table 5, the melting point test results showed that the lipstick formulation F1, containing 2% beeswax and 3.57% candelilla wax, melted at 58°C. The formulation containing 3.57% beeswax and 2% candelilla wax melted at 59.3°C, while the formulation containing 3% beeswax and 3% candelilla wax also melted at 59.3°C. The one-way ANOVA performed on the melting point data yielded a significance value of 0.463 (sig > 0.05), indicating that there was no statistically significant effect of variations in the concentrations of beeswax and candelilla wax on the melting point of lipstick containing angkak extract (*Monascus purpureus*). A good lipstick

preparation should have a melting point ranging from 50°C to 60°C; therefore, these results indicate that the formulated lipsticks possess appropriate melting points (Vishwakarma et al., 2011).

Hardness Test Results

Table 6. Hardness Test Results

Formula	Lipstick Hardness (grams)
F1	512 ±1,00
F2	650 ±50,0
F3	555 ±50,1

Based on the observations presented in Table 6, the hardness test results showed that the lipstick preparation in Formulation F1 exhibited a hardness of 512 g, Formulation F2 exhibited a hardness of 650 g, and Formulation F3 exhibited a hardness of 555 g. The one-way ANOVA conducted on the hardness test data produced a significance value of 0.057, which was interpreted as indicating a statistically significant effect of variations in the concentrations of beeswax and candelilla wax on lipstick hardness.

Low hardness may cause the lipstick to break easily and fail to maintain its shape, making it difficult to apply to the lips. Conversely, excessively high hardness may hinder color release from the lipstick preparation. There is no absolute standard for an ideal lipstick hardness value (Gambara et al., 2015). Lipstick hardness is influenced by the concentration of the wax base, as wax bases generally have high melting points. Beeswax has a melting point of 61–65°C, while candelilla wax has a melting point of approximately 65–69°C. Higher wax concentrations result in harder lipstick products (Warnida et al., 2020).

In the hardness test observations, Formulation F2, with a beeswax concentration of 3.57% and candelilla wax concentration of 2%, produced the highest hardness value compared to F1 and F3. In this formulation, the higher beeswax concentration increased the solid content within the emulsion, thereby resulting in a harder lipstick product.

Spreadability Test Results

Based on the spreadability test, all three lipstick formulations met the required criteria. After five applications, the lipstick preparations produced an even and uniform red color upon application.



Figure 2. Red yeast rice lipstick smear test results

Antioxidant Activity Test Results

Table 7. Lipstick Antioxidant Activity Test Results Using the ABTS Method

Parameter	Result
Test Method	ABTS Assay using Microplate Reader
Sample Type	Lipstick
Test Date	May 27, 2025
Antioxidant Capacity (mmol TE/g)	0,0556 ± 0,0461
% Inhibition (mean)	22,78%
Repetition Rate	Duplo
%RPD Value	≤ 5% (meet the validity requirements of repetition)
Validation	Validated by Quality Manager & Lab Supervisor

Antioxidant activity testing of the lipstick samples was performed using the ABTS method (2,2'-azinobis(3-ethylbenzothiazoline-6-sulfonic acid)), with absorbance readings measured using an ELISA microplate reader. The ABTS method is one of the most widely used techniques for evaluating the ability of antioxidant compounds to scavenge free radicals, as it is simple, sensitive, and applicable to a wide range of samples, including both water- and lipid-soluble substances.

Based on the test results obtained, the antioxidant capacity of the lipstick samples was 0.0556 ± 0.0461 mmol TE/g sample. This value indicates the presence of compounds capable of neutralizing free radicals within the lipstick formulation; however, the activity is relatively low when compared to plant extracts or pure natural materials known to possess high antioxidant capacity.

The %RPD (Relative Percent Difference) value from repeated measurements was $\leq 5\%$, indicating good reproducibility of the test results. In addition, the standard deviation of the triplicate measurements on the standard curve also demonstrated data consistency, with a small deviation (< 1). Therefore, the standard curve results can be considered a valid reference for calculating the antioxidant capacity of the samples.

The antioxidant activity observed in the lipstick product may be attributed to the presence of certain active ingredients in the formulation, such as plant extracts, vitamin E, or polyphenolic compounds, which are commonly incorporated into cosmetic products to provide protection against oxidative stress on the lip skin. However, given that the measured antioxidant activity remains relatively low, increasing the concentration of antioxidant active ingredients in the formulation may be considered in future product development.

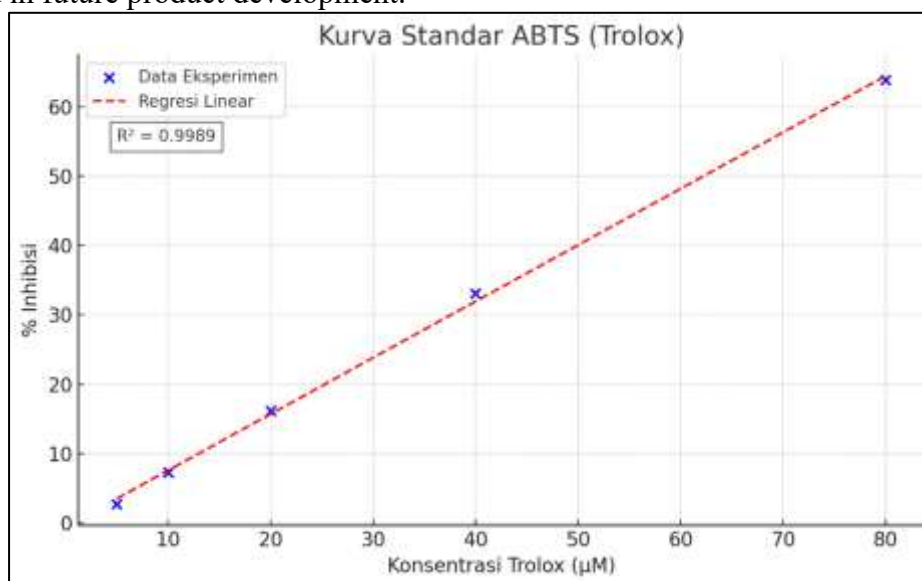


Figure 3. ABTS (Trolox) Standard Curve

The following figure presents the ABTS standard curve based on Trolox concentration versus percentage inhibition. The red line represents the linear regression result, with an R^2 value of 0.9963, indicating a very strong linear relationship between Trolox concentration and antioxidant activity (% inhibition).

CONCLUSIONS

Based on the results of this study on the formulation of lipstick preparations using angkak extract (*Monascus purpureus*) with variations in beeswax and candelilla wax as the base, the formulations met the required physical properties of lipstick preparations, including organoleptic characteristics, pH, spreadability, homogeneity, melting point, and hardness. The variation in the ratio of beeswax and candelilla wax in the formulations influenced the hardness of the lipstick preparations; higher wax concentrations resulted in harder lipsticks. Overall, these findings indicate that the tested lipsticks have potential as functional cosmetic products with antioxidant properties. However, further optimization is required to enhance their antioxidant effectiveness.

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