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Optimization of HPMC Aand Carbopol 940 Bases in the Formulation of Red Beet (*Beta vulgaris* L.) Gel Preparations as Hair Dye

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Abstrak−Red beet (Beta vulgaris L.) is grass-shaped plant with short stems. Betacyianine is a red or purplish red pigment, while the betaxantin pigment has yellow colour and when diluted in water will form a red solution. This study aims to formulate hair dye gel with red beet juiceas colorant, evaluate the coloring capacity of the gel, and evaluate the stability of the formulation. 114.43 grams red beet juice was obtained using juicer, with yield percentage 55.76%. Phytochemical screening indicated alkaloid, tannin, flavonoid and saponin content. Hair dye gel is formulated in three different concentrations, F1 (10%), F2 (20%), F3 (30%) using combination of Carbopol 940 (0.5%) and HPMC (1%) as gel base. Hair dye gel obtained has beet distinctive smell. Evaluation results for the three-formulation showed that the color changed in all formulas. Color changing is influenced by pH degree of the formulation and temperature. The original color of the preparation only stable for 5 days, then the color changed due to oxidation at room temperature. Stability evaluation was conducted using Cycling Test method for 6 cycles in 12 days. All formula showed discoloration after 6 cycles from purple to brownish and they also showed viscosity change, F1 13673,34 cPs; F2 11826,67 cPs; dan F3 10673,34 cPs.

Keywords: Carbopol 940 Base, Hair Dye Gel, HPMC, Red Beet Juice

1. INTRODUCTION

Human hair has two main functions, first as a head protector against cold and hot air, second as a natural decoration that can attract others (Sayuti, 2016). Hair is an important part of a person's appearance, not only as a head protector from environmental conditions but also as an aesthetic element that influences attractiveness. One aspect of hair aesthetics is hair color, which is determined by the melanin pigment in the hair cortex layer. Melanin pigment is produced by melanocytes located in hair follicles (Shapiro et al., 2024).

The emergence of gray hair is generally caused by a decrease in the body's ability to produce melanin, a pigment that gives hair its natural color. Usually, gray hair begins to appear at the age of 45 years and over. However, gray hair can also appear prematurely due to genetic, environmental, or health factors (Wang et al., 2023). Factors that cause gray hair can vary, including unbalanced nutritional intake, metabolic disorders, exposure to chemicals, and the influence of hereditary (Parmadi & Pratama, 2020).

Although gray hair is often considered a sign of aging, the appearance of gray hair at a young age (premature graying) is now a growing medical and cosmetic concern, especially with the trend of treating or covering gray hair using safe and natural hair coloring products. One way to make hair attractive is to dye it. Coloring hair not only changes the hair color from white (gray) to black or the desired color but also for aesthetic purposes. Coloring hair for someone has become a necessity so that every appearance is more attractive. Hair color can be changed artificially using hair dye, in Indonesia it is also called hair polish (Tranggono & Latifah, 2014).

Hair dyes can be obtained from natural ingredients. One of the plants that has the potential as a natural dye that has the best dye content is red beetroot (Beta vulgaris L.). Red beetroot (Beta vulgaris L.) is one of the most useful food ingredients. The benefits of red beetroot are to provide natural color in the manufacture of food products. Red beetroot (Beta vulgaris L.) has been known as one of the natural dyes because of its high betacyanin content. Betacyanin is a pigment that gives red color to beetroot and has good color stability under certain conditions (Kaba et al., 2024). Red beetroot contains the main component, namely betalain pigment which is a combination of betacyanin and betaxanthin pigments. Betalain is a polar alkaloid group pigment, has an N atom in the heterocyclic ring and binds sugar, nitrogenous pigments and is a substitute for anthocyanin. Betacyanin itself is a red or purplish red pigment, while betaxanthin pigment is yellow and is soluble in water to form a red solution. Betacyanin which functions to provide red color and has the potential to be a natural dye for food ingredients that is safer for health than synthetic dyes. Betacyanin found in red beetroot is known to have antiradical effects and high antioxidant activity. In addition to being a natural dye, betacyanin also has antioxidant benefits that support scalp health (Rao, 2006);(Wardiyah, 2016).

Gel preparations were chosen as a form of formulation because of their characteristics which are easy to apply, have good spreadability, and are able to provide an optimal release effect of active ingredients on the hair. In gel-based hair dye formulations, base selection and optimization are important steps to ensure stability, efficiency, and comfort of use. Hydroxypropyl methylcellulose (HPMC) and carbopol 940 are two commonly used gel base materials because of their ability to form high-viscosity gels, good active ingredient release capabilities, and compatibility with various formulation components (Singh et al., 2019); (Stefanov & Andonova, 2021); (Kumar et al., 2024). Therefore, natural hair dye cosmetic preparations from red beetroot (Beta vulgaris L.) are made in the form of gel preparations.

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The increasing demand for natural-based hair dyes has driven the development of new formulations that are both safe and effective. Beta vulgaris (red beet) is known to contain betacyanin, a natural pigment with a reddish-purple color; however, its application as a hair dye remains limited. Previous studies have predominantly explored the use of Beta vulgaris in the food industry rather than in cosmetics. Moreover, most natural hair dyes currently available are formulated as pastes or oils, which are often less practical and less stable.

This study is unique in that it develops a gel formulation using a combination of HPMC and Carbopol 940 bases, optimized to enhance physical stability, ease of application, and hair coloring effectiveness. This approach is expected to produce a natural hair dye that is more user-friendly, with improved consistency and minimal irritation potential, compared to conventional formulations.

2. RESEARCH METHODS

2.1 Research Procedures and Framework

The research conducted was an experimental study, namely post-harvest handling in the form of taking red beetroot, determining red beetroot, making red beetroot juice, phytochemical screening of red beetroot juice, Formulation of hair dye gel preparations and evaluation of hair dye preparations. Testing the stability of the preparation using the Cyling test method. Irritation test and Hedonic test.

2.1.1 Tools

The tools used are dropper pipettes, watch glasses, label paper, stirring rods, laboratory glassware, spatulas, digital scales, slides, 125 g round glass weights, filter paper, plastic pots, rotary evaporators, mortars, pestles, pH meters, blenders, ovens, refrigerators, hot plates, aluminum foil, and Brookfield viscometers.

2.1.2 Materials

In this study, the materials used are red beet juice (Beta vulgaris L.), Carbopol 940, HPMC, Triethanolamine (TEA), Propylene glycol, Methyl paraben (Nipagin), Propyl paraben (Nipasol), Ascorbic acid, Aquades, HCl, Mayer's reagent, Bouchardat's reagent, Dragendorf's reagent, FeCl3, Petroleum ether, Mg powder, anhydrous acetic acid, concentrated H_2SO_4 and Bleaching.

2.1.3 Sample

Sampling was carried out using purposive sampling, the sample used in this study was red beetroot (Beta vulgaris L.) with fresh fruit criteria, namely non-wrinkled skin purchased at Peunayong market, Kuta Alam District, Banda Aceh City.

2.2 Research procedure

2.2.1 Determination

Determination of red beetroot (Beta vulgaris L.) plants used as samples in this study was conducted at the Biology Research Center, Indonesian Institute of Sciences (LIPI) Bogor. The purpose of this determination is to determine the truth of the identity of the plants that will be used in this study.

2.2.2 Preparation of red beet juice

Fresh red beet (Beta vulgaris L.) as many as 5 pieces, wet sorted, washed, and drained (BPOM RI, 2013). Fresh red beet is cut into pieces then extracted to obtain beet juice using a juicer. Then the juice obtained is weighed.

2.2.3 Phytochemical screening of red beet juice

The phytochemical screening analysis conducted in this study was a qualitative analysis. This analysis was conducted to determine the compounds contained in red beet. Testing includes alkaloids, tannins, flavonoids, saponins, steroids/triterpenoids (Bouslamti et al., 2023);(Darkwah et al., 2020).

2.2.4 Formulation of hair dye gel preparation

The gel formulation in this study refers to the formulation that has been carried out in the study of (Sutriningsih et al., 2017) namely "Effectiveness Test and Irritation Test of Hair Dye Gel from Papaya Seed Extract (Caricia papaya L.)" which can be seen in the Table 1 below (Sutriningsih et al., 2017):

Table 1. Hair coloring gel formulation

Material	Fomulas (% b/b)		
	F1	F2	F3
Papaya seed extract	2	3	4
Carbopol 940	1	1	1
Glycerin	5	5	5
Triethanolamine	2	2	2

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Methyl paraben	0,02	0,02	0,02
Prophyl paraben	0.08	0.08	0.08
Green tea fragrance	qs	qs	qs
Distilled water (mL)	Ad 100	Ad 100	Ad 100

The formulation of hair dye gel preparation in this study is a modified result referring to the formula of (Sutriningsih et al., 2017). In this study, optimization was first carried out on the basis of a combination of Carbopol 940 with a concentration of 0.5% -2% and HPMC 1% -4% used as seen in Table 2.

Table 2. Optimization formulation of carbopol 940 and HPMC bases

Material	Formulas(% b/b)						
	F1	F2	F3	F4	F5	F6	F7
Carbopol 940	0,25	0,5	0,5	1	1	1,5	2
HPMC	0,25	0,5	1	1	4	2,5	4
Propylene glycol	10	10	10	10	10	10	10
Triethanolamine	2	2	2	2	2	2	2
Methyl paraben	0,02	0,02	0,02	0,02	0,02	0,02	0,02
Prophyl paraben	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Distilled water (mL)	Ad 100	Ad 100	Ad 100	Ad 100	Ad 100	Ad 100	Ad 100

After obtaining the optimal combination base, the base between carbopol 940 (x) and HPMC (y) will be used as a hair dye formula with red beet juice which will be formulated using variations in beet juice concentrations starting from 10%, 20% and 30% as seen in table 3.

Table 3. Formulation of red beetroot juice hair coloring gel

Material	Formulas (% b/b)		
	F1	F2	F3
Red beetroot juice	10	20	30
Carbopol 940	x	x	x
HPMC	y	y	y
Propylene glycol	10	10	10
Triethanolamine	2	2	2
Methyl paraben	0,02	0,02	0,02
Prophyl paraben	0.08	0.08	0.08
BHT	0,19	0,19	0,19
Distilled water (mL)	Ad 100	Ad 100	Ad 100

2.2.5 Procedure to make hair coloring gel

The process of making hair dye gel is initially carried out by dispersing carbopol in hot water. According to(Sari et al., 2019), carbopol must be dispersed in hot water. Otherwise, the consistency of carbopol will be runny. (Sulistyani et al., 2021) stated that the selection of carbopol as a gel base is based on the appearance of the gel produced is a clear gel. After making the carbopol mass, followed by making the HPMC gel base dispersed in water until completely dispersed and becomes a clear and thick liquid (mass 1). Followed by the addition of BHT, nipagin and nipasol, then propylene glycol is added and stirred until homogeneous (mass II). Mass II is mixed into the base that has been developed (mass I), then the remaining aquadest is added, ground to form a homogeneous gel mass. After the gel mass is formed, red beet juice (Beta vulgaris L.) is added. Then add TEA until the pH is stable and add TEA until a homogeneous gel mass is formed. The addition of TEA was carried out because this material (pH 10.5) can neutralize carbopol which is acidic (pH 2.5-4) (Rowe et al., 2009).

2.3 Coloring stability test produced

2.3.1 Coloring of black hair

Black hair is cut and washed with shampoo, hair coloring gel is applied, left for 30 to 1 hour, then rinsed and dried and the color formed is observed.

2.3.2 Coloring of gray hair

Gray hair is cut and washed with shampoo, hair coloring gel is applied, left for 30 to 1 hour, then rinsed and dried and the color formed is observed.

2.3.3 Coloring of bleached hair

2.4 Evaluation of hair dye preparations

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Black hair is cut and washed with shampoo, first the black hair is bleached for 30 minutes, in order to remove the black hair color before coloring, then hair coloring gel is applied, left for 30 to 1 hour, then rinsed and dried and the color formed is observed.

2.4.1 Organoleptic test

Organoleptic test is conducted by visual observation of color, odor and shape (Helen et al., 2011);(Garg et al., 2002).

2.4.2 Spreadability test

Spreadability test is conducted 48 hours after the preparation is made. A total of 1 g of the preparation is placed between two round glasses, then covered with another round glass. Then left for 1 minute and the diameter of the preparation is measured. Then a load of 125 g is given and left for 1 minute. Then the diameter is measured using a ruler and the diameter is recorded, and the average dianeter is calculated (Garg et al., 2002);(Ningtias & Rani, 2022).

2.4.3 Viscosity test

The test was carried out using a digital Brookfield viscometer using spindle number 7 then dipped into the preparation that had been put into a beaker glass, and rotated at a rotational speed of 20 rpm, then the viscosity of the hair dye gel could be read on the viscometer monitor screen (Andini et al., 2017).

2.4.4 pH test

The hair dye gel preparation was weighed as much as 1 g, put into a beaker glass, added 10 mL of distilled water. Then, the pH meter was dipped into the solution until a constant pH was obtained (Murrukmihadi, 2017);(Fitri et al., 2022).

2.5 Stability test (cycling test)

Each hair dye gel preparation formula was put into a plastic pot. The preparation was placed in an oven at a temperature of 45±2˚C for 24 hours, then placed in a freezer at a temperature of -5±2˚C for 24 hours, counted as one cycle. This cycle was carried out 6 times (12 days). Then observations were made on organoleptic parameters (color, shape and odor), homogeneity, spreadability, viscosity, pH of the preparation and syneresis (Patil et al., 2018).

2.6 Irritation test

The irritation test of the preparation was carried out on 30 volunteers. Each volunteer will receive 3 formulations, namely F1, F2, and F3. Testing was carried out with a time interval of 48 hours for each formulation. Volunteer inclusion criteria include: (1) women aged 20-30 years, (2) no history of allergies, and (3) willing to volunteer. Meanwhile, the exclusion criteria include: (1) pregnant women, (2) having tattoos, scars, or sunburn on the skin area to be tested, (3) using antihistamine, immunomodulator, corticosteroid, or cytostatic drugs, (4) irritation on the skin area to be tested or having skin disease, and (5) participating in other similar studies (Ditjen, 1985);(Walker et al., 1997).
The hair dye gel preparation was taken 1 gram, then applied to the inner upper arm skin, and left for 30 minutes. The preparation was then washed, and the irritation reaction was evaluated immediately after the preparation was washed (0 minutes), 24 hours, and 48 hours, by observing the irritation reaction that arose in the form of itching, swelling, or showing no irritation reaction (Walker et al., 1997).

2.7 Hedonic test

Hedonic testing or test of hair dye gel preparations and coloring on black hair, gray hair and bleached hair that has been colored, is carried out based on respondent research on hair dye gel preparations, which are produced by looking at the product, smelling it with the nose, and touching the natural hair dye gel preparation with the fingertips and applying it to the hand. The parameters studied were the form of the preparation, color, aroma, color on black hair, bleached hair and gray hair. Assessment of the preference test was carried out on a numeric scale using a questionnaire, where a value of 5 = very much like (ss), a value of 4 = like (s), a value of 3 = quite like (cs), a value of 2 = less like (ks), a value of 1 = dislike (ts). The respondents involved in this study were 30 people. Panelists were asked to express their personal impressions about the level of preference for hair dye gel preparations (Indonesia, 2006).

2.8 Data Analysis

The data obtained from the questionnaire were tabulated and the preference value for the preparation was determined by finding the average result for each panelist at a 95% confidence level. To calculate the average preference value interval (hedonic test) of each panelist, the following formula is used (National Standardization Agency, 2006):

$$P\left(\bar{x} - \left(1{,}96.\frac{s}{\sqrt{n}}\right)\right) \leq \mu \leq \left(\bar{x} + \left(1{,}96.\frac{s}{\sqrt{n}}\right)\right) \cong 95\% \quad (1)$$

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \qquad S^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n} \qquad s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n}} \quad (2)$$

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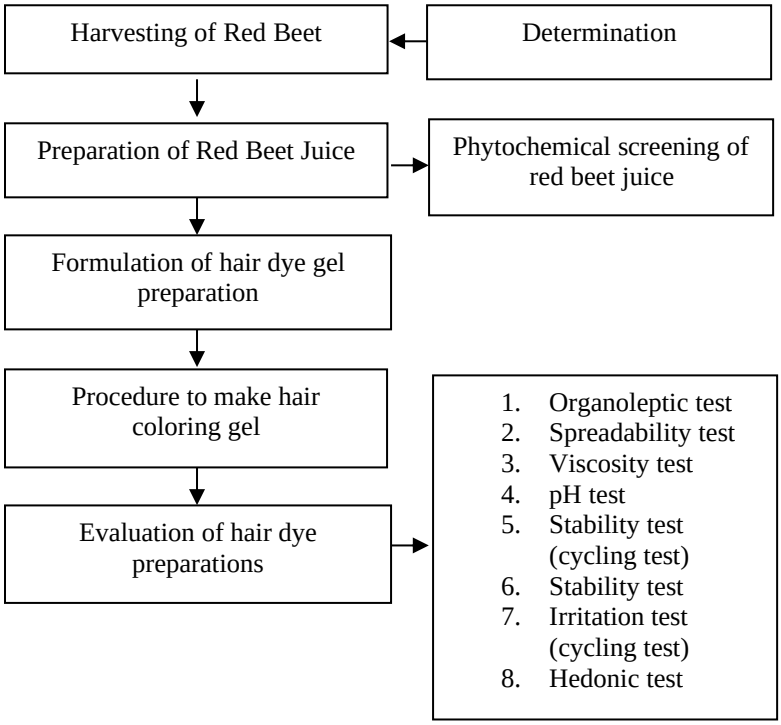
Description:
n = number of panelists
S^2 = diversity of quality values
1.96 = standard deviation coefficient at 95% level
$\bar{x}$ = average quality value
x_i = quality value of panelist i, where I = 1,2,3…..n
s = standard deviation of quality values.

2.9 Research Framework

Figure 1 below is the framework of the research.



Gambar 1. Research Framework

2.10 Research Variables

Table 4 below is a table of variables used in the research.

Table 4. Research Variables

Variable Type	Variable Name	Operational Definition
Independent variable	Concentration of HPMC and Carbopol 940	Different concentrations of HPMC and Carbopol 940 (10%, 20% and 30%)
Dependent variable	Gel characteristics and dyeing effectiveness	Spreadability, Viscosity and pH for gel characteristics dyeing effectvity: Coloring of black hair, grey hair and bleached hair
Controlled variable	Preparation method	Standardized method for mixing and preparing the gel to ensure consistency across formulations

3. RESULT AND DISCUSSION

3.1 Sample Determination and Juice Production

Identification of the sample at the Indonesian Institute of Sciences (LIPI), Bogor, confirmed the plant material as red beetroot (Beta vulgaris L.) from the Amaranthaceae family. A total of 295 grams of fresh red beetroot was processed via wet sorting, washing, draining, cutting, and juicing. The resulting juice yield was 114.43 grams, equivalent to

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55.76%, which aligns with previous findings by (Odoh et al., 2012) indicating a high juice yield due to the water-rich nature of beetroot tubers.

3.2 Phytochemical Screening

Phytochemical analysis revealed the presence of alkaloids, tannins, flavonoids, and saponins, while steroids/triterpenoids were absent. These results corroborate prior research by (Odoh et al., 2012) and reinforce the functional potential of red beetroot as a natural source of bioactive compounds with possible antioxidant and anti-inflammatory benefits. However, unlike earlier studies that emphasized only qualitative screening, this study underscores specific reagent interactions and visual indicators to validate secondary metabolite presence (e.g., Bouchardat's reagent for alkaloids). The results of the phytochemical test can be seen in Table 5 below.

Table 5. Results of phytochemical screening of red beetroot juice (Beta vulgaris L.)

Phytochemical screening	Reagent	Indication	Conclution
Alkaloids	Bouchardat's	+	Chocolate and sediment
	Mayer's	−	no sediment
	Dragendorff's	+	Orange and sediment
Tannins	$FeCl_3$ 10%	+	Dark green
Flavonoid	Mg + HCl concentrated	−	Red
	NaOH + HCl concentrated	+	Faded Brass Green
Saponnins	Hot water and HCl 2N	+	Foamy
Steroid/triterpenoid	Acetic anhydride and H_2SO_4	−	Purple

Description: (+) There are secondary metabolite compounds
(-) There are no secondary metabolite compounds

3.3 Hair Dye Gel Formulation Development

A hair dye gel was formulated using a modified version of (Sutriningsih et al., 2017) substituting papaya extract with red beetroot juice. Furthermore, to enhance the physicochemical stability of the gel, a dual polymer base of Carbopol 940 and HPMC was optimized. Carbopol provides desirable viscosity and dispersion, while HPMC improves film formation and bioadhesion ((Rowe et al., 2009); (Kumar et al., 2024).

3.4 Optimization of Gel Base

Seven combinations of Carbopol 940 and HPMC were evaluated for spreadability, pH, homogeneity, and organoleptic characteristics. Formulation F3 (Carbopol 0.5%, HPMC 1%) exhibited optimal properties, including satisfactory spreadability (6.7 cm) and pH (5.73), which is within the safe scalp pH range (4.5–6.5) (Nurhikma et al., 2018) the formulation for making red beetroot (Beta vugaris L.) hair dye gel can be seen in Table 6 below.

Table 6. Hair coloring gel preparation formulas

Material	Formulas (% b/b)		
	F1	F2	F3
Red beetroot juice	10	20	30
Carbopol 940	0,5	0,5	0,5
HPMC	1	1	1
Propylene glycol	10	10	10
Triethanolamine	0,19	0,19	0,19
Methyl paraben	0,02	0,02	0,02
Prophyl paraben	0.18	0.18	0.18
Distilled water (mL)	Ad 100	Ad 100	Ad 100

3.5 Effect of Red Beetroot Juice Concentration

Three concentrations (10%, 20%, and 30%) were tested. Increased concentration resulted in a more intense coloration of the gel, with F3 showing the deepest purple hue. However, instability was observed when ascorbic acid was used as an antioxidant; oxidation led to discoloration within 2–3 hours. Replacing ascorbic acid with BHT extended stability up to 5 days. This outcome affirms findings by (Patil et al., 2018) on the oxidative lability of betacyanin pigments.

3.6 Stability Analysis (Cycling Test)

The cycling test simulated accelerated storage conditions to evaluate product stability. Post-cycling, minor changes were noted in viscosity (e.g., F1 increased from 8171.75 to 13,673.34 cPs), attributable to thermal gel swelling (Hassan & Peppas, 2000). Despite the viscosity increase, all formulations retained spreadability within the semifluid range (>5 cm, <7 cm). No syneresis or organoleptic inconsistency was detected, signifying formulation robustness.

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3.7 Comparative Performance on Hair Types

Color retention was tested on black, gray, and bleached hair. In agreement with prior studies on melanin interference (Hidayat et al., 2024) no color retention was observed on pigmented hair. However, mild color adherence occurred in bleached hair after initial application, but faded with subsequent washes. This suggests betacyanin adherence is not long-lasting and may require modification for improved substantivity.

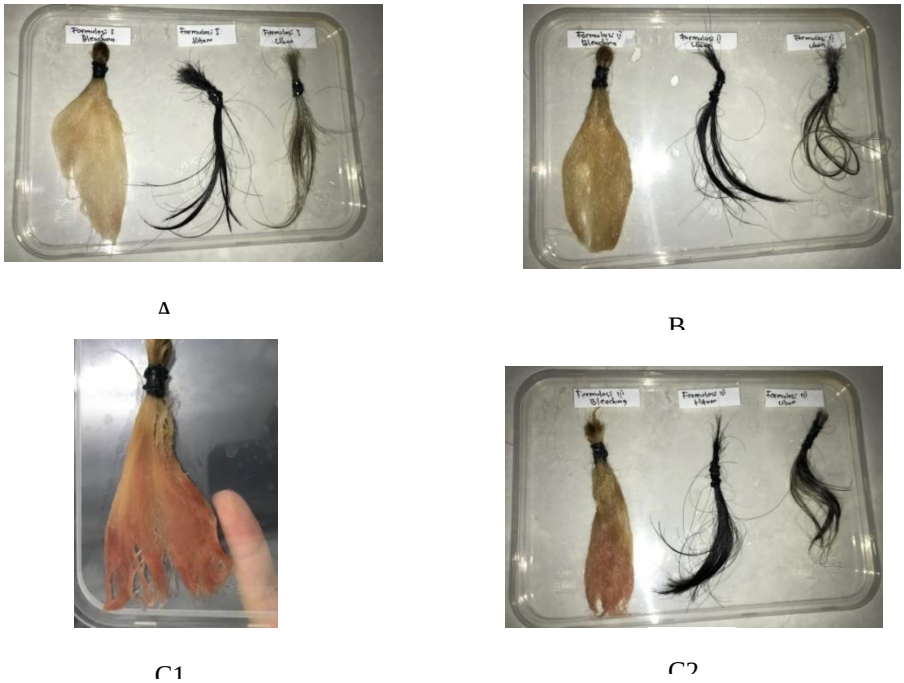

Figure 2. Coloring of hair samples: (A) Coloring using formula 1; (B) Coloring using formula 2; (C) Coloring using formula 3: (C1) First wash; (C2) 2nd and 3rd wash

3.8 Safety and Acceptance Evaluation (Irritation dan Hedonic Test)

The irritation test on 30 volunteers showed no adverse reactions, confirming dermal safety. Hedonic testing revealed moderate acceptance in terms of appearance and aroma, with lower scores in hair coloration, highlighting an area for enhancement, particularly in improving dye adherence and color fastness.

3.9 Recommendations for Future Work

Further formulation refinement is needed to enhance color substantivity, possibly via inclusion of mordant agents or pH modifiers. A quantitative assessment of pigment degradation kinetics under various storage conditions is also recommended.

3.10 References Enhancement

In the revised discussion, more specific and updated sources (Kumar et al., 2024); (Hidayat et al., 2024) have been integrated to provide a more relevant and current context, improving the scientific depth of comparison and critical analysis.

4. CONCLUSION

This study developed a hair dye gel using red beetroot (Beta vulgaris L.) and a Carbopol 940-HPMC base, with F3 (30% juice) showing optimal performance in terms of spreadability, pH, and homogeneity. BHT enhanced pigment stability, retaining color for up to 5 days. The gel offers a natural, antioxidant-rich alternative to synthetic dyes. However, the formulation showed weak color retention on pigmented hair and limited long-term stability. Future studies should focus on improving dye substantivity using natural mordants or encapsulation methods and expanding trials to diverse hair types to support wider cosmetic application.

REFERENCE

Andini, T., Yusriadi, Y., & Yuliet, Y. (2017). Optimasi pembentuk film polivinil alkohol dan humektan propilen glikol pada formula masker gel peel off sari buah labu kuning (Cucurbita moschata duchesne) sebagai antioksidan. *Jurnal Farmasi Galenika (Galenika Journal of Pharmacy)(e-Journal)*, *3*(2), 165–173.

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https://ejurnal.seminar-id.com/index.php/jharma

Bouslamti, M., Elrherabi, A., Loukili, E. H., Noman, O. M., Mothana, R. A., Ibrahim, M. N., Abdnim, R., Slighoua, M., Bouhrim, M., & Bnouham, M. (2023). Phytochemical Profile, Antilipase, Hemoglobin Antiglycation, Antihyperglycemic, and Anti-Inflammatory Activities of Solanum elaeagnifolium Cav. *Applied Sciences*, *13*(20), 11519.

Darkwah, W. K., Koomson, D. A., Miwornunyuie, N., Nkoom, M., & Puplampu, J. B. (2020). Review: Phytochemistry and medicinal properties of *Solanum torvum* fruits. *All Life*, *13*(1), 498–506.

Ditjen, P. O. M. (1985). Formularium kosmetika indonesia. *Jakarta: Departemen Kesehatan RI. Hal*, *83*(85), 106–132.

Fitri, R., Syahputra, H. D., Nasri, N., Kaban, V. E., & Rani, Z. (2022). FORMULATION OF A BIOCELLULOSE MASK CONTAINING THE ESSENCE OF ALOE VERA (L.) BURM. F COMBINATION WITH VITAMIN E AS ANTI-AGING. *ScienceRise: Pharmaceutical Science*, *40*(6).

Garg, A., Aggarwal, D., Garg, S., & Sigla, A. K. (2002). *Spreading of Semisolid Formulation: An Update, Pharmaceutical Tecnology, September 2002, 84-102*.

Helen, I., Hadinoto, I., Hadisoewignyo, L., & Soegianto, L. (2011). Effect of various concentration of vegetable protein in hair mask on the hair texture. *Indonesian Journal of Cancer Chemoprevention*, *2*(1), 159–168.

Hidayat, D. H. Z., Fahmi, A. M., Mubiyna, F., Suri, C. A. M. P., Bagaskara, M., & Maharani, A. F. (2024). The Effect Of Natural Dye Extract From Beetroot (Beta Vulgaris L.) On The Quality Of Lip Tint Cosmetic Products. *Jurnal EduHealth*, *15*(01), 730–734.

Indonesia, S. N. (2006). Petunjuk pengujian organoleptik dan atau sensori. *Badan Standar Nasional*. .

Kaba, B., Zannou, O., Ali Redha, A., & Koca, I. (2024). Enhancing extraction of betalains from beetroot (Beta vulgaris L.) using deep eutectic solvents: Optimization, bioaccessibility and stability. *Food Production, Processing and Nutrition*, *6*(1), 38.

Kumar, L., Chadha, M., Rana, R., Kukreti, G., Kaundal, A. K., Aggarwal, V., & Vij, M. (2024). Polymeric microsponges: An emerging prospect in topical delivery of therapeutic agents. *International Journal of Polymeric Materials and Polymeric Biomaterials*, *73*(11), 1003–1019.

Murrukmihadi, M. (2017). Pengaruh Penambahan Carbomer 934 Dan Setil Alkoholsebagai Emulgator Dalam Sediaan Krim Ekstrak Etanolik Bunga Kembang Sepatu (Hibiscus Rosa-sinenis L.) Terhadap Sifat Fisik Dan Aktivitas Antibakteri Pada Staphylococcus Aureus. *Indonesia Natural Research Pharmaceutical Journal*, *2*(2), 131–140.

Ningtias, A., & Rani, Z. (2022). Formulasi Sediaan Pewarna Pipi dalam Bentuk Padat dengan Menggunakan Ekstrak Buah Buni (Antidesma bunius (L.) Spreng). *INSOLOGI: Jurnal Sains Dan Teknologi*, *1*(4), 448–460.

Nurhikma, E., Antari, D., & Tee, S. A. (2018). Formulasi Sampo Antiketombe Dari Ekstrak Kubis (Brassica oleracea Var. Capitata L.) Kombinasi Ekstrak Daun Pandan Wangi (Pandanus amaryllifolius Roxb). *Jurnal Mandala Pharmacon Indonesia*, *4*(1), 61–67.

Odoh, U., Ezugwu, C., & Okoro, E. (2012). Quantitative phytochemical, proximate/nutritive composition analysis of Beta Vulgaris Linnaeus (Chenopodiceae). *Planta Medica*, *78*(11), s-0032-1320803. https://doi.org/10.1055/s-0032-1320803

Parmadi, A., & Pratama, B. (2020). *Uji Efektivitas Krim Ekstrak Etanol Daun Iler (Coleusatropurpureusl. Benth) Terhadap Penyembuhan Luka Pada Mencit*.

Patil, A., Bhide, S., Bookwala, M., Soneta, B., Shankar, V., Almotairy, A., Almutairi, M., & Narasimha Murthy, S. (2018). Stability of Organoleptic Agents in Pharmaceuticals and Cosmetics. *AAPS PharmSciTech*, *19*(1), 36–47. https://doi.org/10.1208/s12249-017-0866-2

Rao, R. K. (2006). *Food security*.

Rowe, R. C., Sheskey, P., & Quinn, M. (2009). *Handbook of pharmaceutical excipients*. Libros Digitales-Pharmaceutical Press.

Sari, W. P., Gaya, M. L., Irianto, G., & Karima, N. (2019). Managemen Topikal Anti-Aging pada Kulit. *Medical Profession Journal of Lampung*, *9*(2), 228–234.

Sayuti, N. A. (2016). Aktivitas Penumbuh Rambut Mikroemulsi Kombinasi Ekstrak Daun Waru (Hibiscus tiliaceus L) dan Asam Jawa (Tamarindus indica L). *Prosiding Nasional APIKES-AKBID Citra Medika Surakarta*, *1*(1), 29–39.

Shapiro, J., Sicco, K. L., Otberg, N., Cummins, D., & Tuan, H.-H. (2024). *Hair loss and restoration*. CRC Press. Singh, R. K., Ruj, B., Sadhukhan, A. K., & Gupta, P. (2019). Thermal degradation of waste plastics under non-sweeping atmosphere: Part 1: Effect of temperature, product optimization, and degradation mechanism. *Journal of Environmental Management*, *239*, 395–406.

Stefanov, S. R., & Andonova, V. Y. (2021). Lipid nanoparticulate drug delivery systems: Recent advances in the treatment of skin disorders. *Pharmaceuticals*, *14*(11), 1083.

Sutriningsih, S., Sagala, Z., & Meliana, M. (2017). Uji Efektivitas Dan Uji Iritasi Gel Pewarna Rambut Dari Ekstrak Biji Buah Pepaya (Carica papaya L). *Jurnal Muara Sains, Teknologi, Kedokteran Dan Ilmu Kesehatan*, *1*(1), 59–66.

Tranggono, I. R., & Latifah, F. (2014). Buku Pegangan Dasar Kosmetologi: Kosmetik Dekoratif. *Jakarta: PT. Gramedia Pustaka Utama*.

Walker, A. P., Basketter, D. A., Baverel, M., Diembeck, W., Matthies, W., Mougin, D., Röthlisberger, R., & Coroama, M. (1997). Test guidelines for the assessment of skin tolerance of potentially irritant cosmetic ingredients in man. *Food and Chemical Toxicology*, *35*(10–11), 1099–1106.

Wang, S., Kang, Y., Qi, F., & Jin, H. (2023). Genetics of hair graying with age. *Ageing Research Reviews*, *89*, 101977.

Wardiyah. (2016). Kimia Organik. In *Pusat Pendidikan Sumber Daya Manusia Kesehatan*. Kementerian Kesehatan Republik Indonesia Jakarta.