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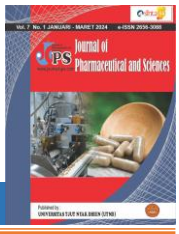

Study on the utilization of jamblang (*Syzygium cumini* L.) bark extract as a herbal-based alternative hair dye

Studi pemanfaatan ekstrak kulit batang jamblang (*Syzygium cumini* L.) sebagai alternatif pewarna rambut berbasis herbal

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Abstract

Hair dye is a cosmetic product used to restore or alter hair colour. Research on herbal-based hair dyes has expanded with the growing interest in natural ingredients. The bark of the jamblang tree (*Syzygium cumini* L.), which produces a black pigment, has long been utilised in various crafts. This potential makes it a candidate for natural hair dye. This study examines the use of ethanol extract from jamblang bark in the formulation of herbal hair dye and its effectiveness in producing a black colour. The research aims to investigate the utilization of ethanol extract from jamblang bark (*Syzygium cumini* L.) as an herbal hair dye. The focus is on evaluating the extract's effectiveness in a formulation with pyrogallol, copper (II) sulfate, and xanthan gum, as well as determining the optimal concentration to achieve black hair colour. The method for preparing the hair dye formulation involved the use of ethanol extract from jamblang bark in varying concentrations of 5%, 7.5%, 9.5%, and 11.5%, with the addition of 2% each of pyrogallol, copper (II) sulfate, and xanthan gum. Distilled water was used as the solvent. The dyeing process was conducted by immersing 200 strands of grey hair in preparation for 4 hours, followed by visual observation of colour changes. Colour stability was tested through 15 wash cycles and exposure to sunlight for 5 hours. An irritation test was also conducted on volunteers to evaluate the safety of the hair dye preparation. The study's results indicate that increasing the concentration of ethanol extract from jamblang bark affects the effectiveness of hair dyeing. The optimal formulation was achieved at a 7.5% extract concentration with the addition of 2% pyrogallol, 2% copper (II) sulfate, and 2% xanthan gum, which resulted in black colour. Stability tests showed that the colour remained unchanged after 15 wash cycles and 5 hours of sunlight exposure. Furthermore, the irritation test on volunteers demonstrated that the preparation did not cause skin irritation reactions. Thus, the ethanol extract of jamblang bark has the potential to serve as a safe natural hair dye, offering good colour stability and effectiveness in darkening grey hair.

Keywords*: *Jamblang Extract, Herbal Hair Dye, Hair Color Stability, Hair Dye Formulation.

Abstrak

Pewarna rambut adalah kosmetik yang digunakan untuk mengembalikan atau mengubah warna rambut. Dengan meningkatnya minat terhadap bahan alami, penelitian pewarna rambut berbasis herbal semakin berkembang. Kulit batang jamblang (*Syzygium cumini* L.) yang menghasilkan pigmen hitam telah lama dimanfaatkan dalam berbagai kerajinan. Potensi ini menjadikannya kandidat pewarna rambut alami. Penelitian ini mengkaji pemanfaatan ekstrak etanol kulit batang jamblang dalam formulasi pewarna rambut herbal serta efektivitasnya dalam menghasilkan warna hitam. Penelitian ini bertujuan untuk mengkaji pemanfaatan ekstrak etanol kulit batang jamblang (*Syzygium cumini* L.) sebagai pewarna rambut herbal. Fokusnya adalah mengevaluasi efektivitas ekstrak dalam formulasi dengan pirogalol, tembaga (II) sulfat, dan xanthan gum serta menentukan konsentrasi optimal untuk menghasilkan warna hitam pada rambut. Metode pembuatan sediaan pewarna rambut diformulasikan dengan ekstrak etanol kulit batang jamblang dalam

variasi konsentrasi 5%, 7,5%, 9,5%, dan 11,5%, serta tambahan pirogalol, tembaga (II) sulfat, dan xanthan gum masing-masing sebesar 2%. Akuades digunakan sebagai pelarut. Pewarnaan dilakukan dengan merendam 200 helai rambut uban dalam sediaan selama 4 jam, diikuti dengan observasi perubahan warna secara visual. Stabilitas warna diuji melalui 15 kali pencucian serta paparan sinar matahari selama 5 jam. Uji iritasi juga dilakukan pada sukarelawan untuk mengevaluasi keamanan sediaan pewarna rambut. Hasil penelitian mengindikasikan bahwa peningkatan konsentrasi ekstrak etanol kulit batang jamblang berpengaruh terhadap efektivitas pewarnaan rambut. Formulasi optimal diperoleh pada konsentrasi ekstrak 7,5% dengan tambahan pirogalol 2%, tembaga (II) sulfat 2%, dan xanthan gum 2%, yang menghasilkan warna hitam. Uji stabilitas menunjukkan bahwa warna tetap bertahan tanpa perubahan signifikan setelah 15 kali pencucian serta paparan sinar matahari selama 5 jam. Selain itu, uji iritasi pada sukarelawan membuktikan bahwa sediaan ini tidak menimbulkan reaksi iritasi pada kulit. Dengan demikian, ekstrak etanol kulit batang jamblang berpotensi sebagai pewarna rambut alami yang aman, memiliki stabilitas warna yang baik, serta efektif dalam mempergelap warna uban.

Kata Kunci: *Ekstrak Jamblang, Pewarna Rambut Herbal, Stabilitas Warna Rambut, Formulasi Pewarna Rambut.*

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Introduction

Hair is a structure that grows from hair roots located within the dermal layer of the skin and extends outward through hair follicles. The part of the hair that emerges from the skin is called the hair shaft (Tranggono and Latifah, 2007). Hair functions as a crown (ornament) and also serves as protection against various stimuli. Firstly, it acts as a barrier against physical stimuli such as heat, cold, humidity, and sunlight. Secondly, it protects against mechanical stimuli such as blows, friction, and pressure. Thirdly, it provides protection against chemical stimuli, including exposure to various chemical substances and sweat (Bariqina and Ideawati, 2001).

Hair color is determined by melanin pigment present in the cortex layer of the hair. The pigment originates from melanocytes located in the hair bulb. Melanocytes are cells that produce pigments (coloring substances), which give natural hair its various shades (Bariqina and Ideawati, 2001). The sequence of pigments determining hair color, from the lightest to the darkest, includes blonde, red, light brown, dark brown, and black.

Blonde hair contains a mix of red and yellow pigments. Red hair contains a combination of red and black pigments. Light brown hair has red, brown, and black pigments. Dark brown hair contains more black pigment than light brown hair. Black hair contains only black pigment (Tranggono and Latifah, 2007). As individuals age, their hair color changes to white, a transformation often considered undesirable (Wasitaatmadja, 1997). Hair color can be artificially altered using hair dye, commonly known in Indonesia as "semir rambut," which is applied to white or gray hair to maintain a black appearance (Tranggono and Latifah, 2007). Hair dye preparations are cosmetic products used in hair styling to either restore natural hair color or change it to a new shade. The desire to color hair has existed since ancient times, with natural ingredients

historically being used as coloring agents. These substances were primarily derived from plants and were intended to enhance personal appearance (Ditjen POM, 1985).

One of the natural materials frequently used as a dye for various handicrafts, such as ceramics and woven mats, is jamblang bark (*Syzygium cumini* L.), which produces a black pigment. Utilizing jamblang as a dye can expand the variety of natural colorants available and enhance the usefulness of the plant (Anonymous, 2008). Based on previous research findings, further development and innovation are needed in utilizing *Syzygium cumini* L. bark extract as a natural hair dye. Given the growing interest in herbal-based coloring agents and the potential of *Syzygium cumini* to produce a stable black pigment, this study is crucial for exploring the optimal formulation and its effectiveness in hair coloring. Furthermore, this research aims to expand alternatives for hair dyes that are safer, environmentally friendly, and possess good color durability. Jamblang (*Syzygium cumini* L.) is a tree that can be used as a natural dye, with its fruits, bark, seeds, and leaves containing pigments (Mukhlis, 2009). It is a tropical plant commonly found in regions such as Aceh, Indonesia. Traditionally, jamblang has primarily been utilized for its edible fruit, which has a tart, sour, and sweet taste.

Research Methodology

Tools and Materials Used

The tools used in this research include volumetric flasks, an analytical balance, stirring rods, tweezers, thread, wool, parchment paper, scissors, roll tissue, cotton buds, a drying cabinet, and a rotary evaporator. Meanwhile, the materials used in this research include jamblang bark, pyrogallol, copper (II) sulfate, 70% ethanol, shampoo, and gray hair.

Sample Processing

A total of 5 kg of fresh jamblang bark (*Syzygium cumini* L.) was thoroughly washed and drained, then cut into small pieces and dried in a drying cabinet at approximately 45°C until completely dry. The dried samples were then stored in a dry place.

Preparation of Jamblang Bark Extract

The extract of jamblang bark was obtained through the percolation method using 70% ethanol as the solvent. A total of 500 g of jamblang bark simplicia was soaked in 1 liter of 70% ethanol for 3 hours. The mixture was then gradually transferred into a percolator, and additional 70% ethanol was added until the simplicia was fully submerged, leaving a thin layer of solvent on top. The percolator was then sealed with aluminum foil and left undisturbed for 24 hours. After the soaking process, the percolator valve was opened, allowing the extract to drip at a rate of 20 drops per minute. During this process, 70% ethanol was periodically added, ensuring that the addition rate matched the percolate drip rate so that a consistent layer of solvent remained above the simplicia. The percolation process was stopped when the last 1 mL of collected percolate was colorless and left no residue after evaporation. The obtained extract was then evaporated under low pressure using a rotary evaporator at a temperature not exceeding 50°C until a thick extract was formed. This extract was further dried using the freeze-drying method to obtain the final jamblang bark extract (Ditjen POM, 1979; Ministry of Health RI, 1995).

Preparation of Standard Formula (Indonesian Cosmetic Formulary)

The selected formula was based on the standard formula found in the 1985 Indonesian Cosmetic Formulary.

Standard Formula

Composition	**Formula**		
	Light Brown -	**Dark Brown**	**Black**
Henna Powder	30	38	73
Pyrogallol	5	10	15
Copper (II) Sulfate	5	7	15

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Orientation for determining the concentration of auxiliary materials used

The jamblang bark extract was formulated into a liquid hair dye preparation with varying concentrations, incorporating auxiliary ingredients such as pyrogallol, copper (II) sulfate, and xanthan gum. Before developing the hair dye formula, an orientation phase was conducted to determine the appropriate concentration of auxiliary ingredients, ensuring that the pyrogallol concentration did not exceed 5%.

The extract was then mixed with pyrogallol, copper (II) sulfate, and xanthan gum at concentrations of 1% and 2%, followed by the addition of distilled water to complete the formulation. A bundle of 100 gray hair strands, each measuring 5 cm in length, was placed in a beaker glass containing 25 mL of the prepared test solution. The hair strands had been pre-washed with shampoo and dried. The mixture was left for 4 hours before the hair strands were removed, washed, and visually examined for color changes. The results were then compared to a standard hair color classification chart.

Based on observations, the mixture that produced a brown color on gray hair consisted of a 5% extract concentration with 1% pyrogallol, 1% copper (II) sulfate, and 1% xanthan gum. Following these orientation findings, hair dye formulations were prepared using jamblang bark extract at concentrations of 5%, 7.5%, 9.5%, and 11.5%, combined with 1% each of copper (II) sulfate and xanthan gum.

The composition of the formulated hair dye

Komposisi	Formula			
	A	B	C	D
Jamblang Bark Extract	5%	7,5%	9,5%	11,5%
Pyrogallol	1%	1%	1%	1%
Copper (II) Sulfate	1%	1%	1%	1%
Xanthan Gum	1%	1%	1%	1%
Add Distilled Water (ml)	100	100	100	100

Description:

- **A**: Formula with 5% jamblang bark extract concentration, 1% pyrogallol, 1% copper (II) sulfate, and 1% xanthan gum.
- **B**: Formula with 7% jamblang bark extract concentration, 1% pyrogallol, 1% copper (II) sulfate, and 1% xanthan gum.
- **C**: Formula with 9.5% jamblang bark extract concentration, 1% pyrogallol, 1% copper (II) sulfate, and 1% xanthan gum.
- **D**: Formula with 11.5% jamblang bark extract concentration, 1% pyrogallol, 1% copper (II) sulfate, and 1% xanthan gum.

Pyrogallol, copper (II) sulfate, jamblang bark extract, and xanthan gum were mixed in a mortar and ground until a homogeneous consistency was achieved. The mixture was then transferred into a beaker glass and diluted with distilled water to a final volume of 100 mL.

Testing on Gray Hair

Four bundles of gray hair, each consisting of 100 strands cut to approximately 5 cm in length and pre-washed with shampoo, were immersed in the prepared hair dye formulation. The immersion process was conducted for 1 to 4 hours, with one bundle removed every hour. The extracted hair strands were then washed, separated, and visually observed to assess the color changes corresponding to the duration of immersion.

Hair Color Observation

Color assessment was performed on gray hair strands that had been immersed in each formulation for 1 to 4 hours. The resulting hair color was compared across different immersion times to evaluate the effectiveness of the dyeing process.

Color Stability Against Washing

After the visual assessment, the formulation that produced the most optimal hair color change was selected. To evaluate color stability, hair strands that had been immersed for 4 hours were washed using shampoo and subsequently dried. The washing process was repeated 15 times, and any changes in hair color post-wash were carefully observed.

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Color Stability Against Sunlight Exposure

Dyed gray hair strands, prepared using the selected formulation and immersion duration, were washed, rinsed thoroughly, and then exposed to direct sunlight for 5 hours, from 10:00 AM to 3:00 PM WIB. The hair color was then examined to determine any changes due to sun exposure.

Irritation Test

The irritation test was conducted on volunteers who were closely associated with the researcher, allowing for easier monitoring of potential skin reactions. The inclusion criteria for volunteers were based on the guidelines from the Directorate General of Drug and Food Control (Ditjen POM, 1985) and were as follows:

1. Healthy female individuals
2. Aged between 20-30 years
3. No history of allergy-related diseases
4. Willing to participate as volunteers

The procedure began by cleansing the volunteer's skin and marking a 3 cm diameter circle behind the ear using a marker to ensure consistency in the testing area. The prepared hair dye was carefully applied to the marked area using a cotton bud, ensuring even coverage, and was left undisturbed for 24 hours. Observations were systematically conducted every 4 hours to monitor potential skin reactions, such as redness, swelling, or irritation. The recorded responses were categorized based on the classification criteria established by Scott et al. (1976) and Ditjen POM (1985) to evaluate the safety and potential allergenic effects of the formulation.

Reaction	Observation
0	No reaction
+	Erythema
++	Erythema and papules
+++	Erythema, papules, and vesicles
++++	Edema and vesicles

This structured approach ensured the systematic evaluation of the hair dye's efficacy, color stability, and potential irritation effects.

Results and Discussion

The orientation was conducted using a formulation of 5% jamblang bark extract with variations of auxiliary ingredients, namely pyrogallol, copper (II) sulfate, and xanthan gum, each at concentrations of 1% and 2%. Each mixture was used to soak 200 strands of gray hair for 4 hours, after which the hair was removed and observed for color changes.

Table 1. Results of the Orientation on the Use of Color-Developing Auxiliary Materials

No	Formula	Color
1	Jamblang bark extract 5% + pyrogallol 1% + copper (II) sulfate 1% + xanthan gum 1%	Medium Brown
2	Jamblang bark extract 5% + pyrogallol 2% + copper (II) sulfate 2% + xanthan gum 2%	Dark Brown

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Jamblang bark extract 5% + pyrogallol 1% + copper (II) sulfate 1% + xanthan gum 1%

Jamblang bark extract 5% + pyrogallol 2% + copper (II) sulfate 2% + xanthan gum 2%

Figure 1. Results of the orientation on color-developing auxiliary materials

Figure 1 illustrates that the increase in the concentration of auxiliary materials is directly proportional to the darkness of the color produced on gray hair. At a concentration of 1%, the resulting color is light brown. Therefore, the formulation of the hair dye utilizes pyrogallol, copper (II) sulfate, and xanthan gum, each at a concentration of 2%, to achieve the desired dark brown color.

Evaluation of the hair dye formulation was conducted through several tests, including the effect of varying concentrations of jamblang bark extract on the dyeing of gray hair, the effect of immersion duration on color intensity, and the impact of adding and combining various auxiliary materials on the color change of gray hair. The tests were performed using different concentrations of jamblang bark powder combined with dye auxiliary materials, each at a concentration of 1%. The results of the tests are presented in Table 2 and Figure 2.

Table 2. Results of observations on the effect of jamblang bark extract concentration on gray hair color

No	Formula	Results of Gray Hair Dyeing
1	Jamblang bark extract 5% + pyrogallol 1% + copper (II) sulfate 1% + xanthan gum 1%%	Brown (Level 5)
2	Jamblang bark extract 7.5% + pyrogallol 1% + copper (II) sulfate 1% + xanthan gum 1%	Brown (Level 4)
3	Jamblang bark extract 9.5% + pyrogallol 1% + copper (II) sulfate 1% + xanthan gum 1%	Dark Brown (Level 3)
4	Jamblang bark extract 11.5% + pyrogallol 1% + copper (II) sulfate 1% + xanthan gum 1%	Dark Brown (Level 2)

Brown (Level 5) Jamblang bark extract 5% + pyrogallol 1% + copper (II) sulfate 1% + xanthan gum 1%%

Brown (Level 4) Jamblang bark extract 7.5% + pyrogallol 1% + copper (II) sulfate 1% + xanthan gum 1%

Dark Brown (Level 3) Jamblang bark extract 9.5% + pyrogallol 1% + copper (II) sulfate 1% + xanthan gum 1%

Dark Brown (Level 2) Jamblang bark extract 11.5% + pyrogallol 1% + copper (II) sulfate 1% + xanthan gum 1%

Figure 2. Results of observations on the effect of jamblang bark extract concentration on hair dyeing

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Table 2 and Figure 2 indicate that the increase in the concentration of jamblang bark extract in the hair dye formulation is directly proportional to the intensity of the color produced on gray hair. The formulation with the lowest extract concentration, which is 5%, yields a medium brown color, while the formulation with a concentration of 7.5% produces a light brown color. Formulations with concentrations of 9.5% and 11.5% yield similar results, producing a light brown color. Based on these results, it can be concluded that the optimal formulation to achieve a light brown color on gray hair is the jamblang bark extract at 7.5%, as it does not show significant differences compared to the higher concentration formulations.

The observations regarding the effect of jamblang bark extract (EKBJ) concentration in the hair dye formulation indicate that the optimal concentration for producing a light brown color on gray hair is 7.5%, with the addition of auxiliary materials such as pyrogallol, copper (II) sulfate, and xanthan gum, each at a concentration of 1%. Considering that the duration of immersion can affect the intensity of the dyeing, further testing was conducted to determine the most effective immersion time for achieving a light brown color. This testing utilized the EKBJ 7.5% formulation with varying immersion times of 1 to 4 hours. Every hour, hair samples were removed and the color changes were observed visually.

Table 3. Effect of duration of immersionon the results of gray hair dyeing

Duration of Immersion	Color Results	Figure
1 jam	Medium Brown	
2 jam	Light Brown	
3 jam	Light Brown	
4 jam	Light Brown	

Table 3 shows that the process of dyeing gray hair occurs gradually, with a color change from white to black. After 1 hour of immersion, the gray hair begins to turn medium brown. With immersion up to 3 hours, the resulting color becomes light brown, and after 4 hours of immersion, no further color change occurs.

The test results indicate that the concentration of jamblang bark extract plays a significant role in the process of dyeing gray hair. The formulation with a concentration of 7.5% produces a light brown color on gray hair. To analyze the effects of pyrogallol, copper (II) sulfate, and xanthan gum in this formulation, additional tests were conducted to evaluate the effects of each material as well as the combinations of materials on hair dyeing. A total of 100 strands of gray hair, each 5 cm long, were immersed in the preparation for 4 hours, after which they were removed and the color changes were observed visually. The results of the observations are presented in Table 4.

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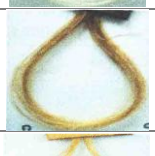
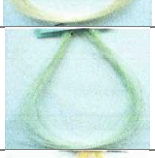
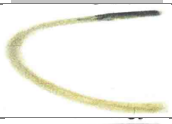
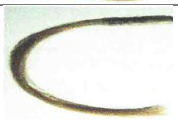
Table 4. Results of observations on the addition of auxiliary material mixtures on gray hair color

No.	Addition of Material Mixtures	Figure
1	Gray Hair	
2	Gray hair + 5% jamblang bark extract	
3	Gray hair + 1% pyrogallol	
4	Gray hair + 1% copper (II) sulfate	
5	Gray hair + 1% xanthan gum	
6	Gray hair + 1% pyrogallol + 1% copper (II) sulfate	
7	Gray hair + 5% jamblang bark extract + 1% pyrogallol	
8	Gray hair + 5% jamblang bark extract + 1% copper (II) sulfate + 1% xanthan gum	
9	Gray hair + 5% jamblang bark extract + 1% pyrogallol + 1% xanthan gum + 1% copper (II) sulfate	
10	Gray hair + 7.5% jamblang bark extract + 1% pyrogallol	
11	Gray hair + 7.5% jamblang bark extract + 1% copper (II) sulfate + 1% xanthan gum	
12	Gray hair + 7.5% jamblang bark extract + 1% copper (II) sulfate + 1% xanthan gum + 1% pyrogallol	
13	Gray hair + 9.5% jamblang bark extract + 1% pyrogallol	
14	Gray hair + 9.5% jamblang bark extract + 1% pyrogallol + 1% xanthan gum	

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15	Gray hair + 9.5% jamblang bark extract + 1% copper (II) sulfate + 1% xanthan gum + 1% pyrogallol	
16	Gray hair + 11.5% jamblang bark extract + 1% pyrogallol	
17	Gray hair + 11.5% jamblang bark extract + 1% copper (II) sulfate	
18	Gray hair + 11.5% jamblang bark extract + 1% pyrogallol + 1% copper (II) sulfate + 1% xanthan gum	

Table 4, point 2, indicates that dyeing gray hair using jamblang bark extract without color-enhancing agents results in a medium brown color that appears very pale. This is due to the natural pigment's properties, which struggle to penetrate the hair cortex and only deposit on the hair shaft's surface, making it prone to washing out. Therefore, to enhance the effectiveness of the dyeing process, the addition of metal colorants such as copper (II) sulfate and organic color-enhancing agents like pyrogallol is necessary.

The effect of adding auxiliary coloring materials is clearly evident in Table 4, points 8 and 9, where formulations with 5% and 7.5% jamblang bark extract combined with 1% pyrogallol, 1% copper (II) sulfate, and 1% xanthan gum yield a light brown color. Furthermore, the dyeing results on gray hair using the formulation with 9.5% jamblang bark extract (points 14 and 15) do not show significant differences compared to the formulation with 11.5% jamblang bark extract (points 16, 17, and 18).

The combination of jamblang bark extract with pyrogallol and copper (II) sulfate enhances the adhesion of the dye pigment to the hair shaft. This occurs because these molecules interact with the cuticle and penetrate the hair cortex, resulting in a more uniform and long-lasting dyeing effect on gray hair.

The color stability test on gray hair aims to assess the durability of the color absorbed from the hair dye preparation. This testing is conducted through two methods: resistance to washing and exposure to sunlight. The stability of the color against washing is tested by washing and drying the gray hair that has been dyed using the formulation that produces a light brown color, specifically a mixture of 7.5% jamblang bark extract, 1% pyrogallol, 1% copper (II) sulfate, and 1% xanthan gum. The washing process is repeated up to 15 times, with visual observations made at each stage. The results of the color stability test are presented in Figure 5 below

1 time washing

5 time washing

10 time washing

15 time washing

Figure 5. Color of gray hair that has absorbed hair dye preparation before and after washing

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Figure 5 shows that the gray hair, which has absorbed color from the hair dye preparation formulated with a mixture of 7.5% jamblang bark extract, 1% pyrogallol, 1% copper (II) sulfate, and 1% xanthan gum, did not experience any color change, both before and after 15 washes. The color stability test against sunlight exposure was conducted by exposing the gray hair that had been dyed using the same formulation to sunlight for 5 hours, from 10:00 AM to 3:00 PM WIB.

Before After

Figure 6. Color of gray hair that has absorbed hair dye preparation before and after sunlight exposure

Figure 6 shows that the gray hair, which has absorbed dye from the preparation formulated with a mixture of 7.5% jamblang bark extract, 1% pyrogallol, 1% copper (II) sulfate, and 1% xanthan gum, exhibits good color stability against sunlight exposure. After being exposed to direct sunlight for 5 hours, the hair color remained unchanged.

Hair dye products intended for marketing should include clear information regarding usage instructions, composition, and the concentration of the ingredients used. Additionally, the product label must include instructions related to the need for irritation testing prior to use to ensure safety for the user.

Irritation testing is conducted to ensure that the hair dye formula does not cause irritation or allergic reactions on the skin. This testing involved six volunteers, with the selected formula being the one that produces a brown color on gray hair, specifically a mixture of 7.5% jamblang bark extract, 1% pyrogallol, 1% copper (II) sulfate, and 1% xanthan gum. The results of the irritation test were obtained from observational data conducted on each volunteer.

Tabel 5 Data Pengamatan Uji Iritasi Terhadap Kulit Sukarelawan

No	Statement	Volunteers					
		1	2	3	4	5	6
1	Erythema	0	0	0	0	0	0
2	Erythema and Papules,	0	0	0	0	0	0
3	Erythema, Papules, and Vesicles	0	0	0	0	0	0
4	Edema and Vesicles	0	0	0	0	0	0

Note: 0 = No reaction occurred

Table 5 shows that the formulated hair dye does not cause irritation to the skin. The results of the testing on the formula that uses natural ingredients, specifically jamblang bark extract combined with 1% pyrogallol, 1% copper (II) sulfate, and 1% xanthan gum, demonstrate that this preparation is capable of transforming gray hair into a light brown color. From the research findings, it is evident that the higher the concentration of jamblang bark extract used, the darker the resulting color of the gray hair. The use of dried jamblang bark extract as a natural dye alone produces a less optimal color; therefore, additional materials such as copper (II) sulfate and pyrogallol are required as color enhancers, along with xanthan gum as a stabilizing agent in the formulation.

The irritation test conducted on six volunteers indicates that this formula does not cause any irritation reactions. Thus, jamblang bark extract has the potential to be developed as a natural hair dye preparation that produces a light brown color and is safe for use.

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Conclusion

Based on the research findings, it can be concluded that the ethanol extract of jamblang bark (*Syzygium cumini* L.) can be utilized in hair dye formulations with the addition of color-developing agents, namely pyrogallol, copper (II) sulfate, and xanthan gum. The optimal concentration of ethanol extract from jamblang bark at 7.5%, with the addition of 1% pyrogallol, 1% copper (II) sulfate, and 1% xanthan gum, produces a light brown color on gray hair that is stable against washing and sunlight exposure. Furthermore, the liquid hair dye preparation based on ethanol extract of jamblang bark with this formulation does not cause skin irritation, thus presenting potential as a safe and effective alternative herbal hair dye.

Conflict of Interest

This study was conducted independently and objectively, with no conflicts of interest. The entire research process was carried out without external intervention or personal interests that could affect the validity and integrity of the results obtained.

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Supplementary Materials

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