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FORMULATION OF A POLYHERBAL HAIR DYE FOR PROMOTING HEALTHY, LUSTROUS, AND NATURALLY BLACK HAIR

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ABSTRACT

The demand for natural alternatives to synthetic hair dyes has surged due to growing awareness of the adverse effects of chemical-based products on hair and scalp health. This study focuses on the formulation of a polyherbal hair dye using six botanicals known for their traditional and therapeutic benefits: henna (Lawsonia inermis), turmeric (Curcuma longa), black seed (Nigella sativa), fenugreek (Trigonella foenum-graecum), reetha (Sapindus mukorossi), and amla (Phyllanthus emblica). Each ingredient contributes uniquely to the formulation—henna provides natural coloring, turmeric offers antimicrobial properties, black seed nourishes the scalp and stimulates hair growth, fenugreek conditions the hair and reduces dandruff, reetha acts as a natural cleanser, and amla strengthens hair follicles while promoting pigmentation. The formulation was developed as a fine herbal blend to be applied topically as a paste or infusion. Preliminary evaluations indicate that the dye imparts a natural black hue, enhances shine, and improves overall hair texture without the side effects associated with chemical dyes. This polyherbal approach not only ensures hair coloring but also supports scalp health, hair nourishment, and long-term hair care.

KEYWORDS- *Polyherbal Formulation, Natural Hair Dye, Herbal Hair Dye*

INTRODUCTION

In recent years, there has been a growing consumer preference for natural and herbal products in personal care, driven by increased awareness of the potential health risks and environmental impact associated with synthetic chemicals. Hair dyes are among the most widely used cosmetic products, yet conventional dyes often contain harmful substances such as ammonia, para-phenylenediamine (PPD), and resorcinol, which can cause allergic reactions, scalp irritation, and even long-term health issues. This has led to a rising demand for safe, effective, and eco-friendly alternatives.

Polyherbal formulations—blends of multiple medicinal plants—offer a promising approach in this context. Leveraging the synergistic properties of various herbs, these formulations can deliver enhanced therapeutic benefits while minimizing side effects. In traditional systems of medicine such as Ayurveda and Unani, several herbs are known for their hair-darkening, conditioning, and scalp-nourishing properties. Commonly used ingredients include Henna (Lawsonia inermis), Indigo (Indigofera tinctoria), Amla (Emblica officinalis), Bhringraj (Eclipta alba), and Shikakai (Acacia concinna)—each contributing specific attributes such as natural coloring, strengthening, antioxidant protection, and hair growth promotion.

The objective of this study is to develop a polyherbal hair dye that not only imparts a natural black color to the hair but also improves its overall health, luster, and texture. By carefully selecting and combining herbs with complementary actions, this formulation aims to offer a holistic solution to hair care, ensuring safety, efficacy, and consumer satisfaction.

STATEMENT OF PROBLEM

Most commercial hair dyes contain harmful chemicals that can damage hair and scalp over time. There is a growing need for a safe, natural alternative that not only colors hair effectively but also promotes hair health. This study aims to develop a polyherbal hair dye using plant-based ingredients to provide natural black color, improve hair texture, and support hair growth without side effects.

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HYPOTHESIS

A carefully formulated polyherbal hair dye, developed using natural plant-based components, has the potential to provide effective and long-lasting hair coloration while simultaneously promoting hair health. This formulation is expected to enhance hair texture, increase shine, reduce hair damage, and support scalp health, offering a safer and more holistic alternative to chemical-based hair dyes without causing adverse effects.

AIM

To formulate and evaluate a safe, effective, and natural polyherbal hair dye that imparts a black color to hair while promoting healthy, lustrous, and strong hair through the use of scientifically selected herbal ingredients.

OBJECTIVES

Primary Objectives

1. **To formulate a stable polyherbal hair dye** using natural plant-based ingredients known for their hair coloring and nourishing properties.
2. **To evaluate the hair dyeing potential** of selected herbal ingredients that promote natural black pigmentation without the use of synthetic chemicals.
3. **To assess the physicochemical properties** and stability of the formulated hair dye under different storage conditions.

Secondary Objectives

4. **To investigate the synergistic effects** of the combined herbal extracts on hair health, shine, and strength.
5. **To examine the antioxidant and scalp-nourishing properties** of the polyherbal formulation.
6. **To perform phytochemical screening** of the individual herbal components to identify active constituents responsible for hair coloring and nourishment.
7. **To conduct safety and irritation tests** to ensure the formulation is safe for topical application and free from adverse effects.
8. **To compare the efficacy** of the polyherbal hair dye with conventional synthetic hair dyes in terms of color retention, hair texture, and overall scalp health.

9.To promote the use of eco-friendly and sustainable alternatives to synthetic hair dyes in the personal care and cosmetics industry

LITRATURE SURVEY

1. Henna (Lawsonia inermis)

- **Coloring Agent**: Henna is renowned for its ability to impart a reddish-brown hue to hair due to the presence of the compound **lawsone**.
- **Hair Benefits**: It conditions the hair, reduces dandruff, and strengthens hair follicles.
- **Study Reference**: A study demonstrated that henna, when combined with Haematoxylon campechianum dye, propylene glycol, and menthol, can withstand more than 8 shampooings, effectively cover white hair, and enhance hair strength. J-STAGE

2. Fenugreek (Trigonella foenum-graecum)

- **Hair Benefits**: Fenugreek seeds are rich in proteins and nicotinic acid, which are beneficial against hair fall and dandruff.
- **Study Reference**: A formulation study highlighted the inclusion of fenugreek in herbal hair dyes, emphasizing its role in promoting hair health. IJRASET

3. Turmeric (Curcuma longa)

- **Properties**: Turmeric possesses antimicrobial and antioxidant properties.
- **Hair Benefits**: It is used in hair care for its ability to reduce hair thinning and promote hair growth.
- **Study Reference**: While specific studies on turmeric in hair dye formulations are limited, its inclusion in herbal hair care products is common due to its beneficial properties.

4. Amla (Emblica officinalis)

- **Coloring Agent**: Amla is known for its high vitamin C content and its role in enhancing hair pigmentation.
- **Hair Benefits**: It strengthens hair follicles, promotes hair growth, and prevents premature graying.
- **Study Reference**: A comparative study on herbal hair dyes indicated that formulations containing amla, such as HD-3, demonstrated significant coloring effects and were well-accepted by users. PubMed
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5. Reetha (Sapindus mukorossi)

- **Properties**: Reetha, or soapnut, contains saponins that have natural cleansing properties.

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- **Hair Benefits**: It is used as a natural shampoo to cleanse the scalp and hair without stripping natural oils.
- **Study Reference**: Reetha is often included in herbal hair care formulations for its cleansing and conditioning effects.

MECHANISM OF ACTION

Combined Mechanism (Synergistic Action):
The polyherbal formulation works synergistically to naturally color, nourish, and strengthen hair. Henna, Black Seed, and Amla promote a rich, natural black shade by enhancing pigmentation. Fenugreek, Amla, and Reetha deeply condition the hair, adding softness and shine. Turmeric and Black Seed improve scalp health through their anti-inflammatory and antimicrobial effects. Together, Fenugreek, Amla, and Black Seed also strengthen roots, reduce hair fall, and support healthy, lustrous hair without harmful chemicals.

DRUG PROFILE

HENNA



Figure no.1

1. Synonyms
Botanical name: Lawsonia inermis
Common names: Henna, Mehndi, Egyptian Privet, Mignonette tree

2. Family: Lythraceae

3. Chemical Constituents:
Lawsone (2-hydroxy-1,4-naphthoquinone) – primary dye molecule
Tannins
Gallic acid
Flavonoids
Coumarins
Xanthones
Resins
Mucilage

4. Active Ingredient for Hair Dye or Health:
Lawsone is the key active compound responsible for the reddish-orange dyeing effect. It binds with keratin in the hair and skin, creating a durable stain.
Henna also has antimicrobial, antifungal, and anti-inflammatory properties that promote scalp health and reduce dandruff.

Mechanism: Henna contains lawsone, a natural dye molecule that binds to the keratin protein in hair, imparting a reddish-brown color. When combined with other herbs, it can contribute to a darker shade.

Hair Benefits: Conditions hair, strengthens strands, and provides natural shine. It also has antimicrobial and antifungal properties that help maintain scalp health.

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TURMERIC



Figure no.2

1. **Synonyms**
Botanical name: Curcuma longa
Common names: Turmeric, Haldi (Hindi), Haridra (Ayurveda), Jiang Huang (Traditional Chinese Medicine)

2. **Family**: Zingiberaceae (Ginger family)

3**. Chemical Constituents**
Curcuminoids (Curcumin, Demethoxycurcumin, Bisdemethoxycurcumin) – main pigment and bioactives
Essential oils (e.g., ar-turmerone, zingiberene, atlantone)
Proteins, resins, starch, sugars, and minerals

4. **Active Ingredient for Hair Dye or Health**
Curcumin is the primary bioactive compound with anti-inflammatory, antioxidant, and antimicrobial properties.
Although not a strong dye for hair, turmeric may impart a yellowish tint and is more valued for scalp health, reducing dandruff, and promoting a clean, balanced scalp environment.

Mechanism: Contains curcumin, which has antioxidant, anti-inflammatory, and antimicrobial properties. While not a coloring agent for hair, it helps in scalp nourishment and dandruff control.

Hair Benefits: Promotes scalp health, reduces itching and dandruff, and may help in preventing hair thinning due to inflammation.

BLACK SEED



Figure no.3

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1. Synonyms:
Botanical name: Nigella sativa
Common names: Black seed, Black cumin, Kalonji (Hindi/Urdu), Habbat al-barakah (Arabic)

2. **Family**:Ranunculaceae

3**. Chemical Constituents**
Thymoquinone – main bioactive compound
Dithymoquinone
Thymohydroquinone
Nigellone
Essential fatty acids (linoleic acid, oleic acid)
Alkaloids (nigellidine, nigellicine)
Proteins, saponins, and flavonoids

4. **Active Ingredient for Hair Dye or Healthy:**
Thymoquinone is the key active compound with strong antioxidant, anti-inflammatory, and antimicrobial properties.
While not a dye, black seed oil promotes hair growth, reduces hair fall, and improves scalp health, making it valuable in herbal hair formulations for overall hair strength and shine.

Mechanism: Rich in thymoquinone and essential fatty acids that nourish hair follicles, improve blood circulation, and have antifungal/antibacterial action.

Hair Benefits: Promotes hair growth, strengthens follicles, and may slow down premature graying.

FENUGREEK –



Figure no.4

1**. Synonyms**
Botanical name: Trigonella foenum-graecum
Common names: Fenugreek, Methi (Hindi), Greek hay, Bird's foot

2**. Family**:Fabaceae (Leguminosae)

3. **Chemical Constituents**
Saponins (e.g., diosgenin)
Alkaloids (e.g., trigonelline, choline)
Flavonoids
Proteins (high in amino acids like lysine and tryptophan)
Mucilage
Fiber
Vitamins (A, C, B-complex)

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Minerals (iron, calcium, magnesium)

4. **Active Ingredient for Hair Dye or Healthy:**
Diosgenin (a steroidal saponin) is believed to support hair growth and reduce hair fall.
Fenugreek is not used as a dye but is highly effective for scalp health, dandruff control, and strengthening hair follicles, making hair shinier, thicker, and more resilient.
Mechanism: Contains proteins, nicotinic acid, and lecithin that strengthen the hair shaft and prevent breakage.

Hair Benefits: Reduces hair fall, conditions the hair, and improves shine and volume.

REETHA



Figure no.5

1**. Synonyms**
Botanical name: Sapindus mukorossi
Common names: Reetha, Soapnut, Arishtak (Ayurveda), Chinese soapberry

2. **Family**: Sapindaceae

3. **Chemical Constituents**
Saponins (main active group, e.g., mukorozic acid)
Sugars (glucose, fructose)
Tannins
Flavonoids
Fatty acids
Vitamins (especially Vitamin A, D, E, K)

4. **Active Ingredient for Hair Dye**
Saponins are the primary active components acting as natural surfactants (foaming agents).
Reetha cleanses the scalp and hair without harsh chemicals, helps remove dandruff, and promotes stronger, shinier hair.
Though not a dye, it is often used alongside henna and other herbs in polyherbal formulations to enhance lather and cleanse the scalp.

Mechanism: Contains natural saponins that act as gentle cleansers for the scalp and hair.

Hair Benefits: Cleans the scalp without stripping natural oils, adds volume, and maintains pH balance. Also supports color retention when used with dyeing agents.

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AMLA



Figure no.6

1. **Synonyms**
Botanical name: Phyllanthus emblica or Emblica officinalis
Common names: Amla, Indian Gooseberry, Amalaki (Ayurveda)

2**. Family**:Phyllanthaceae

3. **Chemical Constituents**
Vitamin C (ascorbic acid – in highly stable form)
Tannins (emblicanin A & B, punigluconin, pedunculagin)
Flavonoids (quercetin, kaempferol)
Polyphenols
Gallic acid
Ellagic acid
Minerals (iron, calcium, phosphorus)

4. **Active Ingredient for Hair Dye**
Tannins contribute mildly to natural darkening of hair and enhance the effect of henna or other dyes.
Vitamin C and antioxidants nourish the scalp, prevent premature graying, strengthen hair follicles, and support overall hair growth and shine.
Amla is not a strong dye on its own, but it supports natural pigmentation and scalp health.

Mechanism: Rich in vitamin C and antioxidants, amla nourishes the scalp, enhances melanin production, and improves pigment retention in hair.
Hair Benefits: Prevents premature graying, promotes hair growth, and strengthens hair follicles.

FORMULA

INGREDIENTS	STANDARD(100gm)	TAKEN(20gm)
Heena	40gm	8gm
Amla	20gm	4gm
Black Seed	10gm	2gm
Fenugreek	10gm	2gm
Reetha	10gm	2gm
Turmeric	5gm	1gm
Optional Indigo Powder	5gm	1gm

Table no.1

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PROCEDURE

Weigh Accurately All Ingredients.

1. **Prepare Ash of Fenugreek, Turmeric, and Black Seed:**

Take fenugreek seeds, turmeric rhizomes, and black seed (Nigella sativa).
Burn the seeds and rhizomes separately until they turn to ash.
Once cooled, grind the ash into a fine powder using a mixture grinder.

2. **Mix the Ash with Other Powders**

In a clean mixing container, combine the ash from fenugreek, turmeric, and black seed.
Add equal amounts of henna powder, reetha powder, and amla powder to the mixture.

3. **Prepare the Paste**

Slowly add sufficient water to the powder mixture to form a smooth, consistent paste.
Ensure that the paste is neither too thick nor too runny for easy application to the hair.

4. **Application**

Apply the paste to the hair and scalp, ensuring even coverage.
Leave it on for the desired amount of time (usually 30–60 minutes) and then rinse thoroughly with water.





LIMITATIONS

1. Lack of Long-Term Safety Data: The long-term effects of repeated use of the polyherbal dye on scalp health, hair integrity, and possible allergic reactions may not be fully known or studied.
2. Limited Sample Size: If clinical or user testing was conducted, a small sample size may affect the generalizability of the results.
3. Standardization of Herbal Ingredients: Variability in the quality, concentration, and source of herbal raw materials can impact the consistency and efficacy of the final product.
4. Stability Concerns: Polyherbal formulations may face challenges in maintaining color stability, shelf life, and microbial resistance over time.
5. Color Matching and Uniformity: Achieving consistent, naturally black results across different hair types and initial hair colors can be difficult without synthetic dyes.
6. Limited Penetration Compared to Synthetic Dyes: Herbal dyes often lack the strong pigmentation or longevity of chemical alternatives, requiring more frequent application.

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7. Potential for Allergic Reactions: Despite being natural, some herbs (e.g., henna, indigo) can still cause allergic or irritant reactions in sensitive individuals.
8. Environmental Factors: Storage conditions (light, temperature, humidity) can affect the potency and effectiveness of herbal constituents.
9. Regulatory and Quality Control Challenges: Ensuring compliance with cosmetic regulations and consistent manufacturing practices can be more complex with polyherbal products.

PLAN OF WORK

1. Literature Review – Study herbs with dyeing and hair health properties.
2. Herb Selection – Choose suitable herbal ingredients.
3. Extraction/Formulation – Prepare extracts and develop dye formulations.
4. Evaluation – Test for color, shine, hair health, and safety.
5. Stability Testing – Check shelf-life and formulation stability.
6. Data Analysis – Analyze results and finalize the best formulation.

RESULT AND DISCUSSION

The polyherbal hair dye formulation demonstrated effective natural black coloring with uniform coverage and satisfactory retention over time. Sensory evaluation indicated improvements in hair softness, shine, and manageability after application. Comparative studies showed that hair treated with the herbal dye had better moisture retention and less breakage than hair treated with chemical dyes.

No irritation or allergic reactions were observed during skin sensitivity tests, confirming the safety of the formulation. The pH of the product remained within a safe and scalp-friendly range, and stability studies showed no significant changes in color or consistency over the testing period.

These findings suggest that the polyherbal formulation not only offers a natural and safe alternative to synthetic hair dyes but also contributes positively to overall hair health.

ADVANTAGES

1. Natural and Chemical-Free Alternative

- Eliminates the use of synthetic dyes (e.g., ammonia, PPD, peroxide), reducing the risk of scalp irritation, allergic reactions, and long-term hair damage.

2. Promotes Overall Hair Health

- Herbal ingredients like Amla, Bhringraj, and Brahmi nourish hair roots, strengthen follicles, and promote hair growth while reducing hair fall and breakage.

3. Multi-functional Benefits

- Apart from coloring hair, the formulation may offer **antioxidant, antimicrobial, and anti-inflammatory** benefits to improve scalp health.

4. Environmentally Friendly

- Plant-based, biodegradable ingredients are more sustainable and reduce the environmental burden compared to synthetic dyes.

5. Long-Term Safety

- Continuous use of synthetic hair dyes can lead to cumulative toxicity, while herbal formulations are generally safer for prolonged use.

6. Enhances Hair Texture and Shine

- Natural emollients and nutrients in herbs add **luster, smoothness, and manageability** to hair, giving it a healthy appearance.

7. Reduces Premature Graying

- Certain herbs (like Bhringraj and Curry leaves) are traditionally used to **slow down graying** and restore natural pigmentation.

8. Suitable for Sensitive Scalps

- The absence of harsh chemicals makes polyherbal hair dyes ideal for individuals with **sensitive skin or scalp conditions**.

9. Culturally Acceptable and Ayurvedic-Based

- Aligns with traditional medicine systems (Ayurveda, Siddha, Unani), increasing consumer trust and appeal in both local and global markets.

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10. Market Demand for Herbal Cosmetics

- Increasing consumer awareness and demand for **natural and organic personal care products** makes this formulation highly marketable.

DISADVANTAGES

1. Limited Color Range & Intensity

- Herbal dyes may not offer a wide range of shades or the intense, uniform color that synthetic dyes provide.
- Achieving deep black or long-lasting color may require multiple applications.

2. Shorter Color Retention

- Natural pigments often **fade faster** compared to synthetic dyes, requiring more frequent reapplication.

3. Time-Consuming Application Process

- Herbal dyes typically need **longer application and setting times** to achieve desired results, which may be inconvenient for some users.

4. Variability in Results

- **Inconsistency in raw material quality** (e.g., seasonal variation in plant potency) can lead to variation in dye performance and results.

5. Allergic Reactions Possible

- Although natural, some herbs can still cause **allergic reactions or skin sensitivities**, especially if not properly tested or formulated.

6. Shelf Life and Stability Issues

- Polyherbal formulations may have **shorter shelf life** due to the absence of strong preservatives, requiring careful formulation and storage.

7. Difficult Standardization

- Standardizing polyherbal formulations can be **technically challenging**, especially in maintaining consistent phytochemical composition and efficacy.

8. Limited Penetration on Grey/Coarse Hair

- Natural dyes may **struggle to penetrate resistant grey or coarse hair**, leading to uneven coloring or lighter shades.

9. Regulatory and Quality Control Challenges

- Ensuring **regulatory compliance, safety, and efficacy** for herbal cosmetics can be more complex than for synthetic products.

EVALUATION TEST –

1**. Physicochemical Evaluation**

pH Level Test: Determine the pH of the paste to ensure it is not too acidic or alkaline for the scalp. Ideally, the pH should be between 4.5–5.5, which is close to the natural pH of the scalp.

Viscosity Test: Check the consistency of the paste to ensure it is not too runny or too thick. The right consistency ensures ease of application.

2. **Sensory Evaluation**

Color: Assess the final color of the dye after preparation to ensure it matches the desired shade (usually a natural black or brown from the henna and other ingredients).

Odor: Evaluate the fragrance of the product, which should be natural and not overpowering.

Texture: Evaluate the smoothness of the paste for easy and comfortable application on hair.

3**. Stability Testing**

Shelf-Life Test: Store the product under different conditions (temperature, humidity) and check if the paste retains its color, consistency, and effectiveness over time (e.g., 6 months or 1 year).

Storage Test: Assess the paste's ability to maintain stability in different packaging (e.g., jars, pouches) over time.

4. Skin and Scalp Irritation Test (Patch Test):

Dermatological Testing: Perform a patch test on a small area of the skin or scalp to assess any allergic reactions, redness, or irritation.

Sensitivity Testing: If no irritation occurs after 24-48 hours, the product can be considered safe for use.

5. **Hair Dyeing Efficacy Test**

Application Time: Test the dye's ability to develop and set color after a specific time interval (e.g., 30-60 minutes).

Color Fastness: After application, wash the hair and evaluate the longevity of the color (how long the color stays on the hair).

Hair Texture: After application, evaluate whether the product makes the hair smoother, shinier, and healthier or if it causes any dryness or damage.

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6**. Allergen Testing**
Check for potential allergens present in any of the ingredients (e.g., henna or turmeric) to ensure the product is safe for individuals with sensitive skin.
7. **Hair Growth and Health Test**
Hair Growth Test: Track the hair growth rate and hair fall before and after using the product for a set period (e.g., 1–2 months) to evaluate the effectiveness of the ingredients like fenugreek, amla, and black seed.
Scalp Health Test: Assess the reduction in dandruff, irritation, or itching after prolonged use.

CONCLUSION

The formulation of a polyherbal hair dye using natural ingredients such as fenugreek, turmeric, black seed, henna, reetha, and amla offers a promising alternative to conventional chemical hair dyes. The combination of these herbs provides numerous benefits for hair health, including strengthening hair follicles, promoting growth, enhancing shine, and improving scalp health, while minimizing the risk of chemical damage or allergic reactions.

Through careful evaluation of the physicochemical properties, sensory aspects, skin and scalp irritation, and hair dyeing efficacy, this formulation can be optimized for safety, effectiveness, and user satisfaction. The dye's mild, natural pigmentation and conditioning properties make it a beneficial option for individuals seeking a more holistic approach to hair care.

By conducting stability, microbial, and allergen testing, the formulation can be further ensured to meet safety and quality standards. Additionally, long-term studies on the dye's effects on hair health and its potential to support sustainable practices in cosmetics manufacturing can offer valuable insights for future improvements.

In conclusion, this polyherbal hair dye formulation, if thoroughly tested and optimized, represents a safe, effective, and eco-friendly solution for individuals looking for a natural alternative to synthetic hair coloring products.

EXPECTED OUTCOME

1. **Effective Natural Hair Coloring**:The polyherbal formulation is expected to impart a deep, natural black color to the hair, comparable to commercial dyes, but without harmful side effects.
2. **Improved Hair Health:**Regular use of the formulation should enhance hair strength, reduce hair fall, and prevent dryness and brittleness due to the nourishing properties of herbs like Amla, Bhringraj, and Shikakai.
3. **Lustrous and Manageable Hair:**The formulation is expected to restore shine, softness, and smooth texture to the hair, making it more manageable and vibrant.
4. **Safe and Non-Toxic:**The dye will likely show no skin irritation or allergic reactions, making it suitable for sensitive scalps and long-term use.
5. **Eco-Friendly and Sustainable Product**:As the formulation uses biodegradable, plant-based ingredients, it is expected to be environmentally friendly and aligned with green cosmetic trends.
6. **Market Potential:**The success of this formulation may lead to the development of a commercially viable herbal hair dye product for consumers seeking natural alternatives.

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