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Formulation and Evaluation of Polyherbal Hair Dye

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Abstract: *Hair coloring, or hair dyeing, is the exercise of converting the hair colour. The primary reasons for this are cosmetic: to cover grey or white hair, to trade to a color regarded as extra elegant or ideal, or to repair the original hair colour after it's been discolored with the aid of hairdressing procedures or solar bleaching. Hair color works like a further coat to your tresses. This gives a look of thicker, voluminous hair.*

Keywords: Hair coloring

I. INTRODUCTION

Hair coloring, or hair dyeing, is the exercise of converting the hair colour. The primary reasons for this are cosmetic: to cover grey or white hair, to trade to a color regarded as extra elegant or ideal, or to repair the original hair colour after it's been discolored with the aid of hairdressing procedures or solar bleaching. Hair color works like a further coat to your tresses. This gives a look of thicker, voluminous hair. In this situation it's miles continually an awesome concept to head for semi-everlasting hair color, it provides strength in your hair and makes them look more healthy. Our tresses are uncovered to exclusive environmental factors each day which includes polluted air, dirt, dirt, immoderate heat and temperature modifications among others[1]. These can have a negative effect on our hair ultimately. While you get your hair coloured, you get a shielding layer which protects your natural hair from those environmental dangers. Within the past natural organic materials were blended with metals inclusive of copper and iron, to supply extra lasting or richer sunglasses. Non-stop utility of such compounds on natural hair reasons more than one side effect which includes skin infection, hypersensitive reaction, hair fall, dry scalp, Erythrema and additionally skin most cancers. It's been observed in the neighborhood market survey that the maximum of the marketed natural formulations in India, though claim to be herbal, safe and powerful may sincerely include the dangerous synthetic agent, Paraphenylenediamine (PPD), at 20-25% concentrations that is the main ingredient of business artificial dyes. Natural dyes are the colors derived from plant, animal or insect be counted with none chemical processing. In India, henna has been used traditionally for colouring fingers and hairs[2].

The number one purpose of premature graying is hereditary and it is stated that via the age of fifty, half of the arena's population will have fifty percent grey hair. Many one of a kind extracts from plant have been used for the motive of hair dyeing in Europe and Asia before the invention of modern-day dyes. Inside the present technology of eco-conservation, using herbal dyes has been revived and reviewed for the colour of textiles and meals substances[3]. Use of these chemicals can bring about unsightly side effects, together with pores and skin irritation, allergic reaction, hair breakage, skin discoloration, sudden hair shade and so on. Hence there is a big call for hair dyes inside the marketplace. The splendor of pores and skin and hair essentially relies upon on character's health, food regimen, conduct, activity ordinary, climatic conditions and renovation. The dyeing of the hair is an historic art that involves treatment of the hair with various chemical substances compound. Hair dye has been used historic Egyptian instances when Rameses reinforced red hair coloration using henna. In historical Greece, the hair turned into bleached with a rinse of potassium answer and rubbed with a sort of ointment made from yellow flower petals and pollens[5].

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As compared to the chemical primarily based hair dye, which purpose pores and skin and different pores and skin associated ailment, natural dye are being these days. Herbal tablets with none adverse impact are used from healthful hair. The need of natural based herbal hair dye is increasing fastly due to their herbal goodness and absence of side effects. Artificial hair dyes that are available within the marketplace, uses aggregate of peroxide and Ammonia which alters the shape of hair and harm it and also reasons allergies[6]. In view that ancient time, researchers have been exploring nature in search of new tablets. Beneficial products may be derived from any a part of the plant like bark, leaves, vegetation, seeds and so on. Plant products were part of phyto drug treatments considering that instances immemorial. For primary healthcare, round 80% of worldwide s population is based on conventional drug treatments, concerning plant extracts.

In traditional systems of Unani, Ayurveda, Homeopathy, and Siddha, nearly 90% of prescriptions were based totally on tablets obtained from flora. Pills from the plant resources are without difficulty available, are less expensive, secure, and green and infrequently have side effects. The ancients also used saffron, indigo, and alfalfa. However herbal dyes most effective coat the hair temporarily, and those wanted chemically altered tresses. Graying of hair is attributed to reasons like genetics, pressure, dietary deficiency and sickness. Plants life has been used traditionally for his or her hair coloring, increase promoting and anti-ageing houses. Drugs from the plant resources are easily to be have, are less expensive, safe, and efficient and infrequently have side consequences. French researchers have located that Egyptians, Greek and Roman had been the usage of to dye their hair several thousand years in the past. Many one of a kind extracts shape plant had been used for the motive of hair dyeing in Europe and Asia before the invention of cutting-edge dyes. There are 3 type of hair dye. This is temporary, semi-permanent, permanent hair color and so on[10].

Amla, Bhringraj, Henna, Nilika, Tulsi, Aloe vera, Mentha are nicely-acknowledged ayurvedic herbal capsules historically used as hair colorant and for hair boom. Indigo, referred to as initial material dye, may be blended with henna to make unique light brown to black shades of hair dye. It's miles part of Islamic and Hindu cultures as a hair coloring and dyeing agent for the cause of decorating the nails or for the formation of brief pores and skin tattoos. Paraphenylenediamine (PPD), a key element of many manmade hair dyes is thought to trigger allergic skin rashes in lots of human beings. there are such a lot of herbs like Kikar, Bihi, Bhringraj, Patnag, Akhrot, Narra, Jaborandi, Jatamansi, Amla, Kuth, Giloe, Behera which can be used as a first-rate parts in hair care preparations mainly intended for dyeing hair[9].

Health Concerns from Chemical Hair Dyes

Synthetic dyes, particularly oxidative dyes, often contain chemicals like p-phenylenediamine (PPD), hydrogen peroxide, and ammonia. These compounds are known to cause skin allergies, dermatitis, irritation, and in some cases, more severe reactions such as erythema and even carcinogenicity with prolonged use [7–11]. Reports suggest that repeated exposure to these chemicals can lead to hair shaft damage, breakage, dryness, premature graying, and loss of natural hair texture.

Sodium sulfite is commonly used as an antioxidant to protect the colorant from premature oxidation. Alkalizers such as ammonium hydroxide are incorporated to elevate the pH for effective dye penetration. Despite these enhancements, many chemical formulations fall short in providing long-term safety and hair conditioning. Hydrogen peroxide, though effective as an oxidizing agent, often contributes to melanin degradation and brittleness of hair.

Advantages and Needs for Herbal Hair Dyes

Due to these drawbacks, there is a growing shift toward herbal dyes, which are safer, eco-friendly, and compatible with the physiology of the scalp and hair. The black dye derived from herbal formulations holds significant promise for replacing chemical dyes in personal care applications. Herbal dyes also offer the benefits of hair nourishment, dandruff control, antimicrobial protection, and improved scalp health.Natural herbal ingredients not only color the hair but also condition and strengthen it. For example:

- Henna (rich in lawsone) imparts a reddish-brown color and has antifungal properties.
- Indigo provides deep blue-black shades.
- Amla acts as a natural hair conditioner, supports melanin production, and slows graying.

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- Bhringraj stimulates hair follicles and adds luster.
- Jatamansi improves hair texture and pigmentation.

However, challenges persist in standardizing these herbal dyes to ensure consistent color development, enhanced saturation, wash fastness, and formulation stability. These challenges can be addressed by optimizing the extraction methods, using suitable mordants, and developing novel formulation techniques such as encapsulation and fermentation-assisted extraction.

Historical and Global Context

Historical records indicate that hair dyeing dates back to ancient civilizations. Egyptians, Greeks, and Romans used plant-based hair colorants thousands of years ago. In ancient Greece, for example, hair was lightened using a potassium-based solution and treated with yellow flower ointments for tonality. These methods reflect a deep-rooted cultural practice of hair beautification using natural resources.

Hair dyes today are classified into:

• Temporary dyes – coat the hair surface; washed off easily.
• Semi-permanent dyes – partially penetrate hair; last for 6–12 washes.
• Permanent dyes – use oxidative agents; long-lasting but more damaging.

Types of Hair Dye

Temporary

• These form of hair hues used to shade the hair for Temporality.
• The colorants which are used would not penetrate into the hair or surrounding.
• Maybe without difficulty rinsed off water one shampooing.
• Temporary hair colouring some time used to use finely floor metals via a Puffer Spray.
• In rinse aqueous or hydro alcoholic solution of simple dye stuffs are used.

Semi-Permanent

• Semi-permanent dye includes particularly either Nitrophenylene diamines or Nitroaminophenes or both Aminoantrhaquinoes.
• Shampoo is the maximum generally used base.
• Overall performance of colorants may be enhanced by the inclusion of solvent.
• Most of them are primary dye stuffs, whose cationic person offers them a natural affinity for the hair.

Permanent

• Maximum popular hair dye merchandise.
• The dyes are shaped throughout the dyeing technique and aren't present, as such in the solution before application.
• They motive some hair damage.

Advantages

• Herbal appearance of use of real human hair fibre.
• Can be styled as a natural hair.
• Capable of coloration and perm.
• Movements like natural hair.
• Much less susceptible to warmth harm.

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Different hair dye products available in market

Sr. No	SYNTHETIC HAIR DYES	CHEMICAL INGREDIENTS
1	Godrej Expert Rich Crème	Hydrogen Peroxide
2	L'Oreal Paris Excellence Creme Hair Color	Para-phenylenediamine(PPD)
3	Revlon Top Speed Hair Color	Para-phenylenediamine(PPD)
4	Schwarzkopf Essensity Ammonia Free Permanent Color	Resorcinol
5	Bblunt Salon Secret Creme Hair Colour	Sodium Sulfite
6	Streax Ultralights Highlighting Kit	Potassium Persulphate

Problems associated with synthetic hair dye

Almost every synthetic hair dyes contain Ammonia, Para-Phenylenediamine (PPD), Hydrogen Peroxide, Resorcinol, Paraben etc. They play critical role in the development of hair dyes. Although the PPD is used for dark color shades, it should not be applied repetitively for long period of time. PPD is an important constituent of hair dye toxicity of which one could herald fatal complications such as rhabdomyolysis, renal failure and respiratory failure. As well as Ammonia, Paraben and Hydrogen Peroxide are harmful chemical contained in hair dyes which cause toxicity to human body. Ammonia containing hair dye is used to open the hair's cuticle so that the dye can come into the shaft. In spite of its useful activity it has various side effects such as damaged cortex, lung irritation, frizzy & brittle hair, etc. Along with PPD and Ammonia,

Paraben, Hydrogen Peroxide and Resorcinol also have various toxic effects on human body such as hormonal imbalance, fertility complications, irritation on scalp, drying of hair, flakes and even hair loss. These chemicals cause eye and lung irritation, hair breakage, dandruff, chemical burns and sometimes cancers as properly.

Approval of natural hair dye in replacement of chemicals used in synthetic hair dye

The dyeing process for natural, chemical-free hair is somewhat distinct from synthetic, chemically prepared hair dyes. Natural hair dyes are widely being adopted worldwide due to its very rare toxic effects. Nowadays people prefer natural hair dye rather than synthetic hair dye.

1. Zaid et al. (2020) emphasized the historical use of henna (Lawsonia inermis) and indigo (Indigofera tinctoria) as natural hair colorants, with henna providing red hues and indigo offering darker shades. The combination of these herbs is widely used in traditional cultures for both hair dyeing and skin decoration.

o Source: Dermatologic Therapy, 33(4):e13788

2. Shinde & Shinde (2018) discussed the dermatological benefits of henna, noting that it not only imparts color but also has antifungal and antibacterial properties, making it ideal for use in hair care formulations.

o Source: Journal of Chemical and Pharmaceutical Research, 10(1):15–21

3. Rajput & Vashisht (2019) investigated the effectiveness of herbal hair colorants and the safe and chemical-free appeal of henna and indigo, highlighting that these herbal dyes are less likely to cause skin irritation and allergies compared to synthetic dyes.

o Source: Pharmacognosy Review, 13(25):124–129

4. Pandey & Kumar (2019) reviewed the antioxidant properties of Amla (Emblica officinalis), which is commonly used in polyherbal formulations. Amla is known to improve hair strength and prevent premature graying by neutralizing oxidative stress.

o Source: International Journal of Herbal Medicine, 7(5):57–63

5. Saha & Basak (2013) noted the growth-promoting and color-enhancing effects of Bhringraj (Eclipta alba), which is commonly used in hair care formulations. This herb is known for its ability to reduce hair fall and promote hair pigmentation.

o Source: Journal of Pharmacognosy and Phytochemistry, 2(4):1–6

6. Thakur & Gupta (2019) explored the properties of Reetha (Sapindus mukorossi) and its role as a natural cleanser and conditioner in herbal hair care products. Reetha improves hair shine and cleanses the scalp without the harsh chemicals found in synthetic shampoos.

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o Source: Journal of Cosmetic Dermatology, 18(5):1234–1242

7. Bhattacharya & Chatterjee (2015) reviewed the antioxidant and antimicrobial properties of Curry leaves (Murraya koenigii), which are used to treat dandruff, hair fall, and scalp irritation. Curry leaves are also added to polyherbal formulations for their ability to support healthy hair growth.

o Source: International Journal of Research in Ayurveda and Pharmacy, 6(3):253–257

8. Singh & Saxena (2018) discussed the challenges in developing consistent and long-lasting herbal hair dyes. They emphasized the role of mordants in improving the intensity and retention of color when using natural plant-based dyes.

o Source: Journal of Industrial Hemp, 23(2):177–185

9. Verma & Agarwal (2020) examined the role of mordants, such as tannins and alum, in polyherbal hair dye formulations. Mordants are essential for fixing the dye on the hair shaft, improving the color fastness and durability of the natural dye.

o Source: International Journal of Applied Science and Biotechnology, 8(1):58–63

10. Ahmed & Raza (2021) explored the potential of nanotechnology to enhance the penetration of herbal dyes into the hair shaft. They highlighted that the use of nanoparticles in polyherbal formulations could improve color uniformity and increase dye retention.

o Source: Herbal Technology, 12(1):44–53

11. Sharma & Prasad (2017) discussed the various extraction techniques for herbal dyes, including supercritical fluid extraction (SFE) and ultrasound-assisted extraction, which increase the yield of active dyeing components from plant materials.

o Source: Phytotherapy Research, 31(5):726–733

12. Singh & Chattopadhyay (2019) reviewed the growing demand for natural hair care products and the market potential for polyherbal hair dyes. Their study indicated that consumers are shifting away from synthetic dyes due to concerns about skin irritation and environmental impact.

o Source: International Journal of Cosmetics Science, 41(3):208–216

13. Kumar & Rani (2020) focused on Amla and Bhringraj for their synergistic effects in promoting healthy hair and color enhancement in polyherbal hair dye formulations. Their study suggests that these herbs contribute to improving both the hair quality and color of the final product.

o Source: Pharmacognosy Reviews, 14(28):174–182

14. Bhatia et al. (2019) evaluated the antifungal and anti-inflammatory properties of polyherbal formulations containing neem and nutmeg in treating scalp conditions like dandruff. Their findings suggest that these herbs provide multiple benefits in addition to hair coloring, such as scalp nourishment.

o Source: Journal of Pharmacognosy and Phytochemistry, 8(3):680–688

15. Lahlou (2013) highlighted the global trend towards using herbal products in the cosmetics industry, particularly for hair care. This review underlined the increasing preference for non-toxic, chemical-free solutions, such as polyherbal hair dyes, over traditional synthetic products.

o Source: Pharmacology & Pharmacy, 4(03):17–3

Aim:

The primary aim of this project is to formulate and evaluate a polyherbal hair dye using a combination of traditional herbal ingredients. The goal is to provide a natural, safe, and effective alternative to synthetic chemical hair colorants, focusing on promoting healthy hair, reducing scalp irritation, and eliminating the harmful side effects commonly associated with conventional hair dyes. This formulation will be evaluated for its dyeing ability, hair conditioning properties, safety, and environmental impact.

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Objectives:

1. Selection and Procurement of Herbal Ingredients:

o Objective: Select herbs with a known history of efficacy in hair care and dyeing, such as Henna (Lawsonia inermis), Indigo (Indigofera tinctoria), Amla (Emblica officinalis), Bhringraj (Eclipta alba), Reetha (Sapindus mukorossi), and Curry Leaves (Murraya koenigii).

o Goal: To ensure the selection of herbs that work synergistically to offer optimal color results and additional benefits for hair health.

2. Formulation of Polyherbal Hair Dye:

o Objective: To prepare a polyherbal hair dye by combining the selected herbal extracts in specific proportions to achieve desired color shades and conditioning effects.

o Goal: The formulation should be capable of providing a long-lasting color without causing damage to the hair, and should promote shine, volume, and smoothness.

3. Standardization of the Hair Dye Formula:

o Objective: Standardize the formulation to ensure consistent quality and performance in every batch. This involves determining the optimal concentration of each herb.

o Goal: Establish dosage levels that offer the best balance of color saturation, hair nourishment, and safety.

4. Evaluation of Dyeing Efficacy:

o Objective: Assess the effectiveness of the polyherbal hair dye in achieving the desired color outcomes (e.g., shades of brown, black, or red).

o Goal: Evaluate the color intensity, color stability (resistance to washing and fading), and overall satisfaction of the users with the final color.

5. Assessment of Hair Conditioning Properties:

o Objective: Assess the conditioning effects of the polyherbal dye on hair texture, shine, and overall health post-application.

o Goal: Ensure the product enhances hair smoothness, moisture retention, strength, and shine while minimizing frizz and dryness.

6. Evaluation of Scalp and Skin Compatibility:

o Objective: Evaluate the dermatological safety of the polyherbal hair dye by conducting patch tests and irritation studies to determine its compatibility with the skin and scalp.

o Goal: Ensure the formulation is free from allergic reactions, skin irritation, and scalp sensitivity.

7. Determination of Antifungal and Antimicrobial Properties:

o Objective: Assess the antimicrobial and antifungal activities of the herbal components in the dye, especially for fungal scalp infections like dandruff and seborrheic dermatitis.

o Goal: Ensure the formulation provides additional scalp protection, improving scalp health while preventing infections.

8. Stability and Shelf-life Testing:

o Objective: Conduct stability studies to evaluate the product's shelf life, effectiveness, and color integrity over time under various storage conditions.

o Goal: Ensure the hair dye maintains its color quality, performance, and safety during storage.

The plan of work outlines the step-by-step approach to achieve the aims and objectives of the project, ensuring systematic progress in the formulation, evaluation, and finalization of the polyherbal hair dye. The work is divided into different phases to ensure efficient management, from the selection of ingredients to the final product.

1. Research and Literature Review

• Objective: To gather comprehensive knowledge on the selection of herbal ingredients and their applications in hair care, dyeing, and health benefits.

• Tasks:

o Review scientific literature, articles, and patents related to polyherbal formulations, herbal hair dyes, and their cosmetic benefits.

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o Identify herbal ingredients that have a proven history in hair color, hair growth, and scalp health (such as Henna, Indigo, Amla, Bhringraj, Reetha, etc.).
o Study formulations of existing herbal hair dyes and understand their effectiveness and limitations.
o Conduct a thorough review of any potential side effects or challenges related to herbal-based dyes.

2. Ingredient Procurement and Preliminary Research

• Objective: To source quality herbal ingredients and prepare them for extraction.
• Tasks:
o Procure raw materials (e.g., Henna leaves, Indigo powder, Amla powder, Reetha, etc.) from certified suppliers.
o Conduct a quality check for all ingredients to ensure they meet standards for use in formulation.
o
o Prepare herbal extracts (if needed) via methods such as cold extraction or solvent extraction, depending on the nature of the plant material.

3. Formulation Development

• Objective: To develop the polyherbal hair dye formulation with the selected ingredients and determine optimal concentrations.
• Tasks:
o Formulate initial batches of polyherbal hair dye by combining different ratios of selected herbs.
o Test combinations for color intensity, application ease, hair conditioning properties, and safety.
o Adjust formulation based on initial testing to improve performance, ensuring an even color distribution and non-irritating properties.
• Deliverables:
o Initial formulations of polyherbal hair dye.
o Evaluation results on color output, texture, and condition of hair.

4. Standardization and Optimization

• Objective: To refine the formulation to ensure consistent performance across different batches.
• Tasks:
o Conduct small batch production to finalize the formulation.
o Determine the optimal concentration of each herbal ingredient for consistent performance.
o Conduct stability tests on the formulation, including testing for changes in color intensity, viscosity, and shelf life over time.

5. Safety and Efficacy Evaluation

• Objective: To evaluate the safety, efficacy, and performance of the polyherbal hair dye through various tests.
• Tasks:
o Patch testing on volunteers to evaluate the safety of the product, ensuring it does not cause skin irritation, allergies, or scalp sensitivities.
o Effectiveness testing on hair, assessing the color intensity, longevity, and condition of hair after dyeing.
o Conduct dermatological testing to confirm the formulation's hypoallergenic properties.

6. Comparative Study and Final Optimization

• Objective: To compare the polyherbal hair dye with synthetic commercial dyes and refine the formulation based on findings.
• Tasks:
o Analyze the results, refine the formulation if necessary, to ensure the polyherbal hair dye offers superior or equal benefits compared to synthetic alternatives.

7. Stability, Shelf-Life, and Packaging

• Objective: To conduct final stability testing and design eco-friendly packaging for the product.
• Tasks:
o Perform long-term stability tests to evaluate the shelf-life of the polyherbal hair dye, including checking for color fading, texture changes, and ingredient degradation over time.

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o Develop packaging design using eco-friendly materials to appeal to the target market.

8. Final Report

• Objective: To prepare the final report and conclude the research project.

• Tasks:

o Summarize the findings, process, and results from each phase of the project.

o Present recommendations for further research or product improvements.

o Provide insights into market potential and how the product can be scaled up for production

Drug profile

1. Henna

• Botanical Name: Lawsonia inermis
• Family: Lythraceae
• Traditional Uses: Natural dye for hair, hands, and feet
• Active Constituents: Lawsone (2-hydroxy-1,4-naphthoquinone)
• Pharmacological Actions: Antifungal, astringent, cooling
• Role in Hair Dye: Provides reddish-brown color; conditions and strengthens hair

2. Hibiscus

• Botanical Name: Hibiscus rosa-sinensis
• Family: Malvaceae
• Traditional Uses: Promotes hair growth, prevents hair fall
• Active Constituents: Anthocyanins, flavonoids, mucilage
• Pharmacological Actions: Hair growth stimulant, anti-inflammatory
• Role in Hair Dye: Mild coloring agent, enhances hair texture and volume

3. Amla

• Botanical Name: Phyllanthus emblica (also Emblica officinalis)
• Family: Phyllanthaceae
• Traditional Uses: Rejuvenating tonic, hair growth promoter
• Active Constituents: Ascorbic acid (Vitamin C), tannins.
• Pharmacological Actions: Antioxidant, antimicrobial, anti-aging
• Role in Hair Dye: Darkens hair, promotes growth, prevents greying

4. Neem

• Botanical Name: Azadirachta indica
• Family: Meliaceae
• Traditional Uses: Antidandruff, lice treatment, scalp infections
• Active Constituents: Nimbin, azadirachtin, nimbidin
• Pharmacological Actions: Antifungal, antibacterial, anti-inflammatory
• Role in Hair Dye: Scalp cleanser, antifungal protection

5. Shikakai

• Botanical Name: Acacia concinna
• Family: Fabaceae (Leguminosae)
• Traditional Uses: Natural shampoo and cleanser
• Active Constituents: Saponins, tannins, alkaloids
• Pharmacological Actions: Mild cleanser, detangler, antifungal
• Role in Hair Dye: Natural cleansing base without stripping oils

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6. Reetha

- Botanical Name: Sapindus mukorossi
- Family: Sapindaceae
- Traditional Uses: Soap nut used for natural washing
- Active Constituents: Saponins, sugars, mucilage
- Pharmacological Actions: Antimicrobial, antifungal
- Role in Hair Dye: Natural foaming agent, gentle cleanser

7. Indigo

- Botanical Name: Indigofera tinctoria
- Family: Fabaceac
- Traditional Uses: Promote hair colouring and premature greying
- Active Constituents: Indigotin, indirubin
- Pharmacological Actions: Antiinflamatory, antimicrobial
- Role in Hair Dye: Strengthens roots, enhances black and dark brown shade

8. Black Tea

- Botanical Name: Camellia sinensis
- Family: Theaceae
- Traditional Uses: Hair darkening and refreshing rinse
- Active Constituents: Theaflavins, tannins, caffeine
- Pharmacological Actions: Astringent, antioxidant
- Role in Hair Dye: Natural darkener, strengthens hair

9. Rosemary

- Botanical Name: Rosmarinus officinalis
- Family: Lamiaceae
- Traditional Uses: Stimulates hair follicles, reduces dandruff
- Active Constituents: Rosmarinic acid, camphor, cineole
- Pharmacological Actions: Antioxidant, circulatory stimulant
- Role in Hair Dye: Enhances hair growth, prevents premature greying

10. Curry leaves

- Botanical Name: Murraya Koenigii
- Family: Rutaceae
- Traditional Uses: Improved circulation, reducing hairloss
- Active Constituents: Alkaloid, Flavonoids, saponins, tannins
- Pharmacological Actions: Anti- inflammatory , Antioxidants, antiulcers

Method of Preparation for Polyherbal Hair Dye

Step 1: Collection of Raw Materials

- Collect high-quality, dried herbal materials like Henna, Indigo, Hibiscus, Amla, Neem, Shikakai, Reetha, Curry Leaves, and Black Tea.
- Ensure the materials are free of contaminants such as mold or pests.
- Use freshly harvested herbs wherever possible to preserve the active ingredients.

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Step 2: Preparation of Herbal Powders

• Drying: If the herbs are not already dried, dry them in the shade at room temperature. Avoid direct sunlight, as it can degrade sensitive compounds like antioxidants and essential oils.

• Grinding:

o Use a stone grinder or mortar and pestle for small batches to ensure the powder is fine and smooth.

o For larger batches, use a food-grade grinder at low speed to avoid overheating the herbs, which can cause loss of volatile compounds.

o Sift the ground powders through a fine mesh sieve to obtain uniform, fine powders.

Step 3: Temperature Control during Preparation

• Herbal Extracts: If using extracts (e.g., hibiscus or amla), ensure they are pre-warmed slightly to room temperature or slightly warm to avoid temperature shock when mixing with powders.

Step 4: Mixing Process

• Herbal Powder Mixing:

o Slowly add the herbal powders (henna, indigo, hibiscus, etc.) to the cold water or herbal extract, ensuring uniform distribution.

o Mix gently with a wooden spatula or non-metallic spoon to avoid introducing air bubbles into the paste.

o Gradually increase the mixing speed once the powders are fully incorporated to create a smooth, lump-free paste.

o Ensure the paste has a smooth, spreadable consistency—not too runny or too thick.

• Additives:

o If required, additives such as essential oils (e.g., rosemary oil or Eucalyptus for fragrance or antimicrobial properties), vitamins (like vitamin E for hair nourishment), and can be added at this stage.

o Mix these additives thoroughly to ensure uniform distribution throughout the dye.

Step 5: Color and Consistency Testing

• After mixing the paste, test its consistency and color. Apply a small amount of the mixture to a test strand of hair or a fabric swatch.

o Check for the desired color intensity and adjust by adding more herbal powder or water as needed.

o If the paste is too runny, add more henna or indigo powder. If it's too thick, add small amounts of warm water to achieve the desired spreadability.

Step 6: Resting Time for Dye Activation

• Allow the paste to rest at room temperature for 6-7 hours to activate the color. This is particularly important for henna as it requires time to release the lawsone molecule, which is responsible for its staining ability.

• During this resting period, keep the paste covered with a moist cloth or plastic wrap to prevent drying out and to retain moisture.

Step 7: Application

• Apply the prepared herbal hair dye evenly on the clean, damp hair using a hair dye brush or your hands (wear gloves to prevent staining of the skin).

• Start from the roots, ensuring even coverage along the length of the hair, focusing on the ends for more intense color.

• Once fully applied, wrap the hair with a plastic cap or shower cap to prevent the dye from drying out and to retain warmth, which helps with the activation of the dye.

• Leave the dye on for 30 minutes to 1 hour based on the desired color intensity. For deeper colors, it can be left longer (up to 2 hours).

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Step 8: Rinsing and Final Care

• After the dye has set, rinse the hair thoroughly with lukewarm water. Avoid using shampoo immediately, as it can strip the color.

• Leave the hair to dry naturally or blow dry on a cool setting.

Sr. No	Ingredient	Formulation 1	Formulation 2	Formulation 3	Role of used ingredient
1	Henna	15gm	10mg	20gm	Provides natural color (reddish-brown) and conditioning
2	Hibiscus	2gm	3gm	2gm	Adds color (red/pink) and promotes hair health
3	Amla	3gm	3gm	3gm	Rich in Vitamin C; strengthens hair and prevents hair fall
4	Neem	2gm	3gm	3gm	Antifungal, antibacterial; promotes scalp health
5	Shikakai	3gm	2gm	2gm	Cleanses scalp, promotes hair growth, and adds shine
6	Reetha	3gm	3gm	2gm	Natural cleanser, enhances foam, promotes hair softness
7	Indigo	10gm	15gm	10gm	Premature Greying, nourishes, and natural colouring
8	Curry Leaves	2gm	4gm	2gm	Promotes hair growth and reduces hair loss
9	Rosemarry	5gm	3gm	3gm	Promote hair growth, stimulates hair follicles
10	Black Tea	5gm	4gm	3gm	Adds color (dark brown/black) and strengthens hair

1. Physical Appearance

The formulated polyherbal hair dye appeared as a fine, non-lumpy, dark brown powder. After mixing with warm water, the paste was uniform, smooth, and non-dripping, which is ideal for hair application. The formulation had a natural herbal aroma, attributed to ingredients like rosemary, peppermint, and hibiscus.

• Powder form: Fine, dry, flowable
• Paste form: Homogeneous, easily spreadable
• Color: Dark brown
• Odor: Pleasant herbal scent

2. pH Evaluation

The pH of the reconstituted formulation was recorded as 6.7, which falls within the ideal range for scalp and hair applications (6.5-6.7). This mildly acidic pH supports scalp health, helps maintain the natural acid mantle, and prevents irritation or dryness.

3. Spreadability and Consistency

The formulation showed excellent spreadability, which is crucial for even distribution along the hair shaft. No clumps or coarse particles were observed during application. Uniform texture was maintained due to proper grinding and sieving of herbal powders.

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4. Dyeing Efficiency / Color Evaluation

The polyherbal dye produced visible color change after the first use, with intensity increasing upon repeated applications. The combined effects of henna (reddish-brown), hibiscus and black tea (tannin-rich dye) resulted in a deep brown to dark brown color. The final shade depended on the application time, base hair color, and concentration.

Application Time	Resulting Hair Color
30 minutes	Light brown / reddish tint
1 hour	Brown
2 hours	Dark brown

• Gray hair coverage: Partial after 1 use, significant after 2–3 applications.
• Color retention: Lasted for up to 2–3 weeks without notable fading.

5. Conditioning and Hair Feel

The hair dye acted not only as a coloring agent but also as a natural conditioner. Herbs like amla, neem, hibiscus improved hair softness, shine, and detangling ability. Users experienced no dryness or breakage, which is often seen with synthetic dyes.

6. Washability and Residue

The paste was easy to rinse off with lukewarm water. No sticky residue or unpleasant smell was noticed post-wash. Hair felt fresh, soft, and manageable.

7. Microbial Stability

Preliminary observations over a 4-week period at ambient temperature showed that the powder remained free from microbial contamination, mold growth, or foul odor. The use of dried plant materials and proper packaging helped maintain stability.

8. Safety and Irritation Study

A small-scale user evaluation (n=5 volunteers) showed no adverse skin reactions such as redness, itching, or allergy. Patch tests were negative, indicating that it is safe for use.

Evaluation of Physical Parameters of Polyherbal Hair Dye Formulations

1. Pre-formulation Evaluation

The prepared herbal hair dye was evaluated for its various parameters such as preformulation evaluation, organoleptic, phytochemical, rheological aspects

Formulation	Bulk Density	Tapped Density	True Density	Angle of Repose
F1	0.44	0.66	0.88	26.92
F2	0.42	0.64	0.92	27.02
F3	0.41	0.62	1.27	25.68

2. Organoleptic Evaluation

Organoleptic characteristics for various sensory characters like color, odour, texture, appearance was care fully noted down illustrated

Parameter	F1	F2	F3
Colour	Greenish Brown	Greenish Brown	Reddish Brown
Odor	Characteristic	Characteristic	Characteristic
Texture	Fine	Fine	Fine
Appearance	Powder	Powder	Powder

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3. Physico-Chemical Evaluation

Physical and chemical features of herbal hair dye were evaluated to determine the pH, its moisture content, its ash value for the purpose of stability, compatibility and amount if inorganic matter present in it.

Parameter	F1	F2	F3
pH	5	6	5
L.O.D	3.2	3.1	3.4
Ash Value	0.67	0.78	0.78

4. Chemical Test Evaluation

Prepared herbal hair dye was subjected to chemical screening to reveal the presence or absence of various chemical constituents such as carbohydrate, alkaloids

Test Name	F1	F2	F3
Foam Test	Present	Present	Present
Molisch's Test	Present	Present	Present
Fehling's Test	Absent	Absent	Absent
Mayer's Test	Present	Present	Present

5. Patch Test

This is usually involves dabbing a small amount of aqueous solution of hair dye behind the ear inan area of 1sq.cm and leaving it to dry. Signs of irritation or feeing of non wellness is noted, if any. Measured and small quantities of prepared hair pack were applied ti the specified area for fixed time. Irritancy, redness, and swelling were checked and noticed for regular intervals up to 24 hours. The results of tests for the signs of irritation are displayed in table below

Parameter	F1	F2	F3
Swelling	Negative	Negative	Negative
Redness	Negative	Negative	Negative
Irritation	Negative	Negative	Negative

6. Stability Test

Stability testing of the prepared formulation was performed by storing it at different temperature conditions for the time period of one month . The packed glass vials of formulation were stored at different temperature conditions room temperature and 35 ° C and were evaluated for the physical parameters like color , odour, pH , texture , and smoothness as highlight.

Condition	Parameter	F1	F2	F3
Room Temp	Colour	Greenish Brown	Greenish Brown	Reddish Brown
Room Temp	Odour	Characteristic	Characteristic	Characteristic
Room Temp	pH	5	6	5
Room Temp	Texture	Fine	Fine	Fine

Discussion

The polyherbal hair dye formulation was successful in meeting the intended objectives. The combination of coloring agents (henna, coffee, indigo, hibiscus) and conditioning herbs (aloe vera, amla, neem, shikakai) offered both natural color coverage and hair nourishment.

Compared to commercial synthetic dyes, the herbal formulation was:

- Free from ammonia, PPD, and harsh chemicals.
- Less likely to cause allergic reactions or irritation.
- Eco-friendly and biodegradable.
- Multifunctional: offered coloring, conditioning, and scalp care.

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