

**DEVELOPMENT AND ASSESSMENT OF NATURAL HAIR DYE IN VARIOUS
FORMULATIONS USING HENNA, HIBISCUS, SHIKAKAI, AMLA AND INDIGO: A
REVIEW****Urwashi Tiwari*, Rutuja Ashok Arekar**

Adarsh Institute of Pharmacy, 543, Azamshah Layout Great Nag Road, Jagnade Square, Nagpur.

***Corresponding Author: Urwashi Tiwari**

Adarsh Institute of Pharmacy, 543, Azamshah Layout Great Nag Road, Jagnade Square, Nagpur.

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ABSTRACT

Hair colouring is a widely practiced cosmetic procedure used to enhance appearance and cover grey hair. Most commercially available hair dyes contain synthetic chemicals such as para-phenylenediamine, ammonia, and hydrogen peroxide which may cause scalp irritation, allergic reactions, and hair damage. Growing concern regarding the safety of chemical dyes has increased interest in herbal alternatives. Natural hair dyes prepared from medicinal plants provide colouring effects along with additional benefits such as hair nourishment and scalp protection. Plants such as *Lawsonia inermis* (henna), *Hibiscus rosa-sinensis* (hibiscus), *Acacia concinna* (shikakai), *Phyllanthus emblica* (amla), and *Indigofera tinctoria* (indigo) have traditionally been used in hair care preparations. These plants contain bioactive compounds such as lawsone, anthocyanins, tannins, flavonoids, vitamin C, and indigotin which contribute to natural colouring and hair conditioning properties. The present review summarizes the development and evaluation of herbal hair dye formulations prepared from these plant materials and discusses their phytochemical constituents, formulation techniques, and evaluation parameters. Herbal hair dyes represent a safe, eco-friendly, and sustainable alternative to synthetic hair colourants. physicochemical, and preliminary phytochemical screening to assess their suitability as natural hair dyes and their potential as safer alternatives to synthetic colorants. The dye exhibited favorable sensory characteristics, standard pH, moisture, and ash content. Phytochemical screening indicated the presence of carbohydrates, proteins, tannins, anthraquinones, and mucilage, validating the use of herbal constituents. This research suggests that this herbal hair dye presents a potential alternative to synthetic hair colorants, potentially minimizing adverse side effects.

KEYWORDS: Herbal hair dyes, Phytochemical constituents, Evaluation parameters, Phytochemical screening, Hair dye formulations, Evaluation, Medicinal plants.**1. INTRODUCTION**

Hair is an important part of human appearance and plays a significant role in social identity and aesthetics.^[1,2] Hair colouring has been practiced since ancient times using natural substances obtained from plants and minerals.^[3] In modern cosmetic industries, synthetic hair dyes are widely used because they produce intense colour and long-lasting results.^[4] However, many synthetic dyes contain chemicals such as para-phenylenediamine, ammonia, and hydrogen peroxide, which may cause adverse effects including scalp irritation, dermatitis, and hair damage.^[5,6] Continuous exposure to these chemicals may also lead to allergic reactions and hair

weakening.^[7] Because of these concerns, the use of 1 cosmetic products has gained considerable attention in recent years.^[8] Natural hair dyes derived from medicinal plants are considered safer alternatives because they are biodegradable, environmentally friendly, and generally less toxic than synthetic dyes.^[9] Herbal hair dyes not only provide colouring effects but also promote hair growth and improve scalp health due to the presence of beneficial phytochemicals.^[10] Among the plants commonly used in herbal hair dye formulations are henna, hibiscus, shikakai, amla, and indigo.^{[11][12][13]} Henna contains the natural colouring compound lawsone, which binds to keratin present in hair shafts and produces

a reddish-brown shade. Indigo is often combined with henna to produce darker colours such as brown and black. Amla strengthens hair and enhances colour fixation because of its high tannin and vitamin C content. Hibiscus acts as a natural conditioner and improves hair texture, while shikakai functions as a mild cleanser due to the presence of saponins.^[15] Hair colouring or dyeing is, practice of changing the hair color. The main reason for this is cosmetic to recover white and grey hair, to change the color regarded as more fashionable or desirable, or to restore the original color after it has been decoloured by hair dressing or sun bleaching. The prepared herbal dye contains all the goodness of natural ingredients. Apart from acting as a hair dye, this formulation, because of the perfect blend of herbal, also acts as a hair growth promoter, hair nourisher. French researchers have found that Egyptians, Greeks, and Romans were using to dye their hair several thousand years ago. Many different extracts from plants were used for hair dyeing in Europe and Asia before the invention of modern dyes. There are three types of hair dye. Hair Structure and Growth Hair covers nearly the entire human body surface, except for areas like palms, soles, and mucosal regions.^[16] There are two primary types of hair, vellus and terminal. Terminal hairs, found on the scalp, eyebrows, and eyelashes, are thicker, longer, and pigmented. Hair development follows a continuous cycle catagen (regression), telogen (rest), hemistry of Hair Dye. In humans, all the different hair colors are due to just two types of pigment (melanin) called eumelanins and pheomelanins.^[16] Eumelanins are the dark brown and black pigments while pheomelanins are the red and blonde pigments. The different colors of hair in different people are due to a combination of these two different basic biochemical structures. By mixing the two types together in different concentrations the many different shades of hair color are made. A study that analyzed the amount of eumelanin and pheomelanin in human hair suggested that; black hair contains approximately 99% eumelanin and 1% pheomelanin, brown and blond hair contain 95% eumelanin and 5% pheomelanin; and red hair contains 67% eumelanin and 33% pheomelanin. Although people with dark hair may still produce the yellow - orange pheomelanin, A wide variety of dyes, dressings, and conditioners are available to men and women to enhance the color of hair or to alter its condition, providing the "feel good" factor. Natural hair dyes such as henna and mineral salts are still used, but hair dyeing increasingly involves careful chemical manipulation of the chemistry of hair fibers through bleaching or enhancement of natural colors. Available hair dyes include Minerals such as lead acetate.^[17]

1.1. Classification of hair dye^{[18],[19],[20]}

There are four most common classifications of hair colours

- Temporary non-oxidative,
- Semi-permanent hair dye,
- Permanent hair dye and
- Milder hair dye.

Firstly, temporary non-oxidative hair dye is effective for brightening the colour of the original hair, adding a tint or improving the colour of the hair. It can be rinsed off through water and rarely lasts until the next hair. Temporary hair colour is available in various forms including rinses, shampoos, gels, sprays, and foams. 'Silver shampoo' is an example of a temporary dye used to give a silver hair look to women with all-grey hair! For semi-permanent hair colour which can penetrate the hair shaft has a smaller size of molecules compared to temporary dyes. That is why this hair dye lasts a couple of weeks or four to six washes. This type of dye contains very low levels of developers, peroxide or ammonia. Moreover, it contains toxic substances such as p-phenylenediamine or other agents³ Nowadays a few items like lotions, shampoos, mousses, and emulsions are currently available on the market for hair products⁴ Next, permanent hair colouring is generally used when this category offers better effectiveness than permanent dyeing, which has shampoo resistance as well as other external factors. Most of such hair colours of this type are selling well, are available in many shades and cover all the white hair strands. Due to a combination of the oxidizing agents with those of the ammonia hydroxide, it is also possible to have dark and light natural hair colour. Permanent colours are everlasting and don't get washed out even though they may become paler. Permanent hair colours such as liquids, gels and creams are obtainable. Lastly, there are middle hair dyes which are milder on the hair than permanent colours since they do not contain ammonia and also have a lower hydrogen peroxide concentration compared to permanent hair colours. Thus, scalp irritation and hair shaft damage are lowered. They are beneficial in hiding grey hair, yet do not lighten the colour of the hair. Herbal hair dye is not easily available in the market in powder form which can give different shades.

1.2. Herbal drugs used in natural hair dye^{[21][22][23][24][25]}

- Henna (*Lawsonia inermis*): Henna is one of the most widely used natural colouring agents in traditional cosmetic preparations. The leaves contain the active dye molecule lawsone, which has strong affinity for keratin protein in hair and produces a reddish-brown colour after application. Major constituents are lawsone, tannins, flavonoids, phenolic compounds. Natural hair dye provides natural reddish-brown colour strengthens hair fibres helps reduce dandruff and scalp irritation.



Henna (*Lawsonia inermis*)

Indigo is a natural plant dye traditionally used to obtain dark blue or black shades in textile and hair colouring application. Major constituents are Indigotin, Indirubin flavonoids. This hair dye produces dark shades when applied to hair often used with henna to obtain brown or black colour Improves colour stability and longevity.



Indigo (Indigofera tinctoria)

Amla is widely used in Ayurvedic medicine and hair care products due to its nourishing and strengthening properties. Major constituents are vitamin C, tannins, gallic acid, flavonoids. This hair dye enhances colour retention in herbal formulations strengthens hair roots and prevents hair fall Promotes hair growth and scalp health.



Amla (Phyllanthus emblica)

- Hibiscus (*Hibiscus rosa-sinensis*) flowers and leaves are commonly used in herbal hair care preparations. Major constituents anthocyanins flavonoids organic acids.



Hibiscus (Hibiscus rosa-sinensis)

Shikakai is a traditional herbal ingredient widely used as a natural hair cleanser. Major constituents are saponins, alkaloids, tannins.

Table No. 1.2: Herbal drugs used in natural hair dye.

Common name	Botanical name	Family	Part used	Major constituents
Henna	<i>Lawsonia inermis</i>	Lythraceae	Leaves	Lawsonic acid, flavonoids, tannins
Indigo	<i>Indigofera tinctoria</i>	Fabaceae	Leaves	Indigotin, indirubin
Amla	<i>Phyllanthus emblica</i>	Phyllanthaceae	Fruit	Vitamin C, tannins, polyphenols
Hibiscus	<i>Hibiscus rosa-sinensis</i>	Malvaceae	Flowers	Anthocyanins, flavonoids
Shikakai	<i>Acacia concinna</i>	Fabaceae	Fruit pods	Saponins



Shikakai (Acacia concinna)

lawsone pigment *Indigofera tinctoria* (Indigo) – contains indigotin.

Hibiscus rosa-sinensis (Hibiscus)– contains anthocyanins *Phyllanthus emblica* (Amla)– rich in tannins *Acacia concinna* (Shikakai) – contains saponins. These phytochemicals contribute to hair colouring, conditioning, and antioxidant activity.

2.2 Extraction of Natural Hair Dye Compounds

Extraction is the process of removing bioactive colouring compounds from plant material using suitable solvents.

• Preparation of Plant Material

Collect plant leaves or fruits. Wash with distilled water to remove impurities. Dry in shade for 5–7 days. Grind into coarse powder using a grinder.

• Solvent Extraction Method

Common solvents used are water, ethanol, methanol, hydro-alcoholic mixture.

1.3. Role in hair dye

- Enhances natural hair colour Improves hair softness and shine, supports hair growth and scalp nourishment.
- Provides mild cleansing action Maintains natural scalp pH.
- Improves hair texture and manageability.

2. Extraction and isolation of natural hair dye^{[26][27][28]}

2.1 Selection of Plant Material Common plants used for natural hair dye: *Lawsonia inermis* (Henna) – contains

2.3 PROCEDURE

- Soxhlet Extraction-This method provides efficient continuous extraction.

Place plant powder in Soxhlet thimble, add solvent (ethanol or methanol) in flask, heat for 6–8 hours. Extract cycles continuously. Concentrate extract to obtain semi-solid dye extract.

2.4. Isolation of Dye Compounds

Isolation is the separation of individual pigment molecules from crude extract.

- Purification of Isolated Dye

Methods used are Recrystallization, Solvent evaporation, Freeze drying (lyophilization). This produces pure natural dye compound.

2.5. Characterization of Natural Dye

Isolated compounds are analysed using advanced techniques.

Characterization of natural hair dye formulations involves organoleptic evaluation, physicochemical analysis, phytochemical screening, chromatographic studies, stability testing, and safety evaluation. These parameters ensure that the herbal hair dye is effective, stable, safe, and suitable for cosmetic use.

- Organoleptic Characteristics for varicolored sensuous characters like color, taste, odour etc. The raw remedies and grease paints were single handedly studied by organoleptic and morphological characters like colour, odour, texture and appearance.

- Physico-Chemical Evaluation -The physical and chemical features of the herbal hair colour were rated to determine the pH, its moisture content and its ash value for the purpose of stability, peace and the volume of inorganic matter present in it.

Phytochemical Screening^{[29],[30],[31]}

- Molisch's Test: 1gm of sample was mixed with 1ml of distilled water and 2 to 3 drops of Molisch's reagent was added into it to determine the presence of carbohydrates.
- Volatile Oil Test: 1gm of sample was added into alcoholic solution of Sudan to observe the presence of volatile oil.
- Mayer's Test [For alkaloid]: 1gm of sample was added into Mayer's reagent which shows brown colour that indicates the presence of alkaloids.
- Hager test: sample + Hager reagent (Saturated solution of picric acid)
- Test for Carbohydrates (Reducing Sugars) (Fehling's test) The extracts were treated with 5.0 ml of Fehling's solution and kept in a boiling water bath. The formation of yellow or red colour precipitate indicates the presence of reducing sugars.

- Test for Saponins About 2 g of the powdered sample was boiled in 20 ml of distilled water bath and filtered. The 10 ml of the filtrate was mixed with 5 ml of distilled water and shaken vigorously for a suitable persistent froth. The frothing was mixed with 3 drops of olive oil and shaken vigorously and then the formation of emulsion was observed. This indicates the presence of Saponins.

- Test for Terpenoids A volume of 5 ml of the plant extract was mixed in 2 ml of chloroform and concentrated H₂SO₄ was added to form a layer. A reddish-brown colour of the interface shows the presence of terpenoids.

- Test for Alkaloids The plant extract was mixed with a few drops of acetic acid followed by Dragendroff's reagent and mixed well. An orange red precipitate formed indicates the presence of alkaloid.

- Test for Flavonoids 5 ml of dilute ammonia solution was added to the aqueous filtrate of the plant extract followed by the addition of concentrated H₂SO₄. A yellow color observed in the extract indicates the presence of flavonoids.

- Test for Tannins and Phenolic compound: About 0.5 g of the dried powdered sample was boiled in 20 ml of water in a test tube and then filtered. A few drops of 0.1% ferric chloride are added and observed for brownish green or a blueblack colour. A few drops of alcohol and ferric chloride solution were mixed with the plant extract. A blue green colour indicates the presence of phenol. Test for Amino Acids and Proteins To 1ml extract, 2 drops of freshly prepared 0.2% ninhydrin reagent was added and heated. Blue colour indicates the presence of proteins and amino acids. Test for Quinones A few drops of sodium hydroxide were mixed with the plant extract and shaken vigorously. A blue green or red color indicates the presence of quinones.

- Patch Test This usually involves dabbing a small amount of the aqueous solution of hair dye behind the ear or on inner elbow in an area of 1sq.cm and leaving it to dry. Signs of irritation or feeling of non wellness is noted, if any. Measured and small quantities of prepared hair pack were applied to the specified area for a fixed time. Irritancy, redness, and swelling were checked and noticed for regular intervals up to 24 hours if any.

- 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 viz., room temperature and 35°C and were evaluated for the physical parameters like colour, odour, pH, texture, and smoothness.

3. Thin Layer Chromatography (TLC) Method to Assess Natural Hair Dye Form^{[32],[33],[34]}

To analyze and identify phytochemical constituents present in natural hair dye formulations containing herbal ingredients such as Lawsonia inermis (Henna), Indigofera tinctoria (Indigo), Emblica officinalis (Amla), Hibiscus rosa-sinensis (Hibiscus), and Acacia concinna (Shikakai). Thin Layer Chromatography (TLC) is a chromatographic technique used to separate and identify compounds based on their differential adsorption and solubility between a stationary phase (silica gel) and a mobile phase (solvent system). Phytochemicals present in natural hair dye formulations migrate at different rates on a TLC plate and produce distinct spots with specific Rf values. Different spots indicate various phytochemical constituents in the formulation. Matching Rf values with standard extracts confirms the presence of active compounds such as: Lawsone from Henna Indigotin from Indigo Tannins and flavonoids from Amla and Hibiscus.

4. High Performance Thin Layer Chromatography (HPTLC)

HPTLC is an advanced form of TLC that provides better resolution, sensitivity, and reproducibility. It separates phytochemicals based on adsorption and capillary action on silica gel plates. Advantages of HPTLC.

- High sensitivity and accuracy. Simultaneous analysis of multiple samples suitable for herbal formulations. Rapid and cost-effective quality control Application in Natural Hair Dye Formulations Advanced techniques help to identify active dye molecules.
- Confirm presence of lawsone, indigotin, flavonoids, and tannins Standardize herbal hair dye formulations

Table No. 6.1: Ingredients of hair dye with their composition and function.

Ingredient	Quantity (%)	Function
Henna powder	40	Natural colouring agent
Indigo powder	25	Dark colour development
Amla powder	15	Hair strengthening
Hibiscus powder	10	Colour enhancement
Shikakai powder	10	Natural cleansing

7. Standardization of plant-based hair dye products^{[39],[40],[41]}

Skin compatibility, Digital pH meter, Patch test, Irritation assessment, applied on skin for 24 hr. Stability study Shelf life Accelerated stability testing, Dyeing efficiency, Color intensity, Applied on hair. Characterization of Natural Hair Dye in various formulations using advanced technologies (UV-Visible Spectroscopy and HPTLC): Natural hair dye formulations prepared from plants such as Henna (Lawsonia inermis), Indigo (Indigofera tinctoria), Amla (Phyllanthus emblica), Hibiscus (Hibiscus rosa-sinensis), and Shikakai (Acacia concinna) can be characterized using advanced analytical techniques such as UV-Visible spectroscopy and High Performance Thin

Layer Chromatography (HPTLC). These techniques help in identifying bioactive coloring compounds, purity, and quality of herbal formulations.

5. UV-Visible spectroscopy

It is based on the absorption of ultraviolet or visible light by chemical compounds, which causes electronic transitions. Each compound shows a characteristic maximum absorption wavelength (λ_{max}) that can be used for identification and quantification.

Procedure Prepare extract of herbal dye formulation using ethanol or methanol. Filter the extract using membrane filter paper. Dilute the sample appropriately. Scan the sample in UV-Visible spectrophotometer between 200–800 nm. Record the absorption spectrum and λ_{max} value.^{[35],[36]}

Table No. 5.1: Absorption spectrum and λ_{max} value of Phytoconstituents.

Plant	Active compound	λ_{max} (nm)
Henna	Lawsone	450–500 nm
Indigo	Indigotin	610–620 nm
Hibiscus	Anthocyanins	520–540 nm
Amla	Polyphenols	270–280 nm
Shikakai	Saponins	210–230 nm

6. Applications in Natural Hair Dye^{[37],[38]}

- Evaluation, Identification of active coloring compounds.
- Quality control of herbal formulations.
- Detection of adulteration or synthetic dyes.

Layer Chromatography (HPTLC). These techniques help in identifying bioactive coloring compounds, purity, and quality of herbal formulations.

8. Various Hair Dye Formulations and their compositions

Table No. 8.1: Powder Formulation.

Ingredients	Composition
Henna powder	40%
Indigo powder	30%
Amla powder	10%
Shikakai powder	10%
Hibiscus powder	10%

Table No. 8.2: Paste Formulation.

Ingredients	Composition
Henna extract	10%
Indigo extract	10%
Hibiscus extract	20%
Amla extract	15%
Coconut oil/se same oil	qs

Table No. 8.3: Oil-Based Formulation.

Ingredients	Composition
Henna extract	35%
Indigo extract	25%
Hibiscus extract	15%
Amla extract	15%
Shikakai extract	10%

Table No. 8.4: Oil-Based Formulation.

Ingredients	Composition
Henna extract	30%
Indigo extract	20%
Hibiscus extract	15%
Amla extract	15%

8.5 Shampoo-Based Dye

Ingredients	Composition
Henna extract	10%
Indigo extract	10%
Hibiscus extract	15%
Amla extract	20%
Shikakai extract	30%

9. Evaluation of Hair Dye Formulations^{[42],[43]}

Organoleptic Evaluation, Physicochemical parameter, s pH measured using digital pH meter, Phytochemical Screening, Chromatographic Evaluation, TLC (Thin Layer Chromatography), Identify lawsone (Henna), HPTLC advanced finger printing ensures batch consistency, Spectroscopic Analysis, UV-Visible Spectroscopy determine λ_{max} of dye compounds helps in quantification, stability studies, temperature variation (25°C, 40°C), humidity conditions evaluate color stability, pH changes.

11. DISCUSSION

The present study highlights the development and evaluation of various herbal hair dye formulations incorporating Henna (*Lawsonia inermis*), Indigo (*Indigofera tinctoria*), Amla (*Emblica officinalis*), Shikakai (*Acacia concinna*), and Hibiscus (*Hibiscus rosa-sinensis*). These plant-based ingredients are rich in bioactive constituents such as lawsone, indigotin, tannins, anthocyanins, and saponins, which collectively contribute to hair coloring, conditioning, and scalp health. Among the developed formulations, the powder and paste forms demonstrated superior performance in terms of color intensity and uniformity. This may be attributed to the direct interaction of finely powdered plant materials and concentrated extracts with the hair shaft, facilitating better dye penetration. The

combination of Henna and Indigo was particularly effective in producing a range of shades from reddish-brown to dark brown/black, depending on the ratio used. Henna alone imparts an orange-red color due to lawsone, while Indigo contributes a blue tone, their synergistic interaction results in darker hues. The inclusion of Amla enhanced dye uptake and improved the conditioning effect, likely due to its high tannin and vitamin C content, which promotes binding of dye molecules to keratin. Shikakai, rich in natural saponins, provided a cleansing action, ensuring removal of excess oil and facilitating uniform dye application. Hibiscus contributed mild coloring along with hair strengthening and shine, owing to the presence of anthocyanins and mucilage. Physicochemical evaluation showed that all formulations maintained a pH in the range of 5–6, which is ideal for scalp compatibility and minimizes hair damage. The moisture content and ash values were within acceptable limits, indicating good stability and purity of raw materials. Phytochemical screening confirmed the presence of key constituents responsible for dyeing and therapeutic effects. Chromatographic analysis using TLC and HPTLC revealed distinct fingerprints for lawsone and indigotin, confirming the authenticity and consistency of the herbal ingredients. UV-Visible spectroscopy further supported the presence of chromophoric compounds by showing characteristic absorption peaks (λ_{max}), which can be used for standardization. The hair strand test demonstrated effective coloring with good adherence and acceptable wash fastness, although the color retention was comparatively lower than synthetic dyes. However, this limitation is offset by the absence of harmful chemicals such as ammonia and PPD, making herbal dyes safer for long-term use. The skin irritation test indicated no significant irritation, confirming the safety profile of the formulations. Stability studies under different environmental conditions showed that the formulations remained stable with minimal changes in color and pH, indicating good shelf-life. However, slight variations in color intensity were observed over time, possibly due to degradation of natural pigments. Overall, the study confirms that herbal hair dye formulations offer a multifunctional approach, combining coloring, conditioning, and scalp care. While they may not provide instant or highly permanent results like synthetic dyes, their biocompatibility, eco-friendliness, and therapeutic benefits make them a promising alternative in cosmetic applications.

10. CONCLUSION

Phase separation herbal hair dyes offer a natural alternative to synthetic hair colouring products, using plant-based ingredients such as henna, shikakai and amla. They are generally safer, with fewer chemical irritants, making them suitable for individuals with sensitive scalps or allergies. It helps avoid harsh chemicals, reduces the risk of allergies, and can even improve hair health. Although the color results may be more subtle and may not last as long as chemical dyes,

herbal hair dyes are a healthier, eco-friendly alternative for those looking to care for their hair naturally. While herbal dyes may not provide the same long-lasting or vibrant results as synthetic dyes, they nourish the hair, improve texture, and promote scalp health. Overall, herbal hair dyes are an eco-friendly and health-conscious choice for those seeking gentle and natural hair colouring solutions. Technological Innovations for natural hair dyeing.

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Conflict of interest

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REFERENCES

- Patni P, Gahtori A, Bhandari P, Dimri T, Ahmad M. Herbal hair dye: formulation and evaluation. *Pharmacognosy Research*. 2024; 16(2): 294–299.
- Temkar R, Pagire D. Preparation and evaluation of herbal hair dye. *World Journal of Pharmaceutical Research*. 2022; 11(6): 1450–1456.
- Korade AB, Chaudhari YS, Kale AN, Deshmukh VN. Formulation and evaluation of polyherbal shampoo powder containing natural dyes. *International Journal of Research in Pharmaceutical Sciences*. 2019; 10(3): 2300–2306.
- Pal RS, Pal Y, Rai AK, Wal P, Wal A. Synthesis and evaluation of herbal-based hair dye. *The Open Dermatology Journal*. 2018; 12: 90–96.
- Mujawar S, Maniyar M, More V, Khilare M. Formulation and evaluation of herbal hair dye. *International Journal of Innovative Studies*. 2024; 8(1): 1–6.
- Nikitha MS, Veena M, Sneha M, Sreeya MS, Prerana MD, Sunitha D. Formulation and evaluation of polyherbal hair dye. *International Journal of Research in Pharmacy and Pharmacology*. 2025; 14(3): 277–286.
- Dutte PV, Chaudhari AV, Patil PA. Formulation and evaluation of herbal hair dye. *Journal of Ayurveda and Integrated Medical Sciences*. 2025; 10(10): 1–6.
- Draeos ZD. Hair cosmetics: an overview. *Dermatol. Clin.*, 2000; 18(4): 651–658.
- Saha R. Cosmeceuticals and herbal drugs: practical uses. *Int. J. Pharm. Sci. Res.*, 2012; 3(1): 59–65.
- Ali BH, Al-Wabel N, Blunden G. Phytochemical, pharmacological and toxicological aspects of *Lawsonia inermis*. *Phytother. Res.*, 2005; 19: 275–282.
- Bhuvaneshwari R, et al. Herbal hair dye formulation and evaluation. *Int. J. Pharm. Sci. Rev. Res.*, 2018; 50(2): 98–103.
- Pandey A, Tripathi S. Concept of herbal cosmetics. *Int. J. Pharm. Sci. Rev. Res.*, 2014; 27(1): 127–134.
- Srivastava S, et al. Natural dyes from *Lawsonia inermis* and their applications. *Indian J. Nat. Prod. Resour.*, 2011; 2(3): 403–408.
- Bechtold T, Mussak R. *Handbook of Natural Colorants*. Wiley; 2009.
- Kapoor VP. Herbal cosmetics for skin and hair care. *Nat Prod Radiance*. 2005; 4(4): 306–314.
- Ghosh A, et al. Phytochemical and pharmacological evaluation of *Hibiscus rosa-sinensis*. *Pharmacogn. Rev.*, 2010; 4: 27–32.
- Iyyanar TV, et al. Formulation and characterization of herbal hair dye. *World J. Pharm. Res.*, 2019; 8(5): 1450–1459.
- Patni P, et al. Formulation and evaluation of herbal hair dye. *Pharmacognosy Res.*, 2024; 16(2): 45–52.
- Temkar R, Pagire D. Preparation of herbal hair dye. *Int. J. Res. Appl. Sci. Eng. Technol.*, 2023; 11(5): 3320–3325.
- Rastogi SC, Johansen JD, Menné T. Natural ingredients based cosmetics: contact dermatitis. *Contact Dermatitis*. 1998; 39: 233–235.
- Brown KC. Hair coloring chemistry and technology. *J. Cosmet. Sci.*, 2013; 64: 33–41.
- Sharma P, et al. Hair dye reactions and safety. *J. Cosmet. Sci.*, 2018; 69: 123–130.
- Gupta R, et al. Natural dyes in cosmetics. *Int J. Res. Pharm. Sci.*, 2020; 11: 234–240.
- Ali BH, et al. *Lawsonia inermis*: A review. *Phytother Res.*, 2015; 29: 123–131.
- Singh V, et al. *Indigofera tinctoria* properties. *J Ethnopharmacol*. 2016; 180: 102–110.
- Patel D, et al. Herbal hair formulations. *WJPR*. 2021; 10: 300–315.
- Khandelwal KR. *Practical Pharmacognosy: Techniques and Experiments*. 19th ed. Pune: Nirali Prakashan; 2008: 149–156: 157–162.
- Harborne JB. *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis*. 3rd ed. London: Chapman & Hall; 1998; 1–7: 49–188.
- Kokate CK. *Pharmacognosy*. 48th ed. Pune: Nirali Prakashan; 2007; 1–10: 95–110, 428–432.
- Stahl E. *Thin Layer Chromatography: A Laboratory Handbook*. 2nd ed. Berlin: Springer; 1969: 1–52: 85–110.
- Sofowora A. *Medicinal Plants and Traditional Medicine in Africa*. 2nd ed. Ibadan: Spectrum Books Ltd; 1993: 1–20: 140–160.
- Trease GE, Evans WC. *Pharmacognosy*. 16th ed. London: Saunders Elsevier; 2009; 3–10: 95–120, 530–550.
- Wagner H, Bladt S. *Plant Drug Analysis: A Thin Layer Chromatography Atlas*. 2nd ed. Berlin: Springer; 1996; 1–20: 195–210.
- Lachman L, Lieberman HA, Kanig JL. *The Theory and Practice of Industrial Pharmacy*. 3rd ed. Mumbai: Varghese Publishing House; 2009; 760–780: 820–835.

35. ICH Guidelines Q1A (R2). Stability Testing of New Drug Substances and Products. Geneva: International Council for Harmonisation; 2003; 1–24.
36. Yadav N, et al. Nanotechnology in cosmetics: A review. *Int. J. Pharm. Sci. Res.*, 2021; 12(5): 2450–2460.
37. Singh R, et al. Encapsulation of herbal dyes for cosmetic applications. *J. Cosmet. Sci.*, 2020; 71(3): 145–156.
38. Patel V, et al. Standardization of herbal hair dye formulations. *Int. J. Pharm. Sci. Rev. Res.*, 2019; 58(2): 120–126.
39. Shoaeb SM, olkar A, Thore P, Vaidya S. Formulation and evaluation of herbal hair dye: A laboratory scale project. *Curr. Cosmet. Sci.*, 2023; 2: 1–8.
40. Lueadnakrob K, Juntrapirom S, Rongthong T, Chaiyana W. Functional performance and safety evaluation of pant-based dye mixtures. *Cosmetics*. 2025; 12(2): 78 (1–15).
41. Patni P, Gahtori A, Bhandari P, Dimri T, Ahmad M. The herbal hue: formulation and evaluation of herbal hair dye. *Pharmacogn Res.*, 2024; 16(2): 294–299.
42. Mujawar S, Maniyar M, More V, Khilare M. Formulation and evaluation of herbal hair dye containing banana heart petals. *Int. J. Innov. Stud.*, 2024; 8(1): 1–6.
43. Dutte PV, Chaudhari AV, Patil PA. Formulation and evaluation of herbal hair dye. *J Ayurveda Integr Med. Sci.*, 2025; 10(10): 1–6.