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FORMULATION AND EVALUATION OF MULTI-TONAL HAIR DYE FROM HENNA WITH INTEGRATION OF VARIOUS HERBAL INGREDIENTS

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ABSTRACT

The rising awareness of synthetic hair dyes results in the expanding need to utilize natural and safe variations of hair dyes. The herbal hair dye contains natural plant based components that provide hair dyeing effects and at the same time act in the healing aspect without damaging the scalp or hair. The present paper dwells on the preparation and testing of the multi-tonal hair dye based on Henna (***Lawsonia inermis***) and mixed with a great number of herbal constituents estimated to be dye-active, hair-conditioning and hair-nourishing.

They have come up with four different compositions by combining the use of traditions such as Indigo, Amla, Shikakai, Chamomile, Moringa, Hibiscus, Rose, Clove, Coffee, and Kaolin clay which are used traditionally in caring of the hair. The formulations were evaluated in terms of colour tone, spreadability, texture, stability and herbal functionality. The mixture of these herbs is supposed to result in shades between reddish-green and dark brown and black, depending upon proportions employed.

The herbal dyes did not only give out multi-tonal shades but also enhanced the texture of hair, cut down the growth of dandruff, ensured the growth of hair and gave an excellent cooling effect on the scalp. The product was developed without usage of harmful chemicals; hence it could be used regularly. This finding reveals that multi-herbal dye blends be a good solution to chemical dyes and would not only be aesthetic but also therapeutic in one mix.

KEYWORDS: Lawsonia inermis, Herbal hair dye, Guava leaf powder, Hair growth.

INTRODUCTION

Natural dyes are colours that are not chemically processed which are obtained out of plants and animals. Phytochemicals obtained in different plant substances, which form part of herbal medicines and shape and nourish healthy skin and hair [1]. The natural organic materials were mixed (in the past) with metals such as copper and iron to yield richer or more durable colour. Many plants are used as the main components in hair care products used in hair colouring, Lawsonia inermis, Acacia arabica, Eclipta alba, Juglans regia, Petrocarpus inducus, Pilocarpus jaborandi, and Nardostachys jatamansi among others [2, 3, 4]. Colourants come in two categories though; temporary and permanent. When using temporary colouring, colour can easily be eliminated in hair. Permanent hair colouring requires addition of aromatic diamine, hydric phenols or poly compounds such as paraphenylendiamine to the mixture. Applications of dye containing substances to natural hair on a regular basis will cause numerous negative things such as erythema, irritant of skin, hair loss or damage as well as cancerous growth to skin [5]. Commercial synthetic colour - para-phenylenediamine is the key ingredient in most of the formulations of the labelled exotics herbal hair dyes in the amount of 2025 percent. A lot of individuals can develop an allergic skin rash. The number of unwanted side effects that this chemical may lead to include skin irritation, allergies, hair damage, skin discolouration, unpredicted hair colour, and many other side effects. Regular use of such chemicals on natural hair may cause a series of side effects, which includes skin cancer, erythema, dry scalp, and loss of hair. Henna has been long used in India on palms and hair. Women use henna on their bodies since the Bronze Age, during weddings and other social events [6]. Chemicals present in synthetic hair dyes are able to eliminate, alter or conceal the natural hair colours. Murder, to enhance and fix the dye colour, comprises inorganic salts like lead acetate, lead acetate, copper sulphate and aluminium sulphate. Applying such chemicals may cause undesired side effects including; cancer, unpredictable hair colour changes, discolour of the skin, loss of hair and temporary skin irritation and allergies. Naturopathy has access to the targeted level of hair which is black, shiny, strong roots [7, 8]. The aim is to come up with four distinct formulations based on varying combinations of herb ingredients in order to obtain different tonal results, determine their physical properties, and determine how effective they are to use as natural hair dyes. The multi-herbal mixes are not only intended to provide wanted colouring, but also increase the

strength of the hair, decrease dandruff, and even the beauty of the rest of the scale- making them safer and more comprehensive replacements to man-made dyes.[9,10]

OBJECTIVES

1. To formulate four different multi-tonal herbal hair dye powders using *Henna* as the base and combining it with various dry herbal powders to achieve diverse natural shades.
2. To utilize only dry powdered plant-based ingredients free from synthetic chemicals to ensure safety, eco-friendliness, and ease of use.
3. To evaluate the physical and functional characteristics of the formulated dry powders, including texture, colour, aroma, powder uniformity, and moisture stability.
4. To assess the colouring performance of the dry herbal dye powders when mixed with water and applied to hair strands, with attention to shade depth, coverage, and tonal variation.
5. To compare the four formulations based on their herbal composition and resulting hair colour to determine the most effective combination for multi-tonal dyeing.
6. To offer a natural and holistic alternative to chemical hair dyes that not only imparts colour but also promotes scalp health, strengthens hair, and minimizes side effects.

MATERIALS AND METHODS

Ten essential herbal powders were selected for the formulation of the Herbal Hair Dye Pack, as shown in **Table 1 (INGREDIENTS)**. All the ingredients—including ***Henna,* Indigo, Amla, Shikakai, Hibiscus, Chamomile, Moringa, Rose, Clove, *and* Coffee**—were obtained in powdered form from authorized herbal retailers in the local market. The selection of herbs was based on their natural colouring ability, conditioning effects, and traditional use in Ayurvedic hair care.

To ensure consistency, all herbal powders were sieved through a 100-mesh sieve and then blended thoroughly in a dry, sterile container to obtain a homogeneous composition. No chemical preservatives, synthetic colours, or additives were included in any formulation.

Hair strands used for the evaluation were natural blonde hair, collected from a local barber's shop with prior permission. These samples were washed, dried, and stored in sterile covers prior to dye application. The hair dye paste was prepared by mixing the powder with warm water immediately before application and applied to the hair strands using a clean spatula.

Each formulation was tested for

- Colour shade and intensity
- Texture and spreadability of the paste
- Hair feel after application
- Stability of the dry powder during storage

Observations were recorded post-application and drying to assess the overall effectiveness of each herbal blend.[11-14]

EVALUATION

The developed herbal hair dye formulations were examined for several parameters, including organoleptic, rheological, patch test, hair colouring and stability studies.

ORGANOLEPTIC EVALUATION

Organoleptic aspects for a variety of sensory attributes, such as colour, odour, etc., were meticulously recorded. As shown in **Table 6**, the organoleptic and morphological characteristics of the raw medications and powders, such as colour, odour, texture, and appearance, were independently examined.[15]

RHEOLOGICAL EVALUATION

For the internal evaluation of the dry powder formulations, physical parameters including bulk density, tapped density, angle of repose, Hausner's Ratio, and Carr's Index were measured and analysed to assess the flow properties of the herbal hair dye powders. These properties are essential for determining the behaviour of powders during processing, storage, and application.

To calculate the bulk density, a known quantity (100 g) of the powder formulation was carefully poured into a graduated measuring cylinder using a funnel. The initial volume occupied by the powder without tapping was recorded. After that, the cylinder was tapped repeatedly to allow the powder to settle and reach a consistent volume. The tapped density was then determined by comparing the final volume after tapping with the original weight of the sample. This comparison gives insight into the packing ability and flow efficiency of the powder under vibration.

The angle of repose was assessed using the fixed funnel method, which evaluates how well the powder flows on a flat surface. The herbal formulation was allowed to flow through a

fixed-height funnel onto a sheet placed on a horizontal surface. As the powder accumulated, it naturally formed a cone-shaped pile. The height (H) and base radius (R) of the heap were measured to calculate the angle of repose, which indicates how freely the powder particles flow. A lower angle suggests better flow, while a higher angle indicates cohesion between particles and potential flow issues.

Hausner's Ratio was derived by comparing tapped and bulk densities. This parameter reflects the inter-particle friction and cohesiveness of the powder. A value closer to 1 indicates free-flowing powder, while higher values suggest poor flow characteristics due to increased cohesion or moisture content.

The Carr's Index was also calculated to evaluate the compressibility of the herbal powder. It is an important indicator of how easily the powder can be packed, stored, or processed without forming clumps or causing flow obstructions in machinery.

Overall, these rheological parameters helped determine the handling quality of the herbal hair dye powders. The results, summarized in Table 7, confirmed that the powder formulations exhibited acceptable flow and packing properties, making them suitable for storage and practical use in cosmetic applications.

PATCH TEST

To evaluate the dermatological safety and potential for skin irritation from the formulated herbal hair dye powders, a patch test was conducted on human skin under controlled conditions. A small amount of the hair dye's aqueous paste was prepared by mixing the dry powder with warm water. This mixture was then applied to a clean area of skin, approximately 1 cm^2 in size, located either behind the ear or on the inner elbow of selected volunteers. The test area was left uncovered and allowed to dry naturally. After application, the site was observed periodically for any signs of irritation, such as redness, itching, swelling, rash, or discomfort. The applied area was continuously monitored for up to 24 hours to assess any delayed hypersensitivity or adverse reactions. The application was done in a measured and minimal manner to replicate a safe and practical usage scenario. No significant symptoms of irritation or allergic response were observed in the tested individuals. The findings confirmed the non-irritant and skin-safe nature of the herbal formulations. All outcomes from the patch test analysis are detailed in **Table 8.**

STABILITY TEST

The formulated dry herbal hair dye powders were subjected to a one-month stability study to assess their physical consistency and shelf-life under standard storage conditions. The powders were packed in sterile, airtight glass vials and stored at room temperature (approximately 35°C) to simulate real-world conditions. During the storage period, the formulations were periodically examined for physical parameters such as texture, smoothness, odour, colour, and pH to identify any signs of degradation or instability. The evaluation was performed at regular intervals throughout the month. No significant changes were observed in the physical appearance or performance of the powders. The texture remained free-flowing with no caking or clumping, the colour and odour remained stable, and no fungal or microbial growth was detected. The pH remained within acceptable limits when the powders were mixed with water for use. These findings confirm the stability and integrity of the herbal hair dye formulations under typical storage conditions. All recorded observations are presented in **Table 9.**

Table 1: Ingredients.

S.No	Ingredient	Botanical Name	Family	Uses
1	Henna	Lawsonia inermis	Lythraceae	Natural red-brown dye, conditioner
2	Indigo	Indigofera tinctoria	Fabaceae	Provides dark blue/black tone
3	Amla	Emblica officinalis	Phyllanthaceae	Strengthens hair, promotes shine
4	Shikakai	Acacia concinna	Fabaceae	Natural cleanser, improves texture
5	Hibiscus	Hibiscus rosa-sinensis	Malvaceae	Enhances color tone, promotes growth
6	Chamomile	Matricaria chamomilla	Asteraceae	Golden tint, soothing to scalp
7	Clove	Syzygium aromaticum	Myrtaceae	Antimicrobial, darkens color slightly
8	Moringa	Moringa oleifera	Moringaceae	Rich in nutrients, scalp nourishment
9	Rose Petal Powder	Rosa indica	Rosaceae	Softens hair, adds pleasant aroma
10	Coffee	Coffea arabica	Rubiaceae	Enhances brown color tone, adds shine
11	Kaolin Clay	-	-	Smoothens paste, absorbs oil
12	Curry Leaves	Murraya koenigii	Rutaceae	Prevents premature greying, strengthens roots
13	Lohabhasma	-	-	Enhances dark color tone, mineral content
14	Soapnut	Sapindus mukorossi	Sapindaceae	Natural cleanser, foaming property
15	Guava Leaf	Psidium guajava	Myrtaceae	Reduces hair fall, improves texture
16	Vetiver	Chrysopogon zizanioides	Poaceae	Cooling effect, strengthens root
17	Lemon Peel	Citrus limon	Rutaceae	Adds shine, prevents dandruff
18	Rosemary	Rosmarinus officinalis	Lamiaceae	Stimulates growth, improves circulation
19	Fenugreek	Trigonella foenum-graecum	Fabaceae	Prevents hair fall, conditions hair
20	Red Sandalwood	Pterocarpus santalinus	Fabaceae	Adds soft reddish tone, soothes scalp
21	Bhringraj	Eclipta alba	Asteraceae	Promotes hair growth, prevents greying
22	Reetha	Sapindus trifoliatus	Sapindaceae	Natural cleanser, makes hair soft and shiny
23	Black Tea	Camellia sinensis	Theaceae	Enhances dark tones, adds shine, reduces hair fall

Table 2: Herbal Hair Dye – Formula 1.

S.NO	INGREDIENTS	QUANTITY(G)
1	HENNA	18
2	INDIGO	36
3	AMLA	5
4	SHIKAKAI	10
5	CHAOMILE	5
6	JATAMANSI	4
7	ROSE	4
8	BHRINGRAJ	4
9	BLACK TEA	10
10	CLOVE	4
MFG DATE: MAR 25		EXP DATE: FEB 26

Figure 1: Formula 1.

Table 3: Herbal Hair Dye – Formula 2.

S.NO	INGREDIENTS	QUANTITY(G)
1	HENNA	40
2	HIBISCUS	10
3	CURRY LEAVES	10
4	AMLA	5
5	CHAOMILE	15
6	MORINGA LEAF	7
7	KAOLIN CLAY	8
8	BHRINGRAJ	5
MFG DATE: MAR 25		EXP DATE : FEB 26

Figure 2: Formula 2.

Table 4: Herbal hair dye – formula 3.

S.NO	INGREDIENTS	QUANTITY(G)
1	HENNA	50
2	LOHABHASMA	5
3	SOAPNUT	10
4	GUAVA LEAF	10
5	LEMON PEEL	5
6	VETIVER	5
7	AMLA	7
8	MORINGA LEAF	8
MFG DATE:MAR 25		EXP DATE: FEB 26

Figure 3: Formula 3.

Table 5: Herbal Hair Dye – Formula 4.

S.NO	INGREDIENTS	QUANTITY(G)
1	HENNA	18
2	SHIKAKAI	6
3	ROSE	6
4	ROSEMARY	6
5	ORANGE PEEL	6
6	FENUGREEK	6
7	INDIGO	36
8	COFFEE	16
MFG DATE: MAR 25		EXP DATE: FEB 26

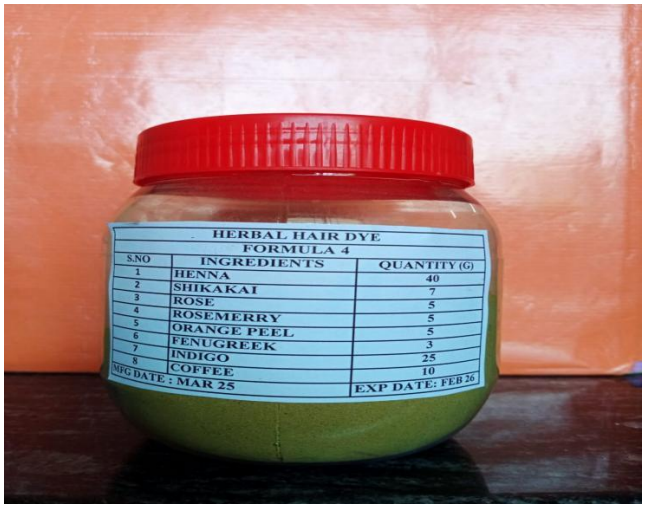

Figure 4: Formula 4.

Table 6: Organoleptic Evaluation.

Parameters	F1	F2	F3	F4	Market sample
Colour	Greenish brown	Green	Dark green	Brown	Dark brown
Odour	Pleasant	Herbal fragnance	Earthy	Floral&woody	Earthy
Texture	Smooth powder	Fine powder	Slightly coarse	Soft powder	Slightly coarse

Table 7: Rheological Evaluation.

Parameters.	F1	F2	F3	F4	Market sample
Bulk density	0.342g\ml	0.312\ml	0.321g\ml	0.309g\ml	0.354g\ml
Tapped density	0.443g\ml	0.5g\ml	0.520g\ml	0.473g\ml	0.50g\ml
Carr's index	22.7%	37.6%	38.2%	34.6%	22%
Hausner's ratio	1.29	1.60	1.61	1.53	1.34
Angle of repose	40	40.6	41	39	40

Table 8: Patch Test.

Parameters	F1	F2	F3	F4	Market sample
Application area	Inner forearm	Behind the ear	Wrist hand	Inner forearm	Behind the ear
Observation time	24hours	24hours	24hours	24hours	24 hours
Skin reaction	No redness, itching	No irritation, slight cooling sensation	No adverse reaction	No sign of allergy and rash	No irritation occurs
Result	Passed	Passed	Passed	Passed	Passed

Table 9: Stability Test.

FORMULA	PARAMETERS			
	COLOUR	ODOUR	TEXTURE	SMOOTHNESS
F1 Room Temperature (20ºC)	NO CHANGE	NO CHANGE	FINE	SMOOTH
35ºC	NO CHANGE	NO CHANGE	FINE	SMOOTH
F2 Room Temperature (20ºC)	NO CHANGE	NO CHANGE	FINE	SMOOTH
35ºC	NO CHANGE	NO CHANGE	FINE	SMOOTH
F3 Room Temperature (20ºC)	NO CHANGE	NO CHANGE	FINE	SMOOTH
35ºC	NO CHANGE	NO CHANGE	FINE	SMOOTH
F4 Room Temperature (20ºC)	NO CHANGE	NO CHANGE	FINE	SMOOTH
35ºC	NO CHANGE	NO CHANGE	FINE	SMOOTH
MARKET SAMPLE 20ºC	NO CHANGE	NO CHNAGE	FINE	SMOOTH
35ºC	NO CHANGE	NO CHAGNGE	FINE	SMOOTH

Figure 5: WHITE BLONDE HAIR

Figure 6: F1 BLACKISH- BROWN COLOUR HAIR.

Figure 7: F2 COPPER ORANGE COLOUR HAIR.

Figure 8: F3 DEEP REDDISH BROWN COLOUR HAIR,

Figure 9: F4 BLACKISH- BROWN COLOUR HAIR,

Figure 10: (MS) BLACK COLOUR HAIR.

RESULTS AND DISCUSSION

Four different herbal formulations (**F1, F2, F3, and F4**) were prepared using combinations of henna, indigo, and various dry herbal powders. For each test, 10 grams of powder were mixed with warm water or slightly add natural acidic lemon juice to form slurry and allowed to rest for 24 hours to activate the herbal components. The prepared paste was then applied onto natural blonde hair strands and left for 1 hour before washing with plain water.

The observed results showed distinct multi-tonal hair colour outcomes

Formulation F1 produced a medium brown shade. This blend contained henna, indigo, amla, shikakai, chamomile, rose, clove, and moringa, offering a balanced tone along with mild cooling and conditioning effects.

Formulation F2 yielded a light brown to auburn shade. It included henna, hibiscus, kaolin clay, curry leaves, chamomile, and moringa. The presence of clay gave a smoother texture to the paste, while hibiscus added shine and red undertones.

Formulation F3 gave a deep reddish-brown tone. This formula had henna, lohabhasma, soapnut, guava leaf, vetiver, lemon peel, and other botanicals. The metallic content of lohabhasma and citrus from lemon enhanced the intensity.

Formulation F4 showed the darkest brown to soft black shade. It was made from henna, indigo (higher proportion), coffee, rosemary, fenugreek, and shikakai. This formulation also provided enhanced shine, better hair grip, and conditioning.

Each formulation not only served as a natural hair dye but also functioned as a scalp revitalizer, anti-dandruff agent, and hair strengthened, owing to the synergistic effect of traditional herbal powders.

All four formulations underwent a patch test, which confirmed no signs of skin irritation, redness, or itching, establishing them as dermatologically safe. They also passed the stability study, remaining physically stable for 30 days at 35°C, with no signs of microbial growth, clumping, or odour change.

Among the four, F4 outperformed the others in terms of colour richness, hair texture improvement, and post-wash shine, likely due to its higher indigo and coffee content balanced with strengthening herbs.

CONCLUSION

In this study, four unique multi-tonal herbal hair dye powders were successfully formulated using Henna as the base, blended with various herbal ingredients including Indigo, Amla, Shikakai, Coffee, Chamomile, Hibiscus, Clove, Moringa, Curry Leaves, and others. All ingredients were used in dry powder form to maintain purity and simplicity in application. The formulated packs were evaluated for physicochemical properties, flow behaviour, stability, and dyeing performance. Among all, Formulation F4 exhibited the darkest and most consistent colour, producing a natural deep brown to soft black tone when applied on blonde

hair. It also showed enhanced benefits such as conditioning, anti-dandruff action, and scalp nourishment. Flow property analysis revealed that Formulation F4 had better rheological performance compared to the other formulations, making it easier to mix into a paste and apply evenly onto the hair. The patch test confirmed the non-irritant nature of all formulations, indicating they are safe for topical use. Stability testing also confirmed that the powders retained their texture, colour, and odour under storage at room temperature. Overall, the herbal hair dye packs demonstrated potential as a safe, effective, and chemical-free alternative to synthetic dyes. However, further research is recommended on application over various hair types and shades, as well as long-term usage studies, to fully understand the spectrum of tones and therapeutic benefits these formulations can offer.

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CONFLICTS OF INTEREST
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