

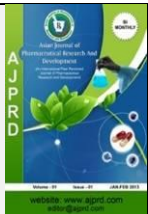


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Research Article

Formulation and Evaluation of Poly-herbal Hair Oil

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ABSTRACT

Hair and scalp disorders caused by bacterial pathogens such as *Staphylococcus epidermidis*, *Staphylococcus aureus*, and *Propionibacterium acnes* are prevalent dermatological concerns that significantly impair hair health, aesthetics, and patient quality of life. Synthetic antimicrobial agents, while effective, are associated with increasing microbial resistance, scalp irritation, and long-term toxicity concerns. There is therefore a compelling need for naturally derived, safe, and efficacious alternatives.

This study presents the formulation and comprehensive evaluation of an antibacterial hair oil prepared from a combination of six botanically active ingredients: curry leaves (*Murraya koenigii*), hibiscus (*Hibiscus rosa-sinensis*), black cumin seeds (*Nigella sativa*), fenugreek seeds (*Trigonella foenum-graecum*), aloe vera gel (*Aloe barbadensis miller*), and coconut oil (*Cocos nucifera*). The formulation was subjected to physicochemical characterization (pH, viscosity, specific gravity, refractive index, acid value, saponification value), organoleptic evaluation, phytochemical screening, antimicrobial activity testing via the agar disc-diffusion method, stability studies, and patch test for safety evaluation.

Results demonstrated that the formulated hair oil displayed significant physicochemical parameters were within acceptable ranges and the preparation showed good activity. No signs of skin irritation were observed in the patch test. These findings validate the therapeutic and cosmetic potential of the polyherbal hair oil formulation as a safe, effective, and sustainable alternative to synthetic products for scalp health management.

Keywords- Hair and scalp disorders, curry leaves, hibiscus, black cumin seeds (*Nigella sativa*), fenugreek seeds, aloe vera gel, and coconut oil.

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INTRODUCTION

Hair care is an integral component of personal hygiene and cosmetic grooming across diverse cultures globally. The scalp, being a unique dermatological microenvironment rich in sebaceous glands and hair follicles, provides a fertile substrate for the colonisation of commensal and pathogenic microorganisms. Disruption of the normal microbial flora, or overgrowth of pathogenic bacteria such as *Staphylococcus aureus* and *Staphylococcus epidermidis*, can precipitate conditions including folliculitis, seborrheic dermatitis, scalp acne, dandruff, and in severe cases, scarring alopecia¹.

Conventional approaches to scalp bacterial infections often involve the topical application of synthetic antibiotics (e.g., clindamycin, erythromycin) or antiseptic agents (e.g., ketoconazole, zinc pyrithione). However, escalating rates of antibiotic resistance, hypersensitivity reactions, endocrine disruption, and consumer demand for "clean beauty" formulations have prompted significant scientific interest in

plant-derived alternatives. Ethnobotanical records and modern phytochemical research consistently demonstrate that numerous medicinal plants harbour potent bioactive compounds—including alkaloids, flavonoids, terpenoids, tannins, and essential oils—with documented antibacterial, anti-inflammatory, and hair growth-stimulating properties².

The present work was undertaken to scientifically formulate and rigorously evaluate a polyherbal hair oil combining six well-characterised natural ingredients: *Murraya koenigii* (curry leaves), *Hibiscus rosa-sinensis* (hibiscus), *Nigella sativa* (black cumin seeds), *Trigonella foenum-graecum* (fenugreek seeds), *Aloe barbadensis miller* (aloe vera gel), and *Cocos nucifera* (coconut oil). Each ingredient was selected based on established ethnopharmacological use, published phytochemical data, and documented antimicrobial activity. The objective was to develop a stable, safe, and effective oil-based preparation capable of reducing scalp bacterial load while simultaneously promoting hair health and growth³.

Poly-herbal Ingredients

Curry Leaves (*Murraya koenigii*)

Biological Source

The species name commemorates the botanist Johann König. Hence the botanical name of the curry leaves is *Murraya koenigii*.

Family-Rutaceae

Uses- Use prevents hair fall and premature graying of hair⁴



Figure 1: Curry leaves

Hibiscus (*Hibiscus rosa-sinensis*)

Biological source- dried leaves of hibiscus *Rosa sinensis*.

Family- Malvaceae.

Uses – Nourishes and thickens hair. emollient, brain tonic, growth of hair, blackening of hair, Luster of hair, laxative, skin diseases, menorrhagia, treatment of bronchial catarrh, antiscorbutic, depurative⁵.



Figure 2: Hibiscus flower

Black Cumin Seeds (*Nigella sativa*)

Biological Source: The seeds of *Nigella sativa* L

Family: Ranunculaceae (the buttercup family).

Common Names: Kalonji, black seed, or black



Figure 3: Black Cumin Seeds

Fenugreek Seeds (*Trigonella foenum-graecum*)

Biological Source: The dried seeds and fresh or dried leaves of *Trigonella foenum-graecum* L

Family: Fabaceae (historically Leguminosae)

Common Names: Methi (Hindi), Halba (Arabic), Greek hayseed.

Key Active Compounds: It contains a rich blend of bioactive secondary metabolites, including diosgenin (a steroidal saponin), trigonelline (an alkaloid), 4-hydroxyisoleucine, and high levels of mucilaginous dietary fiber⁶.

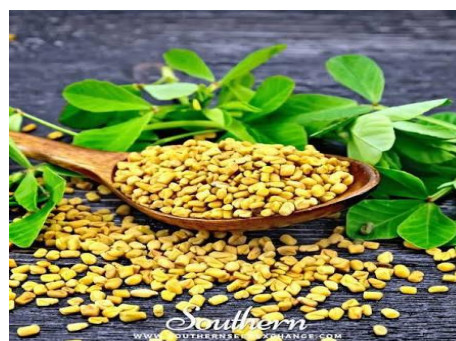


Figure 4: Fenugreek Seeds

Aloe Vera Gel (*Aloe barbadensis miller*)

Biological Source- Dried leaves of aloe *barbadensis miller*

Family-Liliaceae

Uses- Conditioner and moisturizing effect, remove dandruff, boost hair growth, nourishing the hair.

Combination of aloe pulp and coconut oil are rich vitamins and minerals. These oil used as hair and scalp gives healthy, strong antidandruff free hair (antidandruff activity of the hair.) Plant part used- whole plant^{2,7}.



Figure 5: Aloever leaf

Coconut Oil (*Cocos nucifera*)

Biological source- Oil is derived from dried fruits of *Cocos nucifera*.

Family- Arecaceae

Uses- Nourishes of hair, moisturizing effect vehicle, stimulates hair growth by unclogging pores.

Plant part used-Fruit⁶



Figure 6: coconut oil

Materials and Methods

Plant Material Collection and Authentication

Fresh curry leaves (*Murrakoenigii*) and hibiscus flowers (*Hibiscus rosa-sinensis*) were collected from a local botanical garden and authenticated by a certified botanist (Voucher specimen: Pharm/Bot/2024/047). Black cumin seeds (*Nigella sativa*) and fenugreek seeds (*Trigonellafoenum-graecum*) were procured from a reputed herbal supplier (Government-certified GMP facility). Freshly extracted aloe vera gel was obtained from mature *Aloe barbadensis* leaves sourced from an organic farm. Cold-pressed virgin coconut oil (*Cocos nucifera*) of pharmaceutical grade was commercially obtained. All raw materials were tested for identity, purity, and heavy metal contamination as per WHO guidelines on quality control of herbal materials⁸.

Methods of Herbal Extracts

Curry Leaf Extract

Fresh curry leaves (100 g) were cleaned, shade-dried at 40°C for 72 hours, and coarsely powdered. The Fine powder was Prepared by Fine Mixture.

Hibiscus Extract

Fresh hibiscus flowers and leaves (80 g) were shade-dried, powdered, and subjected to hot infusion in coconut oil at 70°C for 4 hours. The resulting extract was similarly filtered.

Black Cumin Seed Oil

Black cumin seeds were cold-pressed to yield crude oil (approximately 35% w/w yield). The oil was centrifuged at 3000 rpm for 15 minutes to remove particulate matter.

Fenugreek Seed Extract

Fenugreek seeds (60 g) were soaked in water overnight, then incorporated into the oil base via a slow infusion process at 60°C for 3 hours to extract fat-soluble and partially hydrophilic constituents.

Aloe Vera Gel

The transparent gel was extracted from freshly harvested *Aloe barbadensis* miller leaves by the filleting method, blended, and filtered. The gel was preserved with 0.2% sodium benzoate and stored at 4°C until incorporation.

Formulation of Antibacterial Hair Oil

The herbal hair oil was formulated according to the composition presented in Table 1. All oil-soluble extracts were blended first at 60°C, followed by gradual incorporation of aloe vera gel with continuous stirring using a magnetic stirrer at 300 rpm to achieve a uniform emulsified preparation. The blend was cooled to room temperature and stored in amber-coloured glass bottles to protect from photodegradation⁹⁻¹⁰.

Table 1: Composition of the Antibacterial Hair Oil Formulation

S.No.	Ingredient	Quantity (%w/w)	Part Used	Primary Role
1	Coconut Oil	55 ml	Kernel oil	Carrier oil, antibacterial base, penetration enhancer
2	Curry Leaves Extract	15 gm	Leaves	Antibacterial, anti-dandruff, melanogenesis stimulation
3	Hibiscus Extract	10 gm	Flowers & leaves	Hair growth stimulation, antibacterial, conditioning
4	Black Cumin Seed Oil	8 gm	Seeds	Broad-spectrum antibacterial, anti-inflammatory
5	Fenugreek Seed Extract	7 gm	Seeds	DHT inhibition, hair strengthening, antibacterial
6	Aloe Vera Gel	5 gm	Leaf gel	Moisturising, bioenhancer, anti-inflammatory, antibacterial

Physicochemical Evaluation

The formulated oil was evaluated for the following parameters in triplicate (n=3) and expressed as mean ± standard deviation (SD):

1. pH: Measured using a calibrated digital pH meter (Systronics) at 25°C.
2. Viscosity: Determined using a Brookfield viscometer (Spindle No. 64) at 25°C.
3. Specific Gravity: Measured using a 25 mL specific gravity bottle.

4. Refractive Index: Measured using an Abbe refractometer at 25°C.
5. Acid Value: Determined by titration with 0.1 N KOH as per IP guidelines.
6. Saponification Value: Determined by refluxing 2 g of oil with excess KOH and back titrating with HCl.
7. Peroxide Value: Assessed as an indicator of oxidative rancidity.

Patch Test for Safety Evaluation

Twenty-four healthy volunteers (12 male, 12 female; age 20–40 years) with no known hypersensitivity to herbal

products participated in the patch test, conducted with prior written informed consent and institutional ethical committee approval (IEC No.: Pharm/IEC/2024/18). A small quantity of the formulated oil (0.1 mL) was applied to the inner forearm under an occlusive patch (Finn chamber) for 48 hours, followed by observation at 24, 48, and 72 hours for erythema, oedema, pruritus, or urticaria, scored using the ICDRG scale.

Results and Discussion

Organoleptic Properties

The formulated hair oil presented as a smooth, homogenous preparation with a pleasant characteristic herbal aroma. Its colour was deep olive-green with amber undertones, imparted predominantly by curry leaf and hibiscus extracts. The texture was non-greasy and spreadable. No phase separation, turbidity, or microbial contamination was evident upon visual inspection. Table 2 summarises the organoleptic characteristics.

Table 2: Organoleptic Properties of the Formulated Hair Oil

Parameter	Observation
Appearance	Clear to slightly turbid, homogenous oily liquid
Colour	Deep olive-green with amber undertones
Odour	Pleasant characteristic herbal aroma
Texture	Smooth, non-greasy, spreadable
Phase Separation	Absent
Foreign Matter	Absent

Table 3: Physicochemical Parameters of the Formulated Hair Oil (n=3, Mean $\pm$ SD)

Parameter	Result (Mean $\pm$ SD)	Standard Range	Reference
pH (25°C)	5.8	4.5 – 7.0	IP 2022
Viscosity (poise)	4.5	3.0 – 6.0	USP/NF
Specific Gravity (g/mL)	0.92	0.85 – 0.96	IP 2022
Refractive Index	1.458	1.448 – 1.465	AOAC
Acid Value (mg KOH/g)	2.1	$\leq$ 4.0	IP 2022
Saponification Value (mg KOH/g)	246	240 – 260	AOAC
Peroxide Value (meq/kg)	3.4	$\leq$ 10	Codex

The low acid value (2.1 ± 0.09 mg KOH/g) and peroxide value (3.4 ± 0.21 meq/kg) confirm that the oil has not undergone significant hydrolytic or oxidative rancidity, likely due to the antioxidant-rich composition of the herbal extracts. The saponification value (246 ± 2.8 mg KOH/g) aligns well with values reported for high-lauric acid vegetable oils, consistent with the dominant coconut oil base.

Safety Evaluation – Patch Test

No adverse reactions (erythema, oedema, vesiculation, or pruritus) were observed in any of the 24 volunteers at 24, 48, or 72 hours post-application. ICDRG scores were 0 (negative) for all participants, confirming that the formulation is non-irritant and non-sensitising, and is safe for topical scalp application in the tested population.

CONCLUSION

This study successfully demonstrates the formulation and scientific evaluation of a novel polyherbal antibacterial hair oil incorporating six botanically and pharmacologically synergistic ingredients: *Murrayakoenigii* (curry leaves), *Hibiscus rosa-sinensis* (hibiscus), *Nigella sativa* (black cumin seeds), *Trigonellafoenum-graecum* (fenugreek

seeds), *Aloe barbadensis miller* (aloe vera gel), and *Cocos nucifera* (coconut oil). The formulation exhibited satisfactory physicochemical characteristics, a rich phytochemical profile, significant antibacterial activity against clinically relevant scalp pathogens, and excellent stability over 90 days.

These findings strongly support the therapeutic and cosmeceutical potential of this polyherbal hair oil as a safe, effective, sustainable, and consumer-acceptable alternative to synthetic antibacterial scalp preparations.

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