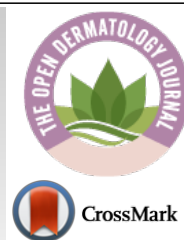


# The Open Dermatology Journal

Content list available at: <https://opendermatologyjournal.com>



## RESEARCH ARTICLE

### Assessment of Nutraceutical Potential of Herbs for Promoting Hair Growth: Formulation Considerations of Herbal Hair Oil

Gaurav Tiwari<sup>1</sup> and Ruchi Tiwari<sup>1,\*</sup> 

<sup>1</sup>Institute of Pharmacy, Pranveer Singh Institute of Technology, Kalpi Road, Bhauti, Kanpur 208020, India

#### Abstract:

#### Background:

Hair loss is a relatively common occurrence that causes concern in people of all ages. In most cases, hair loss is permanent, but it can lead to alopecia. Hair root activation is necessary to improve hair development and prevent hair loss. Herbal cosmetics are increasingly widely used by the general public due to the concept of fewer adverse effects and a higher level of safety and security.

#### Objective:

The primary goal of this study is to prepare and evaluate herbal hair oil made from fresh components of various plants.

#### Methods:

Herbs were acquired from Pranveer Singh Institute of Technology's medicinal garden. Herbs were collected, dried, then ground in a mortar and pestle. Grinded herbs (*Murraya koenigii*, *Hibiscus rosa-sinensis* Linn., *Nigella sativa*, *Trigonella foenum-graecum*) were combined with 60% *Cocos nucifera* oil, heated, cooled, and filtered. Physical appearance, viscosity, pH, sensitivity test, hair growth activity, hair weight, antimicrobial test, stability test, and other criteria were determined and are reported in this text for the created herbal hair oil.

#### Results:

Herbal hair oil was odourless and reddish brown in appearance. Herbal hair oil had an appropriate refractive index, pH, saponification value, and specific gravity. After application, the herbal oil demonstrated Newtonian flow, as well as good hair growth and weight, with no irritation. Phytochemical screening showed the presence of ascorbic acid, sulphur and saponins. The formulation was found to be stable for 30 days.

#### Conclusion:

Conclusively, combination of effective herbs could be used to improve hair growth.

**Keywords:** Herbs, Herbal hair oil, Physicochemical parameters, Antimicrobial study, Hair growth activity test, Hair weight test, Stability study.

#### Article History

Received: September 21, 2021

Revised: November 8, 2021

Accepted: November 24, 2021

## 1. INTRODUCTION

Hair is a protein filament that grows from dermal follicles. Mammalian hair is one of their most distinguishing features. Hair is most commonly associated with hair development, hair types, and hair maintenance, but it is also an essential biomaterial made mostly of protein, particularly alpha-keratin. Dandruff, hair loss, dry hair, split ends, frizzy hair, dull hair, heat damaged hair, colour damaged hair, grey hair, and other

issues are common in cosmetics. Many products, such as hair oils, hair shampoos, hair conditioners, hair serums, hair gels, hair masks, and hair dyes, are available on the market to help with these issues. Hair oils are applied to the hair to dress it, nurture it, and give it a more healthy aspect. They also encourage hair development that is both luxurious and long. Hair tonics are made from hair oils containing herbal medications. These are essentially therapeutic plant extracts in a base of oil. Herbal hair oil hydrates the scalp while also reversing the effects of dry scalp and hair. It contains a variety of vital nutrients that help the sebaceous gland operate normally and promote natural hair growth. The current study was carried out with this objective in mind [1 - 3].

\* Address correspondence to this author at the Institute of Pharmacy, Pranveer Singh Institute of Technology, Kalpi Road, Bhauti, Kanpur 208020, Uttar Pradesh, India; Tel: +91-9369047641; E-mails: [drruchitiwari@gmail.com](mailto:drruchitiwari@gmail.com), [dr.ruchitiwari@psit.in](mailto:dr.ruchitiwari@psit.in)

*Murraya koenigii* (*M. koenigii*) is a member of the Rutaceae family and is commonly employed in the Ayurvedic system of medicine as a medicinally important herb of Indian provenance. Previous research has shown that the leaves, roots, and bark of this plant are high in carbazole alkaloids, which have powerful biological and pharmacological effects. Antioxidant, antidiabetic, anti-inflammatory, anticancer, and neuroprotective properties are among them. *Murraya Koenigii* has long been known for its hair-root-strengthening effects. Massage hair and scalp with a mixture of dry leaf powder and organic coconut oil to promote hair development. Premature greying of hair can be slowed down by applying a curry leaf paste to them. Moisture is 63.2 percent, protein is 8.8 percent, carbohydrate is 39.4 percent, total nitrogen is 1.15 percent, fat is 6.15 percent, total sugars are 18.92 percent, starch is 14.6 percent, and crude fibre is 6.8 percent in the plant leaves. The leaves have been found to be a good source of various vitamins, including vitamin A (B-carotene). Carbazole alkaloids, essential oils, terpenoids, and flavonoids all play important roles in the body [4, 5].

*Trigonella foenum-graecum*, often known as fenugreek seeds, is a member of the Fabaceae family. Hair loss can be caused by a variety of factors, one of which is oestrogen insufficiency. External oestrogen administration has been linked to a disruption in the hormonal cycle and an increased risk of cancer [6]. One of the natural alternatives to oestrogen therapy can be found in a variety of plants that contain natural products, including phytoestrogens, which are molecules with mild estrogenic activity. By filling or attaching to the oestrogen receptor and providing the oestrogen action, phytoestrogen competes with oestrogen. Fenugreek seeds (*Trigonella foenum-graecum* L.) contain phytoestrogen, which is thought to promote hair growth [7, 8].

*Nigella sativa* (*N. sativa*), often known as black-caraway and “Kalonji,” is a well-known seed worldwide. Thymoquinone, thymohydroquinone, dithymoquinone, thymol, nigellidine, carvacrol, nigellimine, nigellidine, and alpha-hederin are some of the chemical elements found in its fixed oil. It was discovered that it affects several sections of our body and has many pharmacological actions such as antibacterial, antiviral, anti-inflammatory, and wound healing properties, as well as acne vulgaris, skin cancer, pigmentation, and many cosmeceuticals usages [9]. Telogen effluvium is a disorder in which hair thinning or shedding occurs as a result of hair entering the telogen phase too soon. *Nigella sativa* seed was employed in the study, which contains Thymoquinone (TQ), a major active ingredient that has anti-oxidant and anti-inflammatory properties by blocking pro-inflammatory mediators including cyclooxygenase and prostaglandin D2. A total of 20 individuals with Telogen effluvium were chosen for double-blind, placebo-controlled, and randomised research. For three months, ten of these patients received daily treatment with a lotion containing 0.5 percent *Nigella sativa*, whereas the other ten patients received daily treatment with a placebo. Before therapy (T0), after three months of treatment (T3), and during the six-month follow-up, video dermatoscopic analysis (Trichoscan Dermoscopy Fotofinder®) and inspection by three independent dermatologists were used to assess improvement

(T6). Patients treated with *Nigella Sativa* showed significant improvement in 70% of cases. In patients treated with *Nigella sativa*, videodermatoscopic research revealed a significant increase in hair density and thickness. In addition, *Nigella sativa* was found to alleviate inflammation in the majority of Telogen effluvium patients [10, 11]. *Hibiscus rosa-sinensis* Linn. (Malvaceae) is a glabrous shrub that is commonly cultivated as an ornamental plant in the tropics. It comes in a variety of varieties, each with different blossom colours. The red flowered type, however, is preferred in medicine. Hair development is stimulated by the leaves and flowers, while ulcer healing is aided by the blooms. The leaves and blooms of *Hibiscus rosa-sinensis* are thought to offer hair growth and anti-greying effects, according to traditional texts. Furthermore, in India, herbal products for hair development on the market include extracts from various portions of *Hibiscus rosa-sinensis*. As a result, the current study focuses on the scientific investigation of the herb *Hibiscus rosa-sinensis*'s hair growth potential [12].

*Cocos nucifera* oil, generally known as coconut oil or copra oil, is a member of the Areaceae family. It's utilised to hydrate hair, prevent hair breakage, improve blood flow and circulation, and function as an antibacterial agent [13].

Hair oils can be made in a variety of ways, including direct boiling, paste, and cloth processes [10]. The evaluation of preparation is the next major step after preparation. The therapeutic efficacy of the product is the next and final phase. The major goal of our study is to develop and test a herbal hair oil for hair growth improvement.

## 2. MATERIALS AND METHODS

### 2.1. Collection of Plant Part

*Murraya koenigii*, *Hibiscus rosa-sinensis* Linn., *Nigella sativa*, and *Trigonella foenum-graecum* were collected from the Medicinal Plant Garden of Pranveer Singh Institute of Technology, Kanpur, Uttar Pradesh, India, and were properly authenticated in the Department of Pharmacognosy for the preparation of herbal hair oil.

### 2.2. Formulation of Herbal Hair Oil

Precisely all the dried and fresh herbs such as *Murraya koenigii*, *Hibiscus rosa-sinensis* Linn., *Nigella sativa*, *Trigonella foenum-graecum* were weighed, grinded and mixed in 60% of *Cocos nucifera* oil (Table 1). The above content was boiled for 15 min, cooled and filtered through a muslin cloth. To the filtrate 25% *Cocos nucifera* oil was added to make up the volume (100 mL) (Fig. 1) [14].

**Table 1. Ingredients used in preparation of herbal hair oil.**

Ingredients	Plant Part	Quantity (%)
<i>Murraya koenigii</i>	Leaves	10
<i>Hibiscus rosa-sinensis</i> Linn.	Flower	5
<i>Nigella sativa</i>	Seeds	10
<i>Trigonella foenum-graecum</i>	Seeds	15
<i>Cocos nucifera</i> oil	Oil base	60

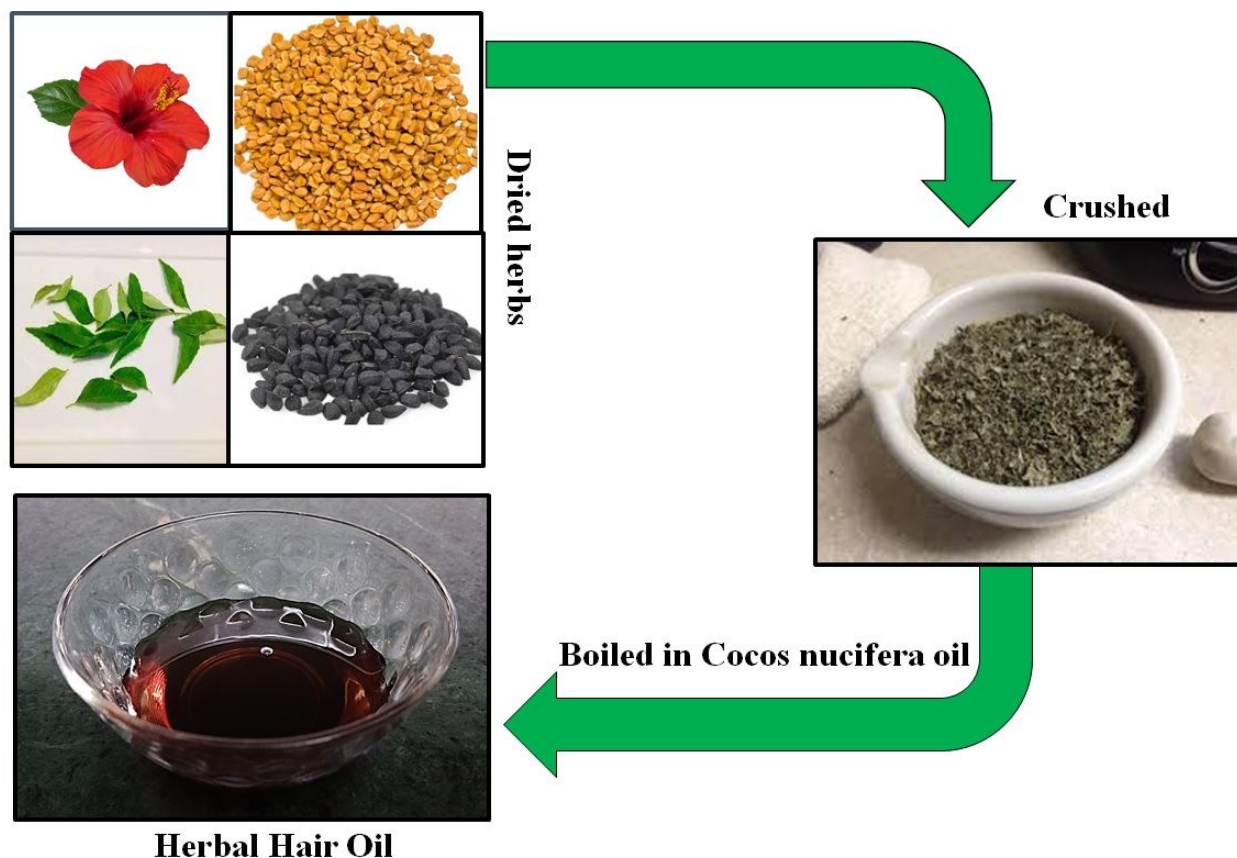


Fig. (1). Formulation of herbal hair oil.

### 2.3. Evaluation of Herbal Hair Oil Preparation

#### 2.3.1. Physical Appearance

The general characters like colour and odour were evaluated manually.

#### 2.3.2. pH Test

The pH metre was calibrated with buffer solutions of pH 4 and pH 7. The electrode was bathed in hair oil for a few minutes until the pH returned to normal [15].

#### 2.3.3. Viscosity

A Brookfield viscometer (RVDV-II+PRO) was used to measure viscosity with spindle number 6. 50 mL of hair oil was poured into the beaker, and the viscosity was tested at 100 rpm [16].

#### 2.3.4. Determination of Refractive Index

The refractometer's temperature was adjusted, and the oil sample was smeared over the cleaned prism before taking readings. The prism was washed with hot water when the measurements were finished. The following equation was used to rectify the readings [17].

$$R = R' + K (T - T')$$

Where, R= Adjusted reading, R'= Reading at T °C, T'=

temp at which readings taken, T= specified temp 40 °C, K= 0.00385 for oil.

#### 2.3.5. Saponification Value

In a 250 mL conical flask, 1 mL of oil was accurately weighed, and 10 mL of ethanol:ether combination (2: 1) was added. 25 mL of 0.5 N alcoholic KOH was added to this flask. The flask was kept for 30 minutes and then cooled. Using phenolphthalein indicator, the cooled solution was titrated against 0.5 N HCl. The blank titration was carried out in the same way but without using any oil (sample). The amount of KOH used in mg was computed [15].

### 2.4. Phytochemical Screening of Herbal Hair Oil Preparation

Using various procedures, the produced herbal oil was subjected to qualitative chemical analysis for the identification of numerous plant main ingredients such as sulphur, ascorbic acid, and saponins [18].

#### 2.4.1. Ascorbic Acid Test

Added 1 drop of freshly prepared 5 percent w/v sodium nitroprusside solution and 2ml of dilute sodium hydroxide solution to 1ml of 2 percent w/v solution and 5ml of water. Drop in 0.6ml of hydrochloric acid, mix, and records found.

### 2.4.2. Sulphur Test

On the test paper, a drop of hydrogen peroxide was placed. When exposed to fumes, the paper becomes brown.

### 2.4.3. Saponin Test

Formation of stable froth was observed by shaking oil and water in a test tube.

### 2.5. Specific Gravity

Specific gravity bottle was taken, rinsed with distilled water, dried in the oven for 15 minutes, cooled, and then weighed (a). Herbal hair oil was filled in the same specific gravity bottle, closed, and weighed again (b). Subtracted the weight (b-a) from the weight of the sample per millilitre [15].

### 2.6. Anti-microbial Evaluation by Cup Plate Method

The zone of inhibition approach was used to investigate the antibacterial activity of herbal hair oil that was diffusion dependent. The plate was incubated for two days at 37°C. The inhibitory zone was measured [19].

### 2.7. Primary Skin Irritation Test

A basic skin irritation test was performed on shaved undamaged skin of rat with a small amount of the produced herbal hair oil. For 3 to 4 hours, the test site was monitored for erythema and edema [12].

### 2.8. Hair Growth Activity *In Vivo*

Two groups of six rats were formed. All of the rats' hair was shaved off and cleaned with surgical spirit in a 4 cm<sup>2</sup> area on the dorsal portion of their bodies. A 10 ml of the produced herbal oil was administered once daily to the denuded areas of group I, while a control group (Group II) got no therapy. On the 15<sup>th</sup>, 20<sup>th</sup>, 25<sup>th</sup>, and 30<sup>th</sup> days of the therapy, hair was randomly taken from the shaved area of selected rats from each group. The average length of 15 hairs was found by measuring their length. The results are expressed as a standard deviation of 15 hairs for the mean length [20].

### 2.9. Hair Weight Measurements

To evaluate the weight of each box, the hair was removed and weighed on day 21 and then statistically measured [3, 20].

### 2.10. Stability Studies

The herbal hair oil was kept in the bottle at room temperature for stability study [18].

## 3. RESULTS AND DISCUSSION

The above-mentioned substances were used to make the herbal hair oil, which was then tested qualitatively.

### 3.1. Evaluation of Herbal Hair Oil

Developed herbal hair oil was reddish brown in colour with a transparent appearance, and when applied, it was smooth. The pH of the whole herbal hair oil was 7.3, which was suitable for hair, implying that the herbal hair oil was

compatible with hair [19]. The viscosity of herbal hair oil was determined to be 30 cps (Table 2), and Newtonian flow behaviour was observed. A Newtonian fluid is one in which the viscous stresses generated from its flow are linearly proportional to the local strain rate, or the rate at which its deformation changes over time, at every place. The viscosity of a Newtonian fluid remains constant regardless of the amount of shear applied at a constant temperature. The viscosity and shear stress of these fluids are proportional. The refractive index was used to determine the quality of herbal hair oil. Herbal hair oil was found to have a refractive index of 1.29 [20]. This demonstrates that a simple refractive index measurement in the laboratory may also be utilized as a quality control approach (Table 2). The smaller the average length of fatty acids, the lighter the mean molecular weight of triglycerides, and vice versa, the higher the saponification value. The saponification value of herbal hair oil was discovered to be 24.32 in practice (Table 2).

**Table 2. Evaluation parameters of herbal hair oil.**

Parameters	Results			
Physical appearance	Reddish brown			
Odour	Good			
pH*	6.8±0.012			
Viscosity (cps) *	30			
Refractive Index*	1.29			
Saponification value*	24.32			
Skin irritation test	No irritation			
Specific gravity*	0.83			
Antimicrobial study (Microorganism: <i>Candida albicans</i> )	Zone of inhibition (cm)			
	Cocos nucifera oil		Herbal hair oil	
	0.81		1.43	
Hair length (mm)*	15 <sup>th</sup> Day	20 <sup>th</sup> Day	25 <sup>th</sup> Day	30 <sup>th</sup> Day
	Control group	0.68 ±0.46	0.94±0.43 3.69 ±1.09	1.87 ±0.37
Herbal oil treated group	1.21 ±1.76		5.03 ±0.99	
Weight of the hair (mg)* on 3rd week of the treatment	Control group		Herbal oil treated group	
	150.12		219.49	

\*The value is expressed as mean ±SD, n=3.

### 3.2. Phytochemical Screening

Herbal hair oil contains ascorbic acid, sulphur, and saponins, according to phytochemical analysis (Table 3). Because of its powerful antioxidant action and nutritional importance as vitamin C, ascorbic acid is one of the most commonly used natural antioxidants. It has therapeutic properties in addition to antioxidant potential. It is a water-soluble vitamin that is easily absorbed but not stored in the body. Ascorbic acid is necessary for the preservation of collagen, which makes up around one-third of the total protein in the body. The ideal amount of ascorbic acid is used to prevent oxidative degradation of the oils. For a good reason, sulphur is commonly referred to as one of the building blocks of hair. Our hair is made up of keratin, a long-lasting protein with a high sulphur concentration. Sulfur is needed for proteins (like keratin) to keep their structure, which helps maintain hair's overall health, strength, and suppleness [21]. Sulfur has

been shown to promote hair development in research. Sulfur has been shown to increase the length of your hair's growing phase. Longer hair is associated with a longer growing phase (before resting and shedding) [18, 19]. Finally, sulphur has been associated with the treatment, alleviation, and prevention of psoriasis, dandruff, eczema, and folliculitis. Saponins are the most common phytochemicals that act as natural surfactants. Natural saponins provide body and gloss to hair, making it feel fuller, silkier, and smoother. Herbal hair oil has a specific gravity of 0.83 [21].

**Table 3. Phytochemical evaluation of herbal hair oil.**

Tests	Observations	Results*
Ascorbic acid test	Color change from yellow to blue	+
Sulphur test	Appearance of brown color	+
Saponin test	Appearance of foam	+

\*The value is expressed as mean  $\pm$ SD, n=3.

### 3.3. Antimicrobial Study

The cup plate method was used to test the antimicrobial activity of *Cocos nucifera* oil and herbal hair oil using the *Candida albicans* organism, and the findings are shown in Table 2 [15].

### 3.4. Primary Skin Irritation Test

The irritation caused by herbal hair oil was evaluated using a primary skin irritation test on rabbits' shaved undamaged skin. The absence of erythema and/or edema in the prepared herbal hair oil suggested that it was non-irritant to rabbit skin (Table 2) [20].

### 3.5. Hair Growth Activity and Hair Weight Tests

At the end of the second week, hair began to grow back from the denuded area, and the length of the hair began to increase until the treatment cycle was completed (Table 2). During the fourth week, when compared to the control group, it was discovered that the herbal oil treatment group had a substantial effect. This could be attributed to the gentle rubbing of shaved skin while applying extracts and placebo (liquid paraffin), which improves blood circulation in the local area and may have an influence on hair growth [22]. When compared to the control group, the herbal oil treatment group had a larger effect on hair length, with 8.89 mm at the conclusion of the course compared to 2.91 mm in the control group (Table 2). This could be caused to follicles moving from the telogen to anagen phase of the hair growth cycle too soon. Hair weight was found to be 219.49 and 150.12 mg for group I and group II, respectively. In Table 2, it can be seen that herbal hair oil corresponded to a higher weight in the third week [23].

### 3.6. Stability Study

The prepared hair oil was maintained at room temperature following the chemical analysis in a glass container. Following the time period, the same oil was tested again. Physical testing revealed a reddish-brown colour, a specific gravity of 0.91, and a viscosity of 30 cps in 30 days stored prepared oil.

## CONCLUSION

One of the most well-known hair treatments is herbal hair oil. Herbal hair oil not only hydrates the scalp, but also helps to heal dry scalp and hair. It contains various vital nutrients that support regular sebaceous gland activity and encourage natural hair growth. In this study, dried portions of *Murraya koenigii*, *Hibiscus rosa-sinensis* Linn., *Nigella sativa*, and *Trigonella foenum-graecum* were made into herbal hair oil and evaluated for their potential as an effective topical formulation for hair growth-promoting action. The results showed that herbal hair oil exhibited good pH, acceptable viscosity, and was stable at room temperature. Furthermore, the animal investigation revealed that the herbal hair oil created has a promising effect on hair growth stimulation with no negative side effects. As a result, it is clear that the herbal plant may be a preferable option for future formulations.

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by Animal Ethics Committee of Pranveer Singh Institute of Technology, Kanpur, India, under the registration number: 1273/PO/Re/S/09/CPCSEA.

## HUMAN AND ANIMAL RIGHTS

The institutional and international guide for the care and use of laboratory animals was followed.

## CONSENT FOR PUBLICATION

Not applicable.

## FUNDING

None.

## AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from the corresponding author [R.T], upon reasonable request.

## CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

## ACKNOWLEDGEMENTS

Declared none.

## REFERENCES

- [1] Ayyanar M, Ignacimuthu S. Medicinal plants used by the tribals of tirunelveli hills, Tamilnadu to treat poisonous bites and skin diseases. *Indian J Tradit Knowl* 2005; 4(3): 229-36. [<http://nopr.niscair.res.in/handle/123456789/8509>].
- [2] Gousia Begum S, Sekar M, Ravikumar K, Sekar Keerthana. Design and evaluation of herbal hair oil formulations by using ethanolic extract of *Ziziphus jujuba* leaves. *Int J Pharma Bio Sci* 2017; 8(3): 322-7. [<http://dx.doi.org/10.22376/ijpbs.2017.8.3.p322-327>]
- [3] Fatima Grace X, Rahul Raj S, Shanmughanathan S, Chamundeeshwari. Preparation and evaluation of polyherbal hair oil. *International journal of pharmaceutical chemistry and analysis* 2014; 1(1): 2394-797.
- [4] Balakrishnan R, Vijayranga D, Jo SH, Ganesan P, Su-Kim I, Choi DK. Medicinal profile, phytochemistry, and pharmacological activities of

- murraya koenigii and its primary bioactive compounds. *Antioxidants* 2020; 9(2): 101. [http://dx.doi.org/10.3390/antiox9020101] [PMID: 31991665]
- [5] Saini SC, Reddy GBS. A review on curry leaves (*Murraya koenigii*): Versatile multi-potential medicinal plant. *Am J Phytomed Clin Therap* 2015; 4: 363.
- [6] Yadav UC, Baquer NZ. Pharmacological effects of *Trigonella foenum-graecum* L. in health and disease. *Pharm Biol* 2014; 52(2): 243-54. [http://dx.doi.org/10.3109/13880209.2013.826247] [PMID: 24102093]
- [7] Tewari D, Jóźwik A, Lysek-Gładysińska M, *et al.* Fenugreek (*Trigonella foenum-graecum* L.) Seeds Dietary Supplementation Regulates Liver Antioxidant Defense Systems in Aging Mice. *Nutrients* 2020; 12(9): 2552. [https://sci-hub.do/https://www.preprints.org/manuscript/202007.0146/v1]. [http://dx.doi.org/10.3390/nu12092552] [PMID: 32846876]
- [8] Wijaya WH, Munim A, Djajadisastra J. Effectiveness test of fenugreek seed (*trigonella foenum-graecum* l.) extract hair tonic in hair growth activity. *Int J Curr Res* 2013; 5(11): 3453-60.
- [9] Ahmad A, Husain A, Mujeeb M, *et al.* A review on therapeutic potential of *Nigella sativa*: A miracle herb. *Asian Pac J Trop Biomed* 2013; 3(5): 337-52. [https://www.sciencedirect.com/science/article/abs/pii/S2221169113600751?via%3Dihub]. [http://dx.doi.org/10.1016/S2221-1691(13)60075-1] [PMID: 23646296]
- [10] Ijaz H, Tulain UR, Qureshi J, *et al.* Review: *Nigella sativa* (Prophetic Medicine): A review. *Pak J Pharm Sci* 2017; 30(1): 229-34. [https://europepmc.org/article/med/28603137]. [PMID: 28603137]
- [11] Amin B, Hosseinzadeh H. Black cumin (*Nigella sativa*) and its active constituent, thymoquinone: An overview on the analgesic and anti-inflammatory effects. *Planta Med* 2016; 82(1-2): 8-16. [https://www.thieme-connect.de/products/ejournals/abstract/10.1055/s-0035-1557838]. [PMID: 26366755]
- [12] Adhirajan N, Ravi Kumar T, Shanmugasundaram N, Babu M. *In vivo* and *in vitro* evaluation of hair growth potential of *Hibiscus rosasinensis* Linn. *J Ethnopharmacol* 2003; 88(2-3): 235-9. [https://www.sciencedirect.com/science/article/abs/pii/S0378874103002319?via%3Dihub]. [http://dx.doi.org/10.1016/S0378-8741(03)00231-9] [PMID: 12963149]
- [13] Rele AS, Mohile RB. Effect of mineral oil, sunflower oil, and coconut oil on prevention of hair damage. *J Cosmet Sci* 2003; 54(2): 175-92. [https://pubmed.ncbi.nlm.nih.gov/12715094/]. [PMID: 12715094]
- [14] Momota Y, Shimada K, Kadoya C, *et al.* The effect of a herbal paste and oil extract on the lipid content of canine hair fibres. *Vet Dermatol* 2017; 28(4): 337-e73. [http://dx.doi.org/10.1111/vde.12428] [PMID: 28261924]
- [15] Anjum F, Bukhari SA, Shahid M, Bokhari TH, Talpur MM. Exploration of nutraceutical potential of herbal oil formulated from parasitic plant. *Afr J Tradit Complement Altern Med* 2013; 11(1): 78-86. [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3957245/]. [http://dx.doi.org/10.4314/ajtcam.v11i1.11] [PMID: 24653557]
- [16] Mohammad Soleymani S, Salimi A. Enhancement of dermal delivery of finasteride using microemulsion systems. *Adv Pharm Bull* 2019; 9(4): 584-92. [https://apb.tbzmed.ac.ir/Article/apb-26452]. [http://dx.doi.org/10.15171/apb.2019.067] [PMID: 31857962]
- [17] Nagase S. Hair structures affecting hair appearance. *Cosmetics* 2019; 6(3): 43. [http://dx.doi.org/10.3390/cosmetics6030043]
- [18] Kuber BR, Lavanya C, Haritha C, Preethi S, Rosa G. Preparation and evaluation of poly herbal hair oil. *JDDT* 2021; 9(1): 68-3. [http://jddtonline.info/index.php/jddt/article/view/2161]
- [19] Amol Joshi A, Pravin Dyawarkonda M. Formulation and evaluation of polyherbal hair oil. *Int J green Pharm* 2017; 11(1): 135-9.
- [20] Tiwari R, Tiwari G, Ramachandran V, Yadav A. Development and evaluation of herbal hair serum: A traditional way to improve hair quality. *Open Dermatol J* 2021; 14: 3-9.
- [21] Rameshk M, Khandani SK, Raeiszadeh M. Medicinal herbs affecting gray hair in iranian traditional medicine. *Iran J Med Sci* 2016; 41(3)(Suppl.): S42. [https://pubmed.ncbi.nlm.nih.gov/27840508/]. [PMID: 27840508]
- [22] Abelan US, de Oliveira AC, Cacoci ESP, *et al.* Potential use of essential oils in cosmetic and dermatological hair products: A review. *J Cosmet Dermatol* 2021. [http://dx.doi.org/10.1111/jocd.14286] [PMID: 34129742]
- [23] Lee HJ, Kwon HK, Kim HS, Kim MI, Park HJ. Hair growth promoting effect of 4HGF encapsulated with PGA nanoparticles (PGA-4HGF) by  $\beta$ -catenin activation and its related cell cycle molecules. *Int J Mol Sci* 2019; 20(14): 3447. [http://dx.doi.org/10.3390/ijms20143447] [PMID: 31337050]