

Pharmaceutical Sciences 2024: Navigating the Future of
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**FORMULATION AND EVALUATION OF HERBAL ANTI-FUNGAL
GEL FOR DANDRUFF**

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ABSTRACT

Fungal diseases become a major medical problem. Fungal diseases are difficult to manage because they tend to be chronic, and hard to diagnose. The fungal infection is a common condition caused by fungi. The herbal antifungal gel was formulated using neem and aloe vera. Herbal medicine is one of the oldest and most universal healthcare systems. The herbal antifungal gel is very helpful and it has fewer side effects. All herbal ingredients are easily available in the market. The herbal antifungal gel is used to treat fungal infections which most commonly affect our skin, hair, and scalp. Herbal antifungal gels are used to treat fungal skin infections such as dandruff, and seborrheic dermatitis. The herbal antifungal gel is natural and safe to use, and the herbal antifungal gel is beneficial in the reduction of fungal infection.

Keywords: Herbal Anti-fungal gel; Dandruff; Herbs; Herbal ingredients; Fungal -infection

1. INTRODUCTION

1.1 HERBAL COSMETICS

The word “cosmetics” is derived from the Greek word “*kosmtikos*”, which means “power, arrangement, and ability in beautifying. According to the Drug and Cosmetic Act 1940, any article intended to be rubbed, poured, sprinkled or sprayed on or introduced to or applied to any part of the human body for cleansing, beautifying, promoting, attractiveness, or altering the appearance and includes any article intended for use as a component of cosmetics (1-5). Herbal cosmetics utilize natural ingredients derived from plants, herbs, and minerals to nourish and enhance the skin and hair. These products often exclude synthetic chemicals, making them popular for those seeking gentler alternatives. Ingredients like aloe vera, tea tree oil, lavender, and rosemary are common in herbal cosmetics for their soothing, moisturizing, and antioxidant properties. Many herbal cosmetics also incorporate traditional remedies from various cultures, such as Ayurveda and traditional Chinese medicine (6-10). These products are believed to be safer and less likely to cause adverse reactions or

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skin irritations compared to their synthetic counterparts. Additionally, they're often environmentally friendly, as they're derived from renewable resources and may be biodegradable (11, 12). However, it's important to note that while herbal cosmetics can offer benefits, individual reactions may vary, and it's crucial to choose products carefully and consult with a dermatologist if you have specific skin concerns. Herbal cosmetics can be of various types based on their application site- Skin, Hair, Eyes, Tooth, and Nails (13-16).

- **Herbal ingredients for various types of skin preparation include-**
 - a) For Dry Skin type- Manjistha, Avacado, Honey, Aloe vera, Banana, Tulsi, Liquorice, Shea butter, Vitamin E, Sesame oil, etc. (17).
 - b) For Sensitive Skin types- Tulsi, Neem, Carrot, Apricot, Eucalyptus, Cucumber, Turmeric, Banana, Pineapple, Coconut oil, Triphala, etc. (18).
 - c) For Oily Skin type- Tulsi, Triphala, Arjuna, Milk, Sour milk, Mustard oil, Cream, Buttermilk, Strawberry, Papaya, etc. (19).
- **Herbal ingredients for hair cosmetics include-** Brahmi, Amla, Mint, Sandalwood, Shikakai, Heena, Aloe vera, Rosemary, Dill, Reetha, Bhringraj, Haritaki, Jatamasi, Shatravari, Oregano, etc. (20).
- **Herbal ingredients for dental preparations include-** Clove, Mint, Peppermint, Ginger, Banyan, Ginger, Neem, Acacia, Black pepper, Amla, etc. (21).
- **Herbal ingredients for nail preparation include-** Thyme, Garlic, Onion, Methi, Rose oil, Aloe vera, etc. (22).
- **Herbal ingredients for eye preparation include-** Parsely, Vegetable oil, etc. (23-25).

1.2 GEL

The gel is a solid, jelly-like material with a three-dimensional cross-linked network in the liquid. The physical connectors and crystalline or other junctions that are still present in an extended liquid can provide the internal network structure (26). Usually, the "solid" phase forms an interconnected network through which the "liquid" phase lies. The gels may be of any type i.e.; Hydro-gels, Organ o-gels, or Xero-gels.

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AQUAGELS	<ul style="list-style-type: none">• It contain approximately 99% of water with natural or synthetic polymer.• Hydro-gels contains high flexibility due to high water content.
ORGANOGELES	<ul style="list-style-type: none">• These are thermoplastic, non-crystalline, non-glassy solids made of liquid organic phase that is confined inside a three-dimensional cross-linked network.• Mineral oil, vegetable oil, or organic solvents are all acceptable liquids for this gel.• These gels are utilized in medications, cosmetics, art conservation and food.
XEROGEL	<ul style="list-style-type: none">• These are solid that is created from a gel by unrestricted drying shrinkage. They have high porosity (25%) and high surface area (150-900sq.m/g), with very small pore size (1-10 NM).• Heat treatment at high temperature to xerogel, produce dense glass. The various gel forming compounds like natural gums, carbomers, cellulose derivatives are used to produce gel.

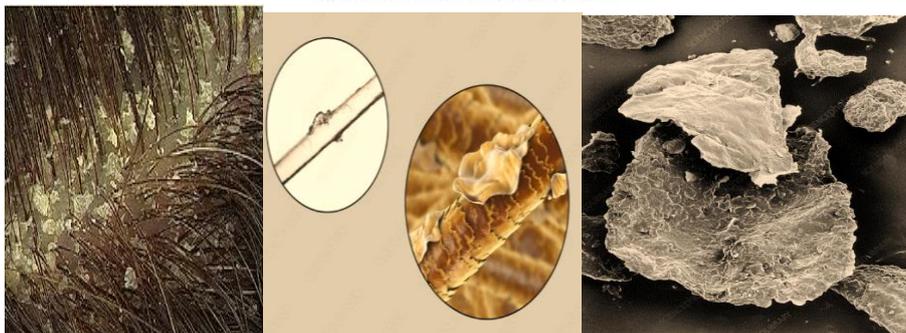
Gel denotes a semi-solid mixture with the following properties- does not flow under the stress of gravity, i.e., at low shear, does flow under higher imposed shear, frequently it is clear, i.e. not an opaque oil-in-water suspension (ointment) nor an opaque water-in-oil suspension (cream), Swelling, Syneresis, Hydration, Clarity, Shear reversibility, Ageing, and Rheology modification (27). Advantages of gel formulation- easy to formulate, elegant and non-greasy formulation, have good adherence properties, non-toxic and non-irritant, softens and moisturizes the skin, shear reversibility, good stability. Risk factors- may dry out, so far increasing the viscosity and stability of gels the glycerol (10%), polyethylene glycol is added, may cause local irritation, so far reducing the size (<500 Dalton) to diffuse through the stratum corneum (28).

1.3 DANDRUFF

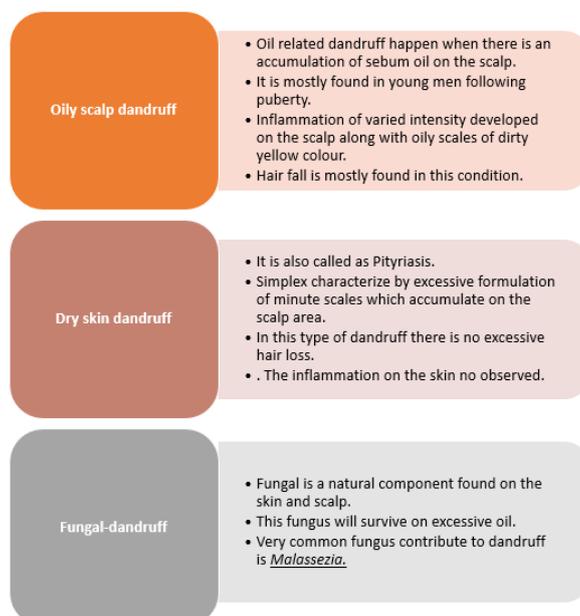
Dandruff is a general scalp condition that affects most of the population at teen-age. The word dandruff is of Anglo-Saxon origin which is a combination of 'tan' meaning 'teeter and 'druff' meaning 'dirty' (29). The dandruff is distributed most commonly in the hairy part of the head, forehead, external ear canals, eyebrows eyelashes, etc. Dandruff is a group of cells (corneocytes) that have a strong degree of cohesiveness and separate from the surface of the stratum corneum surface (30).

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The most prevalent cause of dandruff is the fungus *Malassezia furfur*. This fungus is dependent on lipids. It is responsible for many cutaneous diseases like dandruff, seborrheic dermatitis, etc. (31). During dandruff, there is an increased level of *Malassezia furfur* by 1.5-2 times its normal level. Dandruff may also be caused by frequent exposure to extreme heat and cold; family history; food allergies; excessive perspiration; use of alkaline soaps; and stress contribute to the dandruff production (32). Mainly there are three types of dandruff- Oily scalp dandruff; Dry skin dandruff and Fungal-dandruff (33).



For treatment of dandruff-

- Follow a healthy diet-** Food rich in omega-3 fatty acids, B vitamins, and zinc. The dietary sources for these vitamins and minerals include salmon fish, broccoli, walnuts, spinach, egg, cabbage, whole grain, cereals, dairy products, nuts, red meat, etc. (34).
- Avoid stress-** Invest in stress management techniques like yoga, meditation, and breathing exercises to keep your stress away (35).

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- c) **Shampoos with a combination of various active ingredients against dandruff-** Ketoconazole, Selenium sulfide, Coal tar, Salicylic acid, Ciclopirox, Zinc pyrithione, etc. (36).
- d) **Anti-fungal properties carrying herbal ingredients-** Egg oil, Olive oil, Fenugreek seed, Apple cider vinegar, Neem, Rosemary, Hibiscus, Lime juice, Onion, Aloe vera, Amla, Coconut oil, etc. (37).

1.4 ANTIFUNGAL ACTIVITY

Antifungal gels are topical formulations intended to treat fungal infections of the skin, such as dandruff, seborrheic dermatitis, and hair fall. These gels typically contain active ingredients like clotrimazole, miconazole, terbinafine, or ketoconazole, which work by inhibiting the growth of fungi and eliminating the infection (38). Antifungal gels are applied directly to the affected area and are usually used for a specified duration as directed by a healthcare professional (39). They provide relief from symptoms such as itching, skin flakes, and irritation, and can effectively clear up fungal infections when used consistently and as prescribed (40). It's essential to follow the instructions on the packaging or provided by a healthcare provider for safe and effective use (41-43). Antifungal gel contains agents that either kill or stop the fungal growth and are used to treat or prevent the fungal infection. However, the mechanism of action of most antifungal gels is of two types-

1.3.1 Fungistatic agent- The agent that inhibits fungi's growth and reproduction but does not necessarily kill them is called a fungistatic agent. The fungal growth resumes when such an agent is removed from the environment.

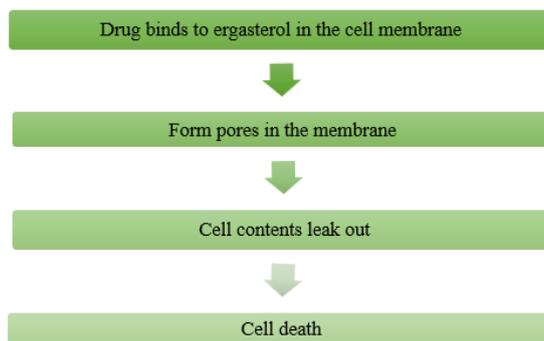
1.3.2 Fungicidal agent- The agent that kills fungi is called a fungicide agent.

Mainly fungicidal mechanism of action is used to treat various types of fungal infections for long-term relief and prevention. It includes various mechanisms of action-

- a) Fungal cell wall synthesis inhibitor-

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b) Inhibition of ergosterol and lanosterol synthesis-

Ergosterol is the major fungal cell component, important for cell membrane rigidity and stability. By inhibiting ergosterol synthesis, initiate the cell membrane loosening and hence results into cell lysis (the process is represented below in the fig 1).

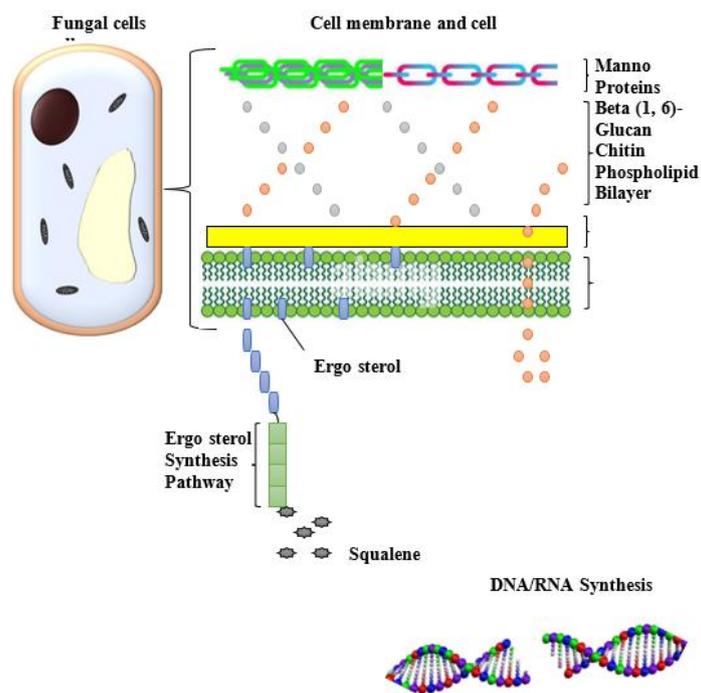
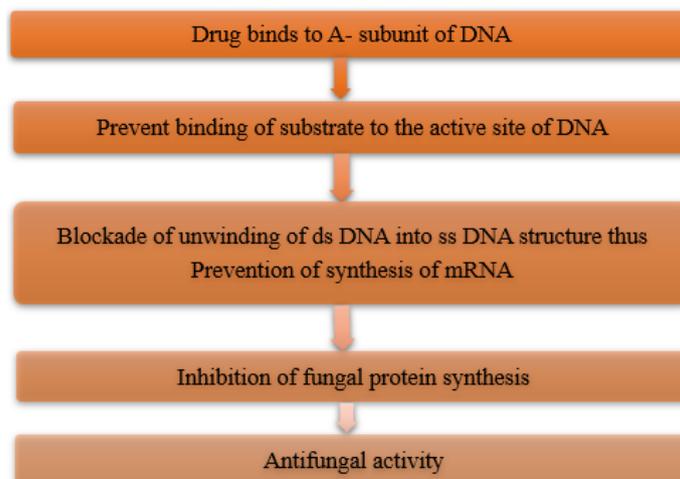


Fig. No. 1 Ergosterol synthesis inhibition

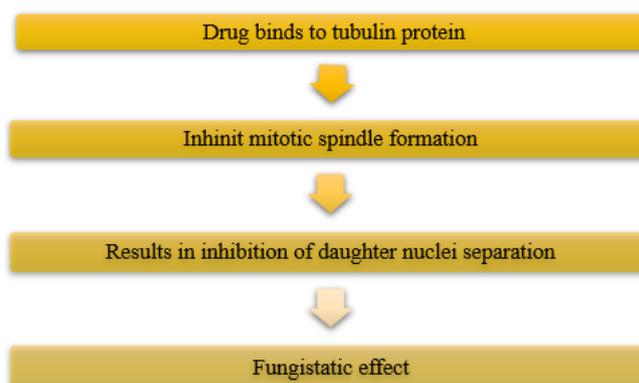
c) Inhibition of nucleic acid synthesis-

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d) Disruption of mitotic spindle and inhibition of fungal mitosis-



1.5 HERBAL INGREDIENTS

Herbal ingredients contain active ingredients. This importance lies in their chemical substances that produce a definite physiological action on the human body (44). The most important of these bioactive compounds include alkaloids, tannins, flavonoids, and phenolic compounds. The health effects of flavonoids include antioxidant, anti-inflammatory, anti-allergic, hepatoprotective, antithrombotic, antiviral, and anti-carcinogenic. Alkaloids show many useful effects like antihypertensive and anti-tumor. Alkaloid-based drugs include caffeine, quinine, nicotine, artemisinin, colchicine, and amblyopia. Tannins include corilagin and geraniin, which show anti-human immunodeficiency syndrome activity by inhibiting reverse transcriptase. Herbal ingredients are safe because they are natural. These are the ingredients with medical properties that manifest beneficial topical actions and provide protection against degenerative skin conditions. Advantages of herbal ingredients- they do not provoke allergic conditions, they do not have negative side effect, they are easily incorporated with

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cosmetic preparations, with small quantities, they are very effective, easily available and found in large variety and quantity, provide additional skin benefits (45). Disadvantages of herbal ingredients- have a slower effect as compared to the allopathic dosage form, it requires long-term therapy, they are difficult to hide taste and odor, the manufacturing process is time-consuming and complicated, no pharmacopeia defines any specific procedure or ingredients to be used in any herbal cosmetics. Storage of herbal products- herbs should be stored in a cool and dry place, avoid moisture around the herbs because it can promote bacterial and fungal growth, dried herbs can be stored in an airtight container, and the herb should be stored in direct sunlight (46). From the use of these herbal ingredients, various types of hair care preparations are formulated. These herbal hair care preparations carry numerous amounts of scalp nourishing properties as well as hair care properties. The herbal ingredients carry a large amount of active constituents that are beneficial in various kinds of skin or scalp-related problems with very less negative side effects. For these herbal hair care preparations, various parts of the plant or whole plant are used based on their active constituent. For nourishing action Aloe vera, Amla, and essential oils are used. For antimicrobial action Neem, Guava, Garlic, Onion, Thyme, and Lime are used. For hair loss prevention Amla, Shikakai, Reetha, and Heena are used (mentioned in Table 1)

Table 1: Herbal plants used in antifungal preparations

Sr. No	Plant	Biological Source	Chemical Constituents	Part Used	Marketed Products	Reference
1	Neem	<i>Azadirachta indica</i> (Meliaceae)	Nimbosterol, nimbin, quercetin, nimbidin, nimbosterol, mergosine, azadirachtin, azadiradione	Leaf, Flower, Seed, Bark	Greenleaf anti-hair fall serum; Khadi Natural Neemasat hair conditioner; Nimbin 2-in-1 shampoo with conditioner	47-49
2	Garlic	<i>Allium sativum</i> (Alliaceae)	Allin, allyl methyl sulfide, diallyl sulfide, allicin, z-ajoene, e-zone	Bulb	Cosmo hair treatment cream; Hollywood Secrets garlic oil;	50-51

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					Ayubal Wellness garlic soft gel capsule	
3	Cumin	<i>Cuminum cyminum</i> (Umbelliferae)	Cumin aldehyde, p-cymene, neo-piene, limonene, perilla aldehyde	Seed, Flowering part	Alvia black cumin seed oil; Avimee herbal Radha moisturizing hair conditioner; Dr. Jain cumin seed oil	52
4	Ginger	<i>Zingiber officinale</i> (Zingiberaceae)	Gingerol, shagol, zingiberine, zingiberol, bisabilone, trace amount of Ca, Mn, Fe, Cu, K	Rhizome	Lotus botanicals ginger root dandruff control shampoo; Lanthome hair growth essence; Sandarbh hair nutrient solution oil, shampoo, and conditioner	53-54
5	Clove	<i>Syzygium aromaticum</i> (Myrtaceae)	Thymol, eugenol, eugenyl acetate, quercetin, caffeic acid	Dried flower bud	Wellmee natural clove oil; Mesmara clove bud essential oil; Seyal clove essential oil	55-56
6	Basil	<i>Ocimum sanctum</i> (Lamiaceae)	Eugenol, carvacrol, estragole	Leaf	Hollywood Secrets tulsi oil; Adven biotech anti-dandruff shampoo; Tulsi adivasi neelambari hair oil	57-60

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7	Oregano	<i>Origanum vulgare</i> (Lamiaceae)	Carvacrol, thymol, linalool, p-cymene, terpinene	Leaf	Pavak herbals oregano essential oil; Muckery oregano essential oil; Alvia oregano oil	61-62
8	Lemon	<i>Citrus limon</i> (Rutaceae)	Citric acid, ascorbic acid, flavonoids	Fruit, Seed	Kisra lemon anti-dandruff hair care combo; Mamaearth lemon anti-dandruff shampoo; Soulflower lemon essential oil	63-64
9	Dill	<i>Anethum graveolens</i> (Apiaceae)	Phellandrene, eugenol, anethole, flavonoids, coumarins, triterpenes, phenolic acids, umbelliferones	Seed	Radiv anti-fungal hair oil; Glowwelle dandruff control hair serum; Bioayurveda anti-fungal and anti-allergy creme	65-66
10	Olive	<i>Olea europaea</i> (Oleaceae)	Triglycerides, phenols, flavonoids, oleocanthal, tyrosol	Fruit, Seed, Leaf	Khadi organique olive oil; Palmers olive oil formula deep conditioner pack; Mamaearth Coco soft massage oil for babies	67-68
11	Guava	<i>Psidium guajava</i> (Myrtaceae)	Vitamin A, C, Fe, P, Ca, saponin, oleanolic acid, lyxopyranoside,	Leaf	Vridhhi guava leaf hair oil;	69-70

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			asabopyraneside, guaijavarin		Foressence apple- guava hair cleanser for dry hair; Oziva plant-based collagen builder	
12	Rosema ry	<i>Salvia rasmerin us</i> (Lamiace ae)	Cineole, piene, camphor, camphene, borneol	Leaf, Twig	Bubblefarm rosemary hydrosol and hair oil; Avimee herbal rosemary hair oil; Orbellaa rosemary water hair spray	71-72
13	Tea tree	<i>Malaleuc a alternifol ia</i> (Myrtaca e)	Terpinen-4-ol, terpinene, cymene, terpineol, limonene	Leaf	Newish tea tree essential oil; Mamaearth tea tree shampoo, hair mask, and conditioner; Body Gold Herbal Essentials anti- dandruff shampoo and conditioner	73-74
14	Aloe vera	<i>Aloe barbaden sis miller</i> (Liliacea e)	Aloetin A, B, phytosterol, saponins, vitamins, lignins, amino acids, proteins	Leaf, Rind	Pilgrim's ultimate healthy and happy hair kit; Aloe global aloe vera shampoo; Bio-organic pure aloe vera gel; Himalayan Organics aloe vera shampoo and conditioner	75

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15	Jjoba	<i>Simmondsia Chinensis</i> (Simmondsiaceae)	Sterols, vitamins, triglycerides	Seed, Root	Organic netra jjoba oil; Dr Batra's hair oil; Cliganic jjoba hair oil	76-77
16	Onion	<i>Allium cepa</i> (Amaryllidaceae)	Allicin, quercetin, fisetin, diallyl disulfide, diallyl trisulphide	Root, Peel, Bulb	Ayur ever red onion hair oil; Lotus botanicals red onion hair care range; Sesa onion hair growth and damage repair kit; Mamaearth onion hair care kit	78-79
17	Pumpkin	<i>Cucurbita maxima</i> (Cucurbitaceae)	Na, Ca, K, P	Seed, Leaf, Pulp, Peel, Rind	Herbins pumpkin seed oil; Young chemist pumpkin seed oil; Cosmo organic neem butter, pumpkin, and ginger hair mask	80-81
18	Thyme	<i>Thymus vulgaris</i> (Lamiaceae)	Minerals-K, Ca, Mg, Se, Fe, Mn, Vitamins-A, C, B, K	Flower, Leaf	Gowoo thyme essential oil; Jovees herbal thyme and Tee Tree anti-dandruff shampoo and conditioner; BRM herbals thyme essential oil	82-83

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19	Turmeric	<i>Curcuma longa</i> (Zingiberaceae)	Curcumanoids, sesquiterpenes, ketones, alcohol	Dried rhizome	Healthgenix pure turmeric oil; Trichoturm dietary supplement; Volamena organics turmeric hair growth scalp scrub	84-86
20	Honey	<i>Apis mellifera</i> (Apidae)	Glucose, fructose, formic acid, dextrin, proteins, vitamins, enzymes	Liquid fluid	Herbal khadi sandalwood honey natural herbal shampoo and conditioner; RHRI psoriasis, eczema, Seborrheic dermatitis shampoo; Bioorganic hair regrowth pack	87-88
21	Amla	<i>Phyllanthus Emblica</i> (Phyllanthaceae)	Emblicanin, A and B, punigluconin, chebulagic acid, phyllantine, phyllembein, gallic acid, glutamic acid, cysteine, lysiene, pectin, ascorbic acid, citric acid	Fruit, Seed, Bark, Leaf, Root, Flower	Earth organic and Ayurvedic Amla hair oil; Nutriol Amla extract for skin and hair care; Adivasi herbal hair oil; Vedix Ayurvedic hair care regimen	89-90
22	Cinnamon	<i>Cinnamomum verum</i>	Cinnamaldehyde, cinnamic acid, eugenol, cinnamate, cinnamyl alcohol,	Bark, Leaf	Vedsun cinnamon oil; J. K. Darchini oil;	91-92

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		(Lauraceae)	volatile oils, monoterpenes, sesquiterpenes, phenyl propenes		Healthgenix cinnamon essential oil	
23	Grapefruit	<i>Citrus xparadise</i> (Rutaceae)	Lycopene, cryptoxanthin, lutein, zeaxanthin, naringenin, narirutin, naringin, hesperidin, didymium, poncirin	Peel, Seed	Actizeet grapefruit essential oil; Laritelle organic shampoo; Head and shoulder deep cleanse anti-dandruff shampoo	93
24	Golden seal	<i>Hydrastis Canadensis</i> (Ranunculaceae)	Berberastine, hydrastinine, canadine	Root, Rhizome	Botanica goldenseal liquid herb; Nature's Answer alcohol-free goldenseal root extract; Oneka goldenseal and citrus shampoo	94
25	Echinacea	<i>Echinacea purpurea</i> (Asteraceae)	Glycosides, achinacosides, echinacin, polysaccharides, caffeic acid, essential oils, flavonoids, volatile oils, vitamins, minerals	Leaf, Flower, Root	Bio India echinacea plus tonic; Biotic Echinacea capsules; Alvia echinaceae oil; Nature's Way echinacea and vitamin C vegan capsule	95
26	Geranium	<i>Geranium</i>	Citronellol, linalool, citronellyl formate, p-menthone,	Leaf, Stalk, Flower	Divine aroma geranium essential oil;	96

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		<i>graveolens</i> (Geraniaceae)	tannins, flavones, organic acids, lignans, steroids, triterpenoids		Lifemantraa essential oil; Keya Seth aromatherapy geranium therapeutic essential oil	
27	Eucalyptus	<i>Eucalyptus globulus</i> (Myrtaceae)	Cineole, piene, eucalyptol, hydrocyanic acid, cymene, terpinene, methyl amyl acetate, aromadendrene, viridiflorol	Leaf	Camveda pure eucalyptus essential oil; Froot root flake fixer; Vaadi herbals eucalyptus essential oil	97
28	Calendula	<i>Calendula officinalis</i> (Compositae)	Flavonoids, carotenoids, coumarins, triterpenoids, glycosides, saponins, volatile oils, amino acids, steroids, sterols, quinine	Flower petals	Nature 4 Nature growth potion hair oil; California baby calendula shampoo and body wash with hair conditioner; Lemora Cosmetics calendula oil	98
29	Fenugreek	<i>Trigonella foenum-gracum</i> (Fabaceae)	Flavonoids, amino acids, saponins, alkaloids, soluble fibers	Seed, Leaf	MeriBana Khadi and Silky anti-dandruff shampoo; Khadi Organique Fenugreek hair cleanser; Khadi Natural onion and fenugreek shampoo	99

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2. FORMULATION OF HERBAL GEL

2.1 MATERIALS AND METHOD

2.1.1 Collection of plant material

The plant *Psidium guajava*, *Azadiracta indica*, *Emblica officinalis*, and *Aloe barbadensis* was collected from the HCP, campus, Sonipat. The fresh leaves and seeds were separated from the plant and used for the extraction.

2.1.2 Preparation of leaf extract of *Psidium guajava* and *Azadiracta indica*

The collected fresh leaves of *Psidium guajava* were washed with water and dried in shade (100). After drying plant leaves were coarsely powdered and kept in well closed container. 20gm of each plant's coarse powder leaf was weighed and soaked in 200ml of water and left for maceration for about 4-5 days. After maceration the extract was concentrated and used for further formulations (101).

2.1.3 Preparation of fruit extract of *Emblica officinalis*

The collected fresh fruit of *Emblica officinalis* were washed with and dried. After drying the fruits after removal of seeds were blended in a mixer or juicer (102). After proper blending the extract was strained and used for further formulation.

2.1.4 Preparation of leaf extract of *Aloe barbadensis*

The collected fresh leaves of *Aloe barbadensis* were washed and dried. After drying the leaves were peeled and the fresh gel is extracted. The gel extract was used for further formulation (103).

2.1.5 Formulation of Herbal anti-fungal gel formulation for dandruff

The herbal anti-fungal gel formulations for dandruff were prepared by simple gel formulation preparation method with carbopol gel base (104-107). The gel formula contains phenoxyethanol, polyethylene glycol (PEG), carbopol 940, and triethanolamine. Carbopol 940 four grams and measured quantity of extracts was dispersed in 80ml of distilled water and mixed by stirring continuously in magnetic stirrer at 800rpm for 1h or by manually. The mixture was neutralized by drop wise addition of triethanolamine. Mixing was continued until a transparent gel was formed. The concentrations as

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shown in Table 2 were incorporated in carbopol base gel and prepared herbal anti-fungal gel formulations for dandruff.

Table 2. General formula for Herbal Anti-fungal Gel Formulation for Dandruff

Ingredients	Quantity taken
Carbopol 940	4.0gm
Propylene glycol	10.4ml
Phenoxyethanol	0.1%
Triethanolamine	1-2 %
Distilled water	Q.S.

Table 3. Development of Herbal Anti-fungal Gel Formulation for Dandruff

Ingredients	Quantity taken (100ml)
<i>Azadiracta indica</i> extract	2.5ml
<i>Psidium guajava</i> extract	2.5ml
<i>Emblica officinalis</i> extract	1ml
<i>Aloe barbadensis</i> extract	1ml
Carbopol 940	4.0gm
Propylene glycol	10.4ml
Phenoxyethanol	0.1%
Triethanolamine	1-2 %
Distilled water	Q.S. to 100%

2.2 Evaluation of Herbal Anti-fungal Gel Formulation for Dandruff

2.2.1 **Physical Examination** - All the formulated herbal gels were checked for colour, texture, lumps formation, smoothness and homogeneity by visual observation (108-111).



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2.2.2 PH- The pH of all the formulated herbal gels was measured by using digital pH meter or pH strips (112-115).



2.2.3 Viscosity- Viscosity of herbal gels was determined by using Brookfield rotational viscometer at 100rpm using spindle no. 64 (116-118).

2.2.4 Spreadability- The spreadability of gel formulation was determined by measuring the spreading diameter of 1gm of gel between two horizontal plates (119-125).

Procedure

For the determination of spreadability excess of sample was applied in between two glass slides and was compressed to uniform thickness by placing 1000 gm weight for 5 min.

Weight (240gm) was added to the pan.

The time required separating the two slides, i.e. the time in which the upper glass slide moves over the lower plate was taken as measure of spreadability (s).

$$S = m * l / t$$

Where m = weight tide to upper slide

l = length moved on the glass slide

t = time taken.



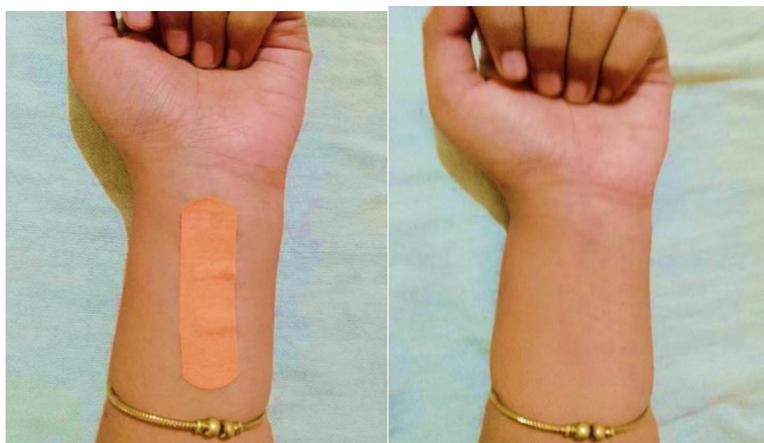
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2.2.5 Skin irritation test - Apply a small amount of gel to the skin of volunteers or animal models. Observe for signs of redness, irritation, or allergic reactions over 24 to 48 hours (126-128).



2.2.6 Patch test- Apply the gel to a small patch of skin and cover with a bandage. Observe for any adverse reactions over 48 hours (129-131).



3. RESULTS AND DISCUSSION

All the formulations of herbal hair gels were studied for colour, homogeneity, pH, viscosity, color, texture, lumps formation, skin irritation, patch test, and spreadability (132). The results are given in Table 4.

Table 4. Evaluation parameters and their results

Parameters	Observations
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Appearance	Gel
Color	Olive Green
Texture	Soft and Uniform
Smoothness	Smooth
Lumps formation	No lumps formation
Homogeneity	Homogeneous
pH	5.7
Viscosity	2500cps
Spread-ability	Good spread-ability
Skin irritation	No skin irritation
Patch	No skin irritation

The antifungal activity of herbal gels was done by cup plate method. The gels were tested against *Candida albinos*. A loopful of the pure fungal culture was suspended in nutrient broth and incubated for 24 hours. Nutrient agar media was sterilized, inoculated with *C. albicans* and poured into petri plates. After solidification, bore was made with the help of borer and different concentrations of herbal gels were added. A marketed preparation acts as control. Later, the zone of inhibition around the bore was measured and recorded (133).

4. CONCLUSION

On the basis of prepared herbal anti-fungal gel for dandruff (prepared with *Psidium guajava*, *Azadirachta indica*, *Emblica officinalis*, and *Aloe barbadensis*) and their evaluation studies, it is concluded that: the gel gives no local irritation, the gel is stable with the pH of scalp, the gel is highly viscous, the gel is maintaining the homogeneity, the gel smoothens the texture of scalp and provide moisture, the gel can be used for any type of scalp condition. Hair gels containing natural ingredients and herbal extracts have potential effects in controlling hair fall and removing dandruff. Herbal hair gels help to overcome the various damages caused by chemical agents in various marketed products. The prepared product was tested for its antifungal activity using test organism, which causes dandruff

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and various scalp problems. Herbal hair gel containing herbal plant extract is a solution for nourishing hair, treating dandruff and other scalp problems. The products can be manufactured in large scale and commercialized as an alternative for chemical hair gels.

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