

## A Comprehensive review on dandruff and its management by using herbal formulations

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**Abstract:** Dandruff has become a prevalent dermatitis condition that has been around for generations. Dandruff is caused by a minimum of three etiological reasons i.e. *Malassezia* species, sebum production, human sensitiveness. Dandruff is caused by a microbe that is 100% natural known as *Malassezia*. Currently, a variety of chemical/synthetic antidandruff agents are used to treat dandruff. Because the side effects of synthetic antidandruff agents have limited their pharmacological benefits, the drug of choice is plant origin, which adds the value required to replace synthetic antidandruff agents. Herbal ingredients or their formulations can be used as a substitute for synthetic antidandruff agents. Herbal antidandruff agents are intended to reduce the formation of dandruff flakes. The combined effect of nanotechnology and traditional medicinal herbs could be a powerful tool for developing future herbal medicines with higher bioactivity and lower toxicity to manage dandruff. incorporating "herbal remedy" into nanocarriers would therefore significantly raise its medical applications in treating dandruff.

**Keywords:** Dandruff, *Malassezia*, herbal antidandruff agents, management, nanotechnology

### 1. INTRODUCTION

Dandruff has become a prevalent dermatitis condition that has been around for generations, medically it is also called as Seborrheic dermatitis/ Pityriasis capitis/ Pityriasis simplex<sup>[1]</sup>. The condition is affecting half of the global population and has been known since ancient times. Dandruff can be an unpleasant condition that begins around or after puberty, because of its high prevalence, noticeable condition, and incidence, leading to psychosocial discomfort for the person<sup>[2]</sup>. Skin regions that have sebum productions are affected causing scaling disorders. It affect up to half of the population between the ages of 15 - 50 causing cosmetic issues, anxiety, and discomfort<sup>[3]</sup>. Dandruff is distinguished by the presence of white or grey fragments on the hairline, either diffusely or in patches, itchiness, a crumbly sensation in the affected area without any kind of visible inflammatory response<sup>[4]</sup>.

Dandruff has a high socioeconomic impact. Due to androgen hormones, males have a higher prevalence dandruff than females<sup>[5]</sup>. Neither citizenry in any area of the world has ever lived without being affected by dandruff at some point in their lives<sup>[6]</sup>. Several times the hair loss is due to dandruff. With rapid urbanization the prevalence can rise sharply<sup>[7]</sup>. Severe dandruff leads to frustrating condition. Dandruff could also develop as a result of water and air pollution, a change in surroundings, an irregular daily routine, unhygienic conditions and immunity, dripping with sweat, and psychological anguish, all of which can result in a variety of infections caused by fungi<sup>[8]</sup>.

## 2. SIGNS AND SYMPTOMS OF DANDRUFF

- Appearance of flakes
- Scratching on the affected area
- Skin discoloration around the scalp
- Severe itchiness on the affected area
- Patches of skin scaling and turning red <sup>[9]</sup>.

## 3. COMMON DANDRUFF DISTRIBUTION SITES

The distribution is generally symmetrical and specific distribution sites are hairy areas of head, forehead, external ear lines, post auricular creases <sup>[10]</sup>.

## 4. CAUSES OF DANDRUFF

Dry skin, inadequate cleansing of hair, scrubbing of the scalp, sensitive to hair products, psoriasis, eczema. Dry skin and *Malassezia* spp. are the foremost prevalent reason for scalp flaking because layer of the epidermis repeatedly replicates itself; old cells are therefore continued to push out to eventually die and peel. These skin flakes are too small to be visible in most people. Flaking skin clump together in huge, sebum clusters that begin to show up on the scalp, skin and clothes as white or grayish patches <sup>[11]</sup>.

### 4.1. Internal causes of dandruff

Internal lead to dandruff includes hormone levels, allergens hypersensitivity, fatigue and insomnia, poor nutrition, mental anguish, anxiousness and frustration <sup>[12]</sup>.

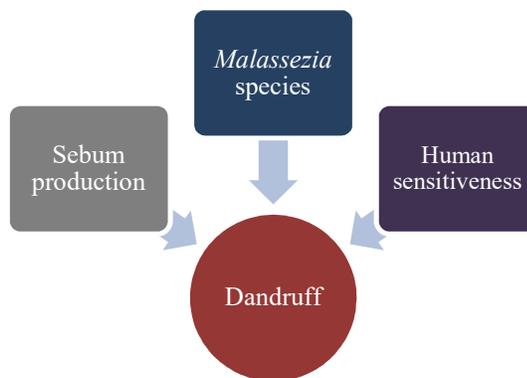
### 4.2. External causes of dandruff

External lead of dandruff includes application of hair sprinklers and serums on a regular basis, use of mousse, hairspray, heated hair straighteners, dandruff can be exacerbated by infrequent shampooing or poor rinsing of the scalp, winter season, tightly wrapped scarves and hats, extreme temperature conditions, usage of alcohol-containing serums can contribute to an increase in dandruff incidence <sup>[12]</sup>.

## 5. ETIOLOGY

Dandruff is caused by a minimum of three etiological reasons i.e. *Malassezia* species, sebum production, human sensitiveness (Figure 1).

- a) Skin microorganisms metabolic byproduct (most specifically *Malassezia* species, a lipophilic fungus)
- b) The skin oil is commonly known as sebum production
- c) Human sensitiveness to the presence of species *Malassezia* <sup>[13]</sup>.



**Figure 1: Correlation among sebum production, *Malassezia* species, and human sensitiveness in the formation of dandruff**

## 6. CAUSATIVE ORGANISM OF DANDRUFF

Dandruff is caused by a microbe that is 100% natural known as *Malassezia*. *Malassezia* was the name first given by Malassez in 1898<sup>[14]</sup>. In the initial part of 20<sup>th</sup> century, this genus was renamed as *Pityrosporum*. The fungus genus *Malassezia* is monophyletic present in both warm-blooded mammalian species as well as humans and is responsible for dandruff, seborrheic dermatitis, pityriasis versicolor and atopic eczema/dermatitis<sup>[15]</sup>. *Malassezia* yeasts are both lipophilic and non-lipophilic. *Malassezia* spp. can grow by metabolising the fatty compounds found in sebum<sup>[16]</sup>.

To date, fourteen well-known *Malassezia* species as well as four new species have been reported. Out of 18 species, 10 species (*M. globosa*, *M. furfur*, *M. restricta*, *M. sympodialis*, *M. obtusa*, *M. dermatis*, *M. slooffiae*, *M. japonica*, *M. yamatoensis* and *M. arunalokei*) were mainly identified from human epidermis, while the remaining were confined to animal skin. The most common fungi species on humans have been recognized as *M. restricta* and *M. globosa*. *M. pachydermatis* is a zoophilic species that is frequently identified from companion animals like dogs<sup>[17]</sup>.

Currently, a variety of chemical/synthetic antidandruff agents are used to treat dandruff by reducing the number of fungus on the scalp. Because the side effects of synthetic antidandruff agents have limited their pharmacological benefits and reappearance of symptoms after discontinuation so the drug of choice is plant origin, which adds the value required to replace synthetic antidandruff agents<sup>[18]</sup>.

Chemical/synthetic antidandruff agents enhance the texture of the hair however cease by being disadvantageous to the hair follicles as well as induces more hairfall, hair greying and premature ageing, itchy and dry scalp, excessive hair loss and split ends, hair brittle, make the scalp more sun-sensitive, increased allergic reactions include rash, hives on the scalp<sup>[19]</sup>.

The chemical compound being used in synthetic anti-dandruff agents to treat dandruff have certain limitations such as their inability to control recurrence, which is really a preferred and distressing concern. To counter all of these problems, it is best to turn to herbs for anti-dandruff treatment that will compensate for the nutrient loss and nullify the way of damage<sup>[20]</sup>.

## 7. MANAGEMENT OF DANDRUFF USING HERBAL REMEDIES

Herbal drugs or their formulations can be used as a substitute for synthetic drugs. Herbs are safe to use on both skin and hair of humans. Herbs, as opposed to synthetic chemical ingredients, have been absolutely suitable, highly efficient, that has virtually no adverse reactions because of their reliability with the human epidermis. Herbal cosmetics are becoming more popular, owing to the belief that they are safe and have no adverse side effects. Many plants seem to have skin friendly advantageous effects and therefore are currently the most frequently included in skincare products. Herbal drugs are the safest alternative for dandruff sufferers who prefer a natural solution. Vitamins, phytohormones, essential oils, bioflavonoids, enzymes, amino acids, tannic acid, fruit acids, and glycosides are among the active components of medicinal herbs that are playing a major role in anti-dandruff remedies [21]. Herbs commonly used to treat dandruff are described in Table 1

There are numerous herbal treatments available in the form of natural remedies that are being used by people for decades. Several herbal preparations has been studied, as well as significant anti-dandruff effects have been carried out by many researchers. The *in vitro* anti-malassezial effect is assessed by observing the diameter of inhibition zone around a disc dipped in the aqueous or alcoholic extract of the herbal extract [22]. The following are some relevant data from the literature on botanicals with anti-dandruff properties:

### Amla

Amla botanically known as *Embelica officinalis*, belonging to family Euphorbiaceae. It is still widely recognized as Indian gooseberry, contains a high amount of vitamin C. Dry powder form of amla is an important component in hair herbal remedies because it promotes hair growth by improving hair discoloration. The most significant advantage has been that it reduces thinning hair and loss of hair. The active constituents of amla are phyllembin, ascorbic acid and gallic acid. A certain effectiveness has been because of the tannin content, which includes tannic acid, antioxidant material and iron which prevents dandruff-induced damage caused by free radicals to stratum corneum [23].

**Active constituents:** Vitamin C, Gallic acid Tannic acid, Albumin Cellulose

Rasika *et al.*, 2016 examined the antidandruff effect of different extracts using ethanol, aqueous and fresh juice of *E. officinalis* against the test microbes viz., *M. furfur* and *M. globosa* by disc diffusion method. Fresh juice of *E. officinalis* was found most effective against the *M. furfur* and *M. globosa*. The aqueous and ethanol extract showed appreciable antifungal activity [24].

### Hibiscus

**Hibiscus** botanically known as *Hibiscus rosa-sinensis* L. belonging to family Malvaceae. Its more favourable constituent for hair growth is hibiscus, also known as gudhal. It's being used to promote hair regeration and regrowth after loss of hair. Hibiscus contains proteins, Vitamin A, C, and alpha - hydroxy acids, various essential minerals that are beneficial to skin and hair health. As they always take the utmost care of the affected area but also decrease incidence of dandruff within hair [25].

**Active constituents:** Galactose, Mallic acid, Citric acid, Tartaric acid, Flavonoids, 5-diglucoside, Anthocyanins and Cyaniding-3Quercetin-3, Quercetin-3-diglucoside, Cyaniding-3-sophoroside-5- glucoside, 7-diglucoside.

John *et al.*, 2018 studied anti-dandruff activity of *Hibiscus rosasinensis* against *Malassezia* sp. using the agar well diffusion assay. The leaf showed great zone of inhibition hence the study reveals the use of this plant in anti-dandruff formulations [26].

**Aloe vera**

Aloe vera botanically known as *Aloe barbadensis*, belonging to family *Asphodelaceae*. Since ancient times, aloe vera has been used in traditional remedies. Aloe vera is commercialised for its nourishing, restoration, and moisturising features in the skincare products and traditional medicinal industries [27]. Dandruff/ seborrheic dermatitis can be relieved with aloe vera lotion. It's also a great hair care treatment. Hair conditioners and shampoos containing aloe vera are widely used for this purpose [28].

**Active constituents:** Vitamins A, B, C, E, amino acids like leucine, isoleucine, glycosides, saponin.

Fozouni *et al.*, 2018 investigated the antifungal effect of different concentrations of Aloe vera extract on clotrimazole resistant isolates was determined by using the agar well diffusion method and minimum inhibitory concentration (MIC) by the broth microdilution method. Aloe vera extract showed inhibitory effects against clinical clotrimazole-resistant *Malassezia furfur* isolates. Therefore, it can be used to treat fungal diseases [29].

**Neem**

Neem botanically known as *Azadirachta indica*, belonging to family *Meliaceae*. It is extremely beneficial for dermal cleanser. It helps to clear redness and inflammation as well as stimulates new hair. The restorative features have been beneficial in the management of dandruff. Neem possesses antimicrobial as well as medicinal effects and could be used to treat many different types of hair concerns. Neem leaves can be used as a rinse to remove dandruff [30].

**Active constituents:** Flavonoids, phenols, nimbin, nimbidin, cyclic trisulfide, gedunin.

Saranya *et al.*, 2016 assessed the antifungal activity of the silver nanoparticles synthesized through green synthesis using *Azadirachta indica* leaf extract and characterized by UV-Visible spectrophotometer, Transmission electron microscope (TEM), X-Ray diffraction spectrophotometer (XRD) and Fourier transform infrared spectrophotometer (FTIR). The characterized silver nanoparticles inhibited the growth of *Malassezia* species by forming zone of clearance. This study suggests that the silver nanoparticles could be an alternative to treat the fungal infections [31].

**Shikakai**

Shikakai botanically known as *Acacia concinna*, belonging to family *Mimosaceae*. Shikakai commonly known as the 'hair fruit'. It has been used in herbal remedies for hair growth and cleaning since ancient times. It controls dandruff, reduces hair loss, and soothes skin irritations. Shikakai's active component contains the essential oils and vitamins required for hair growth. It is extremely important for regaining hair's lustre and length. It precludes split ends, breakage and hair fall by strengthening the hair from the roots. It has a bubbles form as well as anti-dandruff properties, and it also tidies the dead skin cells by removing dandruff, it acts as a kind of cleaning agent [32].

**Active constituents:** Lupeol, citic acid, oxalic acid, succinic acid, acacia acid, spinosterol, glucose, lactone, arabinose.

Vaishali *et al.*, 2018 investigated fungal isolates of *Malassezia* spp. for its susceptibility towards 20 different plant extracts. Antifungal activity of plant extracts was tested *in vitro*. Among the 20 plant extracts, the extract of *A. concinna* showed most effective against the tested fungus *Malassezia* spp. Hence it can be used to as natural antifungal agents [33].

### Henna

Henna botanically known as *Lawsonia inermis*, belonging to family Lythraceae. It has traditionally been used as a medicinal plant by diverse group of tribal/ethnic people, it is a common skin and hair colouring agent in many regions of the world. It has anti-inflammatory, antimicrobial, antifungal, anti-rheumatic, anti-neuralgic, and wound-healing properties. Henna's main colouring compound is "Lawsone," a reddish coloured main ingredient found in dried leaves. Henna has antifungal properties against *Malassezia* species (the dandruff-causing organism). Henna prevents premature hair loss and greying by balancing the pH of the scalp. Henna leaf paste is used to treat skin problems [34,35].

**Active constituents:** Lawsone, lawsoniasides, flavonoids, quinoids, xanthenes,  $\beta$  sitosterol glycoside, galic acid, coumarins, 2-hydroxy-1, 4-naphthoquinone.

Mehta *et al.*, 2017 evaluated the utilization of henna leaves extract as sources of natural anti-dandruff compounds against *Malassezia furfur*. Henna extracts were prepared using different solvents like ethyl acetate, acetone and milliq water. Antifungal activity of various crude extracts were detected by well and disc diffusion methods followed by partial fractionation of extraction through TLC and characterizing it by  $^1\text{H}$  NMR and  $^{13}\text{C}$  NMR. The antidandruff compound was present in the ethyl acetate extract of henna leaves [35].

Ishaku *et al.*, 2021 evaluated the antifungal activity of the leaf extract of *Lawsonia inermis* on *Malassezia* spp. The ethanolic extract of *L. inermis* extract recorded to have antifungal effect on the fungi. *Lawsonia inermis* may be effective in combating *Malassezia* species which are the causative agents of dandruff and hence, the use of naturally acquired herbs should be encouraged in combating dandruff [36].

### Tulasi

Tulasi botanically known as *Ocimum sanctum*, belonging to family Lamiaceae. It is very much recognised as holy basil, is being used for religious purposes for centuries. It promotes hair growth by improving blood flow and keeping the dermal deep relaxation, which reduces itchiness as well as dandruff. It's applied as a paste to prevent dandruff and keep scalp clean. It's a powerful antimicrobial plant [37].

**Active constituents:** Eugenol (1-hydroxy-2-methoxy-4-allylbenzene).

Punyoyai *et al.*, 2018 aimed to investigate *Malassezia furfur* inhibitory activity of the fermented product from *Ocimum sanctum* and developed an antidandruff shampoo. The fermented product obtained from the aerial part of *O. sanctum* during the fermentation process. The inhibitory activity of the fermented product and shampoos containing the fermented product against *M. furfur* was investigated using the broth dilution and agar diffusion method. With the minimum inhibitory concentrations of *M. furfur*, the fermented product showed high antifungal activity. The shampoo containing 2% (w/w) of the fermented product of *O. sanctum* possessed inhibitory activity against *M. furfur*. As a result, it was suggested that this shampoo can be used to treat dandruff [38].

### Reetha

Reetha botanically known as *Sapindus Mukorossi* belong to family *Sapindaceae*. It also known as soapnut. Reetha has cooling properties and works well as a skin cleanser. Soapnuts help to keep the skin soft by preventing it from drying out. It acts as frothing agent that helps to prevent hairfall but also acts has antibacterial and healing properties that are beneficial for septic systems. Because it is thought to be beneficial to the health

of hair, reetha is used as the major ingredients in soaps and shampoos for cleaning. For its superior medicinal benefits in preventing scalp and skin conditions, the reetha fruit has been widely used in ayurvedic medicine. Reetha also has antifungal properties that can help treat fungal infections of the scalp and hair<sup>[39,40]</sup>.

**Active constituents:** Saponins, saponic acid, saponoside A&B, lupeol, oxalic acid, oleanolic acid, succinic acid, mukuroziosides, trifoliosid.

Pingili *et al.*, 2016 worked on to know the activity of twelve different plant extracts against the dandruff causing organism *Malassezia furfur* among that *Sapindus Mukorossi* was one among the plant extracts. For the activity tests, both crude and powered extracts were used. The cup plate method was used for evaluation. *Sapindus Mukorossi* plant extracts showed promising antifungal activity against *M. furfur*<sup>[41]</sup>.

### **Bhringraj**

Bhringraj botanically known as *Eclipta prostrate*, belong to family Asteraceae. It is also known as false daisy, is a hair-growth-promoting herb. It's a well-known ayurvedic hair-growth constituent. It promotes blood flow towards the epidermis by boosting as well as inducing hair regrowth that was damaged because of variety of factors, most notably dandruff. It also protects the scalp from dandruff and irritation, ensuring that hair growth is unaffected. It helps in hair regrowth, prevents hair fall, premature white hair, and dry hair. Bhringraj oil has antimicrobial and antifungal properties, which can aid in dandruff reduction<sup>[42,43]</sup>.

**Active constituents:** Vedelactone, ecliptine.

Kumar *et al.*, 2018 formulated and evaluated herbal anti-dandruff shampoo from bhringraj leaves. The formulated shampoo was subjected to evaluation parameters and antifungal activity test against dandruff causing organism. Formulation exhibited good antifungal activity *i.e.*, maximum zone of inhibition. The investigation demonstrated that bhringraj powder showed excellent antifungal activity. Bhringraj powder was used as the main antidandruff ingredient in the formulation of an antidandruff shampoo<sup>[44]</sup>.

### **Lemon**

Citrus particularly lemon, botanically known as *Citrus limon*, belong to family Rutaceae. It is beneficial in the treatment of dandruff and other skin problems. It contains a lot of vitamin C and can work to maintain a skin's pH balanced. Lemon oil is used as a natural and normal cleaning agent, oil exfoliator, shiny and smoothing of hairs, cleansing as well as antidandruff agent<sup>[45]</sup>.

**Active constituents:** Limonene, E-citral,  $\alpha$ -terpineol,  $\beta$ -myrcene,  $\beta$ -pinene,  $\alpha$ -pinene,  $\alpha$ -terpinolene.

Arun *et al.*, 2019 estimated the antifungal efficacy of lemon juice by agar diffusion method. The zone of inhibition of lemon juice showed good antifungal effect on *Malassezia furfur*. This study justifies the use of lemon juice as a remedy for *M. furfur* infected scalp and hair<sup>[46]</sup>.

### **Bilva patra/Bael**

Bilva patra/Bael botanically known as *Aegle marmelos*, belong to family Rutaceae. This plant has numerous medicinal applications in the Ayurvedic, Unani and Siddha systems of medicine. Bael fruit pulps have detergent properties and are therefore substituted for soap. It is effective as anti-inflammatory, antidandruff and antifungal agents. The rind of the bael fruit is commonly used to treat dandruff. Excessive hair fall as well as scaly scalp skin can be treated by soaking the fruit pulp in coconut oil or even in ginger oil<sup>[47,48]</sup>.

**Active constituents:** Arabinose, galactose, carotenoids, L-Rhamnose, uronic acid.

Sibi *et al.*, 2014 determined the susceptibility pattern of *Malassezia* spp. isolated from patients diagnosed with dandruff against 20 plant extracts among that one plant extract was *Aegle marmelos* by well diffusion and broth dilution method. *Aegle marmelos* demonstrated anti-dandruff activity against the isolates tested <sup>[49]</sup>.

**Table 1: Herbs commonly used for antidandruff treatment**

Sl. No.	Herbs name	Botanical name/ Family	Parts used	Advantages
1	Amla	<i>Embelica officinalis</i> Gaertn. (Euphorbiaceae)	Leaves, dried ripe fruits, root, bark	Darkening of hairs, hair growth promoter and prevents dandruff-induced free radical damage to hair follicles
2	Hibiscus	<i>Hibiscus rosa-sinensis</i> L. (Malvaceae)	Dried leaves, flower	Prevents hair loss, helps as a hair regrowth stimulant and decrease the incidence of dandruff
3	Aloe vera	<i>Aloe barbadensis</i> Mill. (Asphodelaceae)	Leaves	Conditioner, moisturizing effect and dandruff can be relieved
4	Neem	<i>Azadirachtha Indica</i> A. JUSS (Miliaceae)	Dried leaves	Prevent the dryness of hairs and flaking of dandruff
5	Shikakai	<i>Acacia concinna</i> (WILLD.) DC. (Mimosaceae)	Bark, leaves, pods	Foam base and antidandruff
6	Henna	<i>Lawsonia inermis</i> L. (Lythraceae)	Leaves, roots, flowers	Growth of hair, conditioner and antifungal properties against <i>Malassezia</i> species
7	Tulasi	<i>Ocimum sanctum</i> Linn. (Lamiaceae)	Leaves	Reduces itchiness caused by dandruff
8	Soap nut/Reetha	<i>Sapindus mukorossi</i> GAERTN. (Sapindaceae)	Dried fruit	Detergent and antidandruff
9	Bhringraj	<i>Eclipta prostrate</i> (L.) L. (Asteraceae)	Whole plant	Scalp problems caused by dandruff and irritation, hair growth
10	Lemon	<i>Citrus limon</i> (L.) (Rutaceae)	Leaves, fruit	Hair cleaning agent, antidandruff property
11	Bilva patra/Bael	<i>Aegle marmelos</i> (L.) (Rutaceae)	Leaves, rind of the fruit	Antidandruff agent, treats excessive hair loss as well as itchy scalp

## 8. CURRENT TOPICAL HERBAL TREATMENTS FOR DANDRUFF

Topical herbal treatments are used for dandruff and these are formulated in a variety of herbal preparations *i.e.*, shampoos, hair oils, gels so as to provide ease of application along with maintaining effectiveness of the active agents. Herbal antidandruff agents are intended to reduce the formation of dandruff flakes.

### 8.1. Antidandruff herbal antidandruff shampoos:

A shampoo is the cosmetic formation that is used to wash the hair and scalp and it is manufactured in an easy-to-use format. Its main purpose is to remove accumulated sebaceous glands, dandruff, and hair debris from the hair <sup>[50]</sup>.

People nowadays are enthusiastic in using liquid polyherbal antidandruff shampoos, which are an alternative to commercially available synthetic antidandruff shampoos. Polyherbal antidandruff shampoos are made from a variety of plant/natural extracts and their combinations. Fungistatic herbs are used in anti-dandruff shampoos to combat dandruff. Natural antidandruff shampoos are more popular on the market because they have fewer side effects and are more safe. There are presently various types of nutritional and anti-dandruff shampoos in the market that contain vitamins, amino acids, and proteins <sup>[51]</sup>.

Sandeep *et al.*, 2021 worked to develop the polyherbal antidandruff herbal shampoo and evaluated the formulated herbal shampoos. The polyherbal antidandruff shampoo was prepared using plant leaves extract namely *Azadirachta indica*, *Lawsonia inermis*, *Hibiscus labeis*, *Mimosa pudica*, and *Murraya koenigi* in varying concentrations. All the ingredients used for the preparation of polyherbal shampoo was found to be safe and all the formulated herbal antidandruff shampoos showed acceptable results. The formulations showed gradual increase in zone of inhibition which may be due to increased concentration of plant extracts. The study revealed that polyherbal shampoos can be prepared easily from the natural plant sources having antimicrobial properties and herbal antidandruff shampoos are better alternatives than synthetic shampoos <sup>[52]</sup>.

### 8.2. Antidandruff herbal antidandruff hair oil:

The antidandruff herbal hair oil with natural oils helps to prevent dandruff by removing microbial infections from the scalp. The plant species that has been used in preparation are those that are used in Ayurvedic hair oils for the treatment of head and scalp problems. The plants contain constituents that could induce hair growth and remove dandruff through systematic standardisation (quality control) from raw materials to the final product <sup>[53]</sup>.

Deepak *et al.*, 2010 formulated polyherbal antidandruff hair oil using volatile oils of *Eucalyptus globules* and *Ocimum gratissimum* along with the petroleum ether extract of *Hibiscus rosa sinensis*, *Phyllanthus embelica*, *Tridax procumbens*. The formulated polyherbal antidandruff hair oil was tested against *Malassezia furfur* possessed antifungal activity. The MIC values of extracts, volatile oils and the extract concentration that showed hair growth activity, the hair oil was developed. Hence, the formulated polyherbal antidandruff hair oil is very effective in the management of dandruff <sup>[53]</sup>.

Krishnamoorthy *et al.* (2006) used microbiological and clinical tests to investigate Dano, a poly-herbal hair oil for anti-dandruff activity. The plant extracts used was *Wrightia tinctoria*, *Cassia alata*, *Azadirachta indica*. The prepared Dano was tested against *Pityrosporum ovale* and zone of inhibition was observed and it possessed antifungal activity against *P. ovale*. Dano is very effective against *P. ovale in vitro*. According to *in vivo* experiments Dano appears to be very effective at killing *P. ovale* cells *in vivo*. The study revealed that Dano is very effective in the management of dandruff <sup>[54]</sup>.

### 8.3. Antidandruff herbal antidandruff hair gel:

Considering the prevailing lifestyle as well as user preferences, a standardised preparation with both pack and gel form is commonly used. The Gel form is more convenient to carry and apply, as well as having a longer shelf life. The antidandruff herbal hair gel is commonly used to manage dandruff <sup>[55]</sup>.

Madan *et al.*, 2021 studied the efficacy of a polyherbal hair pack and hair gel in the treatment of dandruff. Hair pack was made using brahmi, haritaki, amalki, yashtimadhu, bibhitaki, japa, musta, and it was converted into gel form. Analytical study for standardization of powder and gel dosage form was done. Clinical evaluation of both

dosage forms for efficacy was tested. Hence, the new advanced herbal preparation would therefore demonstrate considerable results in controlling dandruff as well as its clinical signs, and the combination dosage, i.e. gel, would therefore solve the powder's limitations as well as provide a cost-effective personal care products in controlling dandruff<sup>[55]</sup>.

Naphade *et al.*, 2021 aimed to formulate and evaluate the herbal gel containing hibiscus flower extract, alovera leave extract. The gel formulation was designed in aqueous as well as ethanolic extract. This article give us the idea of an anti dandruff formulation which content hibiscus extract which help in promote hair growth provide nourishment and are in rejuvenates scalp and alovera which is used in treatment of dry hair, reduce dandruff and moisturized hair and scalp<sup>[56]</sup>.

Sayare *et al.*, 2020 formulated and evaluated antidandruff gel containing Lawsone to minimize all the side effects and to show rapid action on dandruff. The anti-dandruff activity of lawsone was tested using *Malassezia furfur* pure culture at various concentrations. Lawsone showed good antidandruff activity. Lawsone gel was prepared. Formulations were evaluated for the zone of inhibition for their anti-dandruff activity against *M. furfur*. The formulations showed good zone of inhibition<sup>[57]</sup>.

## 9. NOVEL NANOTECHNOLOGY BASED FORMULATIONS FOR THE TREATMENT OF DANDRUFF

Nanotechnology has proven to be safe as well as accurate towards the topical administration of many medications, and now it provides a revolutionary treatment for a variety of skin conditions such as dandruff. Patients with dandruff must use treatments on a regular, long-term basis, usually on a daily basis. These are commonly accessible in various of topical dosage forms. There is a really critical must to create alternative herbal formulations that are more aesthetically and cosmetically appealing to patients, and that can be effectively applied it in to a patient's regular hair- or skin-care routine to improve the patient effectiveness. Nanotechnology has developed as an important topical delivery method that allows for managed, prolonged, and targeted drug delivery, reducing unwanted risk of adverse events while preserving and enhancing treatment effectiveness<sup>[58]</sup>.

Nanotechnology demonstrates advances in the area of research and development by enhancing product effectiveness *via* delivery. Nanotechnology is being used in the field of cosmeceuticals to achieve some of the drawbacks found in conventional products. Nanocosmeceuticals, that are being used to treat dandruff, alopecia, and hair damage, have become very popular. These new nanocarriers have a number of benefits over conventional methods, including better cosmetic penetration, dosage forms control as well as consistency, longer cycle life, site-specific targeting, and maximum adsorption efficiency<sup>[59]</sup>. Because of their small particle size and controlled drug release, nanotechnology is leading a new concept for delivery of drugs. As a result, incorporating "herbal remedy" into nanocarriers would therefore significantly raise its medical applications in treating dandruff. Silver nanoparticles are popularly used in antidandruff shampoos due to their antifungal properties<sup>[60]</sup>.

Mishra *et al.*, 2020 synthesized silver nanoparticles (AgNPs) using *Glycyrrhiza glabra* root extract and evaluated their antimicrobial potential against dandruff causing pathogens. It is extremely important to develop a better class of antidandruff agents based on sustainable alternatives. The zone of inhibition for *Glycyrrhiza glabra* extracts and AgNPs, as well as AgNPs showed lowest MIC against dandruff causing pathogens. As a

result it was found that utilization of *Glycyrrhiza glabra* based synthesis of AgNPs could be explored to manage dandruff<sup>[61]</sup>.

Jena *et al.*, 2018 worked to develop lemon grass oil loaded chitosan nanoparticle gel for improved antidandruff action. The optimized formulations were tested for antifungal activity against *Malassezia globosa*. The prepared nano formulation showed significant antifungal activity *in vitro* against *M. globosa* using the agar plate diffusion method. Hence, the study demonstrated the successful development of a lemon grass-loaded nanoparticle gel formulation as one of the dandruff-control strategies<sup>[62]</sup>.

Mishra *et al.*, 2018 evaluated the antimicrobial potential of *Punica granatum* peel extract and its biosynthesized silver nanoparticles (AgNPs) against dandruff causing pathogens. The aqueous extract of pomegranate peel was used to successfully synthesise silver nanoparticles. The plant extract and AgNPs proved the highest zone of inhibition against *Malassezia furfur*. The synthesized nanoparticles showed the antimicrobial activity against all the dandruff causing pathogens. The studies suggest that biosynthesized silver nanoparticles could enable a new way for the development of a new class of anti-dandruff treatments<sup>[63]</sup>.

Rao *et al.*, 2016 worked on the silver nanoparticles based green formulation of an antidandruff shampoo. In situ capped silver nanoparticles (Ag NPs) were prepared by green routes using Acacia and Acacia+ *Aegle marmelos* leaf extract. The antifungal activity studies of Ag NPs against *M. furfur* showed better inhibiting activity. Therefore, Ag NPs' promising anti-Malassezia activity in Acacia media, combined with their superior suspension stability against microbial contamination, have the potential to be an active antidandruff simple shampoo formulation<sup>[64]</sup>.

Saranya *et al.*, 2016 studied to assess the antifungal activity of the silver nanoparticles synthesized through green synthesis using *Azadirachta indica* leaf extract and characterized by UV-Visible spectrophotometer, Transmission electron microscope, X-Ray diffraction spectrophotometer and Fourier transform infrared spectrophotometer. By forming a zone of clearance, the identified silver nanoparticles inhibit the growth of *Malassezia* species. This study suggests that the silver nanoparticles could be an alternative to treat the fungal infections caused by *Malassezia* species<sup>[65]</sup>.

## 10. FUTURE PROSPECTS

Due to the unsatisfactory results of synthetic drugs and synthetic antidandruff shampoos, herbal remedies have emerged as a viable treatment option. The optimistic effects of natural herbal remedies benefit dandruff infected individuals become more aware of how to manage dandruff. Nanotechnology is advancing and highly helpful research area with important effects in medicine and cosmetics. The combined effect of nanotechnology and traditional medicinal herbs could be a powerful tool for developing future herbal medicines with higher bioactivity and lower toxicity to manage dandruff. The combination of plant sciences and nanotechnology does have the opportunity to generate a helpful symbiotic association between the green revolution and nanotechnology, to manageable potentials for reducing the fungus that cause dandruff. Novel formulations with increased efficacy and management of disease could very well be long term dosage form. As a result, there is a lot of opportunities for different new formulations and drug advancements in various fields of research. Hence use of silver nanoparticles could be an alternative to treat dandruff.

## CONCLUSION

Herbal drugs or their formulations can be used as a substitute for synthetic drugs. Herbs are safe to use on both skin and hair of humans. People from around the world have been highly dependent on the herbal appropriate treatment approach for their primary health care since the development of science and technology, as well as modern medical practise because of its lower cost, minimal side effects and wide distribution in nature. Nanotechnology has proven to be safe as well as accurate towards the topical administration of many medications, and now it provides a revolutionary treatment for a variety of skin conditions such as dandruff. Nanocosmeceuticals, that are being used to treat dandruff. Because of their small particle size and controlled drug release, nanotechnology is leading a new concept for delivery of drugs. As a result, incorporating "herbal remedy" into nanocarriers would therefore significantly raise its medical applications in treating dandruff. Nanotechnology enables in the development and design of drugs and delivery methods with greater reliability and validity while using less energy and cost. Silver nanoparticles are popularly used in antidandruff shampoos due to their antifungal properties. Hence silver nanoparticles could be an alternative to treat dandruff caused by *Malassezia* species. Thus newly designed herbal silver nanoparticles treatment provides more significant result in managing dandruff.

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