

A Comprehensive review on dandruff causing organism *Malassezia* species and its commonly used treatments for the management of dandruff

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Abstract: Dandruff is a widespread dermatological condition that has existed since centuries. It has a high socioeconomic impact. Due to androgen hormones, males have a higher prevalence dandruff than females. Dandruff is caused by a minimum of three etiological factors i.e. *Malassezia* yeast, sebaceous secretions and individual sensitivity. Dandruff is caused by a microbe that is 100% natural known as *Malassezia*. There are two alternatives in dandruff treatment. They are Synthetic antidandruff agents and Herbs used as antidandruff treatment. Currently, a variety of chemical agents are used to treat dandruff by reducing the number of fungus on the scalp. 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. Continuous use of synthetic antidandruff agents make hair brittle, causes dryness of the scalp, grey hair and make the scalp more sun-sensitive. Herbal antidandruff treatments are based on plant ingredients are believed to be safe and free from side effects.

Keywords: Dandruff, *Malassezia*, sebaceous secretion, individual sensitivity, antidandruff treatments

1. INTRODUCTION

Dandruff is a widespread dermatological condition that has existed since centuries, medically it is also called as Pityriasis simplex/Pityriasis capitis/Seborrheic dermatitis (confined to scalp).¹ The condition is widespread, 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 to its chronic condition, visible appearance, and recurrence, leading in psychosocial discomfort for the individual.² The scalp and other regions of the skin with sebaceous glands are affected by scaling disorders. They are prevalent conditions that affect up to half of the population between the ages of 15 - 50, causing cosmetic issues, anxiety, and discomfort.³ It is distinguished by the appearance of loosely adherent white or grey flakes in the scalp, either diffusely or in patches, as well as itching and a dry feeling in the scalp with no visible inflammation. Dandruff flakes can be found on eyelashes, eyebrow, nose corners, and regions in the ears in addition to the scalp.⁴

Dandruff has a high socioeconomic impact. Due to androgen hormones, males have a higher prevalence dandruff than females.⁵ No population in any region of the world would have lived freely at any stage in their life without being affected by dandruff.⁶ Several times the hair loss is due to dandruff. With rapid urbanization the prevalence can rise sharply.⁷ Severe dandruff leads to frustrating condition. Dandruff can arise due to air pollution, water pollution, changed lifestyle, irregular daily regimen, poor hygiene and immune system, sweating, mental stress which can lead to numerous fungal infections.⁸

2. SIGNS AND SYMPTOMS OF DANDRUFF

- Presence of fragments
- Itching of the scalp
- Redness around the scalp
- Intense itching of the scalp
- Patches of skin scaling and turning red.⁹

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.¹⁰

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 the epidermal layer continuously replaces itself; cells are pushed outward where they are finally die and peel. These skin flakes are too small to be visible in most people. Dead skin cells are shed in huge, oily clumps that appear on the scalp, skin and clothes as white or grayish patches.¹¹

4.1. Internal causes of dandruff

Internal causes of dandruff are hormonal imbalance, allergic hypersensitivity, fatigue and an insomnia, improper nutrition, stress, anxiety and tension.¹²

4.2. External causes of dandruff

External causes of dandruff are use of hair sprays and gels on a regular basis, use of mousse, hairspray, heated hair straighteners, dandruff can be exacerbated by infrequent shampooing or poor rinsing of the scalp, cold weather and dry indoor heating, tight fitting of hats and scarves, extreme weather conditions, oily scalp, and the use of alcohol-containing lotions can contribute to an increase in dandruff incidence.¹²

5. ETIOLOGY

Dandruff is caused by a minimum of three etiological factors i.e. *Malassezia* yeast, sebaceous secretions and individual sensitivity (Figure 1).

- a) Skin microorganisms metabolic byproduct (most specifically *Malassezia* yeast, a lipophilic fungus)
- b) The skin oil is commonly known as sebum or sebaceous secretions
- c) Human susceptibility to the presence of species *Malassezia*.¹³

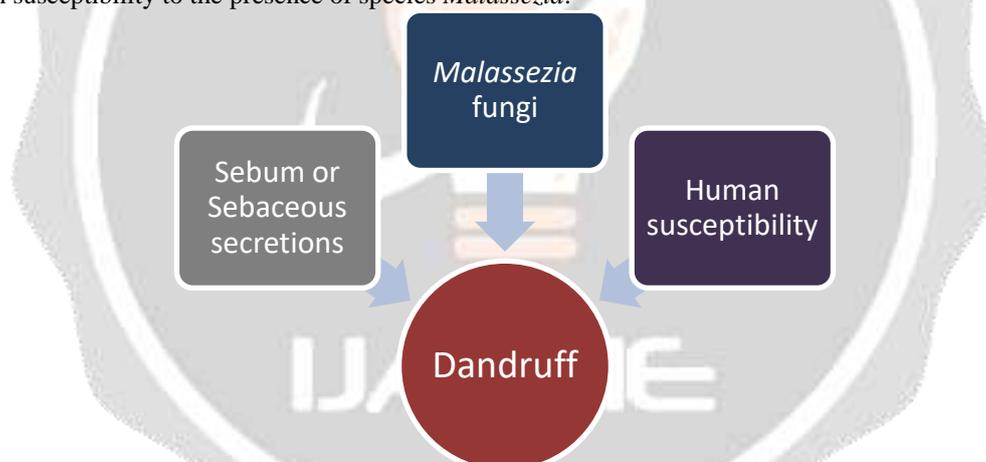


Fig 1: Interaction between sebum secretion, *Malassezia* fungi and human susceptibility in development of dandruff

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 1898.¹⁴ During the second half of the 20th century, this genus was renamed as *Pityrosporum*. *Malassezia* is a monophyletic genus of fungi present in both warm-blooded mammals and humans and it is responsible for dandruff, atopic eczema/dermatitis, pityriasis versicolor, seborrheic dermatitis and folliculitis.¹⁵ *Malassezia* yeasts are both lipophilic and non-lipophilic. *Malassezia* spp. can grow by metabolising the fatty compounds found in sebum. The increased prevalence of *Malassezia* spp. on the skin of people suffering from dandruff by 1.5-2 times the usual level was the main evidence that formed a connection between *Malassezia* spp. and dandruff in the late 19th century. Different *Malassezia* spp. was found in people with dandruff because of geographic variations according to the epidemiological data.¹⁶

Due to its relationship with different skin problems, *Malassezia* an extensive genus of the fungal microflora present on human skin, is considered as an opportunistic fungus. Basidiomycota, Ustilaginomycotina, Malasseziomycetes, Malasseziales, and Malasseziaceae are the phylum, subphylum, class, order, and family of *Malassezia*. To date, fourteen well-known *Malassezia* species as well as four new species have been reported.

Out of 18 species, 10 species (*M. restricta*, *M. globosa*, *M. arunalokei*, *M. sympodialis*, *M. dermatis*, *M. slooffiae*, *M. furfur*, *M. obtusa*, *M. japonica*, and *M. yamatoensis*) were mainly isolated from human skin, while the others were confined to animal skin. The most common fungi species on humans have been recognized as *M. restricta* and *M. globosa*. *M. pachydermatis* is one of the most common zoophilic species isolated from companion animals like dogs.¹⁷

7. TREATMENT OF DANDRUFF

There are two alternatives in dandruff treatment.¹⁸ They are

1. Synthetic antidandruff agents
2. Herbs as antidandruff treatment

7.1. SYNTHETIC ANTIDANDRUFF AGENTS

Currently, a variety of chemical agents are used to treat dandruff by reducing the number of fungus on the scalp. The most commonly used active agents for dandruff control these days include imidazole derivatives such as ketoconazole, as well as other compounds such as selenium sulfide, zinc pyrithione, piroctone olamine, salicylic acid, sulphur, steroids, tar derivatives.¹⁸ The synthetic antidandruff agents commonly used to treat dandruff are described in Table 1.

7.1.1. Ketoconazole

Ketoconazole is the antifungal medication that is widely used. It is normally used in shampoos at a concentration of 0.25-2% to combat fungal infections. Ketoconazole works by interfering with the biosynthesis of Ergosterol. It prevents Lanosterol from being converted to Ergosterol by inhibiting the Cyp-450 enzyme. Inhibition of ergosterol synthesis reduces membrane permeability and impairs membrane function.^{19,20} Ketoconazole is a broad-spectrum antimycotic agent that is active against *Malassezia* spp. Of all the imidazoles currently available, it has emerged as a leading contender among treatment options due to its efficacy in treating dandruff/seborrheic dermatitis.²¹

7.1.2. Selenium sulphide

It is thought that selenium sulphide controls dandruff through its anti-Pityrosporum effect rather than its anti-proliferative effect; however, it also significantly slows cell turnover. Selenium Sulphide is typically used in shampoos at a concentration of 1 to 2.5% for its antifungal properties. It exists to have anti-seborrheic properties and a cytostatic effect on epidermis and follicular epithelial cells.^{22,23}

7.1.3. Zinc pyrithione

Zinc pyrithione is found in the majority of anti-dandruff products. It is typically used in shampoos at a concentration of 0.5-2% for antifungal activity. Zinc pyrithione has antifungal properties and can disrupt membrane transport by blocking the proton pump that powers the transport mechanism. It enhances epithelial keratinization, sebum production or both to heal the scalp. Following the application of zinc pyrithione, some studies have revealed a significant decrease in the number of yeast organisms. The use of zinc pyrithione shampoo reduces the structural abnormalities found in dandruff. *Malassezia* organisms were reduced in number, parakeratosis was eliminated, and corneocyte lipid inclusions were lowered. As a result, it's thought that zinc pyrithione's normalisation of the stratum corneum ultrastructure is secondary to the correction of pathology in the living epidermal layers.^{24,25,26}

7.1.4. Salicylic acid

Salicylic acid is a beta-hydroxy acid keratolytic agent that helps to remove scaly, hyperkeratotic skin by decreasing corneocyte cell-to-cell adhesion.²⁷ Salicylic acid with a concentration of 1.5 to 6% is commonly used in shampoos for its keratolytic properties.²⁸

7.1.5. Steroids

The pharmacokinetic properties of topical corticosteroids are determined by the structure of the agent, the vehicle, and the skin to which it is applied. Topical corticosteroids work by reducing inflammation and

inhibiting proliferation. Lotions or solutions with a moderate-to-high potency are commonly used on the scalp. Topical steroids are frequently used in conjunction with other therapies, such as antifungal medical conditions.²⁹

7.1.6. Sulphur

It is a yellow non-metallic element that has keratolytic and antimicrobial properties. The keratolytic effect is thought to be mediated by the reaction of sulphur and cysteine in keratinocytes, whereas the anti-microbial effect may be mediated by normal skin flora or keratinocytes converting sulphur to pentathionic acid.³⁰

7.1.7. Tar derivatives

Tar derivatives acts as the anti-proliferative agent. Tars have customarily been used to treat psoriasis, but they are also an effective treatment for dandruff. Tar is a second-line therapy for most patients due to staining, odour, and messiness in application (A stain-free lecithinized coal tar formulation has been developed as a solution to the staining problem.). Tar gels are made from coal tar extract and are less messy and odoriferous than tar. Although definitive analyses are difficult due to the large number of biologically active components in coal tar products, tar shampoos work through antiproliferative and cytostatic effects. Scales are dispersed by tar products, which may reduce *Malassezia* colonisation. Coal tar is typically used in formulations at a concentration of 0.5-3% w/w for anti-proliferative and anti-inflammatory properties.³¹

7.1.8. Piroctone olamine

The anti-dandruff active ingredient piroctone olamine soothes inflamed scalp and reduces flaking. It has a specific action against *Pityrosporum ovale*, the agent that causes dandruff. The anti-dandruff product containing piroctone olamine slaughters the fungus infection that causes dandruff and prevents new dandruff from forming. It also keeps the scalp clean, itch-free.³²

7.1.9. Hydroxypyridones

Hydroxypyridones do not affect sterol biosynthesis in dermatophytes and yeasts; instead, they disrupt active transport of essential macromolecule precursors, cell membrane integrity, and cell respiration. Ciclopirox, a member of the hydroxypyridone family, is effective against dermatophytes, yeast, and fungi on a broad scale. In human polymorphonuclear cells, it has been shown to have anti-inflammatory properties. This agent also prevents the production of prostaglandins and leukotrienes.³³

7.1.10. Fluconazole

The fungus cytochrome P450 enzyme 14-demethylase is inhibited by fluconazole. Fluconazole has a much lower effect on mammalian demethylase activity than it does on fungal demethylase. This inhibits the conversion of lanosterol to ergosterol, a necessary component of the fungal cytoplasmic membrane, and the subsequent accumulation of 14 α -methyl sterols. Fluconazole is primarily fungistatic, but it can be fungicidal in dose-dependent concentrations against certain organisms.³⁴

Table 1: Synthetic antidandruff agents commonly used to treat dandruff

Sl. No.	Synthetic/Chemical agents	Mechanism of action
1	Ketoconazole	Biosynthesis of ergosterol a primary sterol derivative found in fungal cell membranes is inhibited
2	Selenium sulphide	It has anti-seborrheic properties and has a cytostatic effect on epidermal cell and follicular epithelium
3	Zinc pyrithione	Normalises epithelial keratinization, sebum development or both in order to heal the scalp
4	Salicylic acid	It reduces cell to cell adhesion between corneocytes, which helps to remove scaly, hyperkeratotic skin
5	Steroids	Topical corticosteroids function by reducing inflammation and inhibiting cell proliferation
6	Sulphur	It is a yellow non-metallic element that has keratolytic and antimicrobial

		properties. The keratolytic effect is thought to be mediated by the reaction of sulphur and cysteine in keratinocytes, whereas the anti-microbial effect may be mediated by normal skin flora or keratinocytes converting sulphur to pentathionic acid.
7	Tar derivatives	Because of limitations such as staining, odour and messiness in application it is used as a second line therapy. Scales are dispersed by tar products for potentially reducing <i>Malassezia</i> colonization
8	Piroctone olamine	The anti-dandruff product containing piroctone olamine slaughters the fungus infection that causes dandruff and prevents new dandruff from forming
9	Hydroxypyridones	Disrupt active transport of essential macromolecule precursors, cell membrane integrity, and cell respiration
10	Fluconazole	Fluconazole is primarily fungistatic, but it can be fungicidal in dose-dependent concentrations against certain organisms.

7.2. HERBS AS ANTIDANDRUFF TREATMENT

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, in contrast to chemical-based products, are completely safe, extremely effective, and have virtually no side effects due to their compatibility with the human body. The use of natural products in cosmetics has increased dramatically over the last few decades. Herbal cosmetics are becoming more popular, owing to the belief that they are safe and have no adverse side effects. Many plants have been reported to have hair-beneficial properties and are commonly used in shampoos.³⁵ Herbs commonly used to treat dandruff are described in Table 2.

7.2.1. Amla

Amla, also known as Indian gooseberry, is high in vitamin C. It has numerous of health benefits. Powdered amla is an important component of hair tonics, as it promotes hair growth by improving hair pigmentation. It strengthens the roots, maintains the colour, and improves shininess. The most advantage is to reduce baldness and hair loss. This quality is due to the tannin content, which includes tannic acid, ellagic acid, gallic acid, iron, and antioxidant material, which prevents dandruff-induced free radical damage to hair follicles.³⁶

7.2.2. Hibiscus

Hibiscus also known as gudhal, is the most favourable ingredient for hair. It is used to promote hair growth, regrowth and hair loss. Amino acids, Vitamin A, C, and alpha hydroxyl acids, as well as other nutrients, are all found in hibiscus and are beneficial to hair and scalp health. They keep the scalp healthy and decrease the incidence of dandruff in the hair.³⁷

7.2.3. Aloe vera

Since ancient times, aloe vera has been used in traditional remedies. Aloe vera is widely used in the cosmetics and alternative medicine industries, where it is marketed for its rejuvenating, healing, and soothing properties.³⁸ 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.³⁹

7.2.4. Neem

Neem plays a vital role in the cleansing of the scalp. It unclogs clogged pores and boosts hair growth. The regenerative properties are beneficial for dandruff treatment. It has antiseptic and healing properties, and can be used to treat a wide range of hair problems concerning. Neem leaves can be used as a rinse to remove dandruff. The most common application of neem has to be in our hair care routines.⁴⁰

7.2.5. Shikakai

Shikakai has been used in herbal remedies for hair growth and cleaning since ancient times. It has a foam base and anti-dandruff properties, and it clears dandruff and dirt from the scalp, it acts as a cleanser.⁴¹

7.2.6. Henna

Henna 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.⁴² Henna's main colouring compound is "Lawsone," a reddish-orange coloured compound found in dried leaves at a concentration of 1-1.5% w/w. 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.⁴³

7.2.7. Tulasi

Tulsi, also known as holy basil, has been used for religious purposes for centuries. It promotes hair growth by improving blood circulation and keeping the scalp calm, which reduces irritation and dandruff. It's applied as a paste to keep dandruff away and the roots of the scalp clean. It's a powerful antimicrobial plant.⁴⁴

7.2.8. Reetha

Reetha 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. Reetha is a foaming agent that helps to prevent hair loss and has antibacterial and antifungal properties that are beneficial for septic systems.⁴⁵

7.2.9. Bhringraj

Bhringraj, also known as false daisy, is a hair-growth-promoting herb. It's a well-known ayurvedic hair-growth constituent. It promotes blood circulation to the scalp by stimulating and triggering hair growth that has been lost due to a 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 growth, prevent hair loss, premature greying of hair and split ends.⁴⁶

7.2.10. Brahmi

Brahmi is a herbaceous creeping herb that grows along the banks of rivers. Essential oils, sterols, flavonol, glycoside, and triterpenoid saponins are found in Brahmi. It has the ability to delay signs of ageing, such as hair greying. It is commonly used in hair tonic to support good health of hair.⁴⁷

7.2.11. Lemon

Citrus, particularly lemon, may be beneficial in the treatment of dandruff and other skin problems. It contains a lot of vitamin C and can help to maintain the skin's pH balance. Lemon oil is used as the natural cleanser, oil remover, shiner, softening of hairs, cleansing agent, antidandruff.⁴⁸

7.2.12. Ginger

Ginger is an excellent hair conditioner because it contains minerals and essential oils that make hair more manageable, softer, and shinier. It helps relieve from itchy scalp, dryness, and dandruff. It has anti-inflammatory and antiseptic properties that help keep the scalp healthy and clean.⁴⁹

7.2.13. Bilva patra/Bael

Bilva patra/Bael plant has numerous medicinal applications in the Ayurvedic, Unani, and Siddha systems of medicine. Bael fruit pulp 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 applied to the scalp to treat dandruff. Excessive hair fall and scaly scalp skin can be treated by soaking the rind in either coconut oil or ginger oil.⁵⁰

Table 2: Herbs commonly used for antidandruff treatment

Sl. No.	Host name/ Common Name	Botanical name/ Family	Parts used	Uses
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 growth promoter and decrease the incidence of dandruff in the hair
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	Brahmi	<i>Centella asiatica</i> (L.) (Apiaceae)	Dried roots, dried leaves, whole plant	Hair tonic, support health of hair
11	Lemon	<i>Citrus limon</i> (L.) (Rutaceae)	Leaves, fruit	Hair cleaning agent, antidandruff property
12	Ginger	<i>Zingiber officinale</i> Rosc. (Zingiberaceae)	Rhizome	Hair conditioner, relieve from itchy scalp, dryness, and dandruff
13	Bilva patra/Bael	<i>Aegle marmelos</i> (L.) (Rutaceae)	Leaves, rind of the fruit	Antidandruff agent, treats excess hair fall and scaly skin of the scalp

8. Benefits of Herbs as antidandruff treatment

Herbs as antidandruff treatment are mutually beneficial, compatible with the human skin and hair, low cost, absolutely safe, non-toxic nature, reduce the allergic reactions, good health of hair, no side effects.

9. Limitations of Synthetic antidandruff agents

Chemical/synthetic antidandruff agents enhance the texture of the hair along its length but end up by damaging the hair roots and cause hair loss, 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, increased or abnormal hair loss, blistering, peeling, or burning of the skin or scalp.

The chemicals used in synthetic anti-dandruff agents to treat dandruff have certain limitations such as their inability to prevent recurrence, which is a common and troublesome problem. 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.⁵¹

CONCLUSION

Dandruff can be an unpleasant condition that begins around or after puberty, because to its chronic condition, visible appearance and recurrence, leading in psychosocial discomfort for the individual. Patients with dandruff lose two or three times more hair than people with non-dandruff scalps. While dandruff is not a life-threatening disease, it has a strong cosmetic significance and causes social disruption in both genders by causing itching,

scratching, scale shedding and hair loss, as well as causing an untidy appearance. Continuous use of synthetic antidandruff agents make hair brittle, causes dryness of the scalp, grey hair, make the scalp more sun-sensitive, increased allergic reactions and have certain limitation as their inability to prevent recurrence. The world is shifting toward safe and secure, nontoxic, herbs with traditional form and antidandruff agent. Increasing awareness and need for cosmetics with herbs, as these ingredients are widely believed to be safe and free from side effects. Herbal antidandruff treatments are viable alternative to synthetic antidandruff agents.

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