

Microscopic Bridges: Cellular Mechanics and Physiological Roles of *Cuscuta reflexa* Epicuticular Extensions.

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Abstract : Traditional system of medicines relies on the plant products for the treatment of various disorders. Medicinal properties of the plant are used to cure diseases. These medicinal properties of the plant are due to the active phytoconstituents of the plants, having therapeutic potential. *Cuscuta reflexa* is a parasitic weed plant having medicinal properties and have an important place in the Ayurveda. *Cuscuta reflexa* grows over the host plant and draws nutrients from host plant so the medicinal properties also depend on its host plant. Various chemicals have been isolated from this miracle plant having therapeutic potential possessing ethnomedical and pharmacological activities. This review represents a detailed survey on the studies of *Cuscuta reflexa*, its chemical constitution, ethnomedical uses and pharmacological activities.

Keywords- Medicinal plant, *Cuscuta reflexa*, Parasitic plant, Phytoconstituents, Ethnomedical ^[1]

INTRODUCTION

1.1 Overview of herbal cosmeceutical and their rising demand

Cuscuta is a genus of parasitic flowering plants belonging to the family Convolvulaceae. It is commonly known as dodder or amarbel. The plant is characterized by thin, thread-like, yellowish or orange stems and has very small, scale-like leaves. *Cuscuta* lacks well-developed chlorophyll and obtains water and nutrients from its host plant through specialized structures called haustoria. ^[2]

The plant's medicinal characteristics are used to treat a number of ailments. It is frequently employed in the Unani system of medicine for its beneficial therapeutic benefits because of its active ingredients. ^[3]

1.2 Role of traditional herb in hair

They have the hair growth promoting activity and enhanced the regrowth of hair at shaved site. Similar results observed in testosterone-induced alopecia in albino mice with petroleum ether extract of *Cuscuta* ^[4]

Supports Hair and Skin Health

Cuscuta is sometimes used in hair oils and skincare preparations due to its nourishing properties. It may help strengthen hair, reduce hair fall, and improve skin texture ^[5] · A Study of *Cuscuta reflexa* herbal oil report reduced, hair fall in human volunteers.

Anti-dandruff activity : herbal oils prepared from *Cuscuta reflexa* show the activity relevant to dandruff control. Possible effect on androgen-related hair loss: Experimental research found that *Cuscuta reflexa* extract inhibited 5 α -reductase activity, suggesting a possible mechanism for its effect in androgen-induced alopecia. Hair-cycle activity: A polyherbal ^[6]

Fig No:01



1.3 Importance of cuscuta reflexa in Ayurveda and traditional medicine

Liver and jaundice: Cuscuta reflexa has traditionally been used in some Indian practices for jaundice and to support liver function.
Hair care: cuscuta reflexa has a traditional reputation for use in dandruff and hair-fall preparations.
Tonic/rejuvenating uses: Some Cuscuta species have been used traditionally as tonics and in preparations intended to support general vitality.
Eye disorders: Traditional use for certain eye complaints has been reported in India, China and Korea.^[7]

Medicinal properties of the plant are used to cure diseases. These medicinal properties of the plant are due to the active phytoconstituents of the plants having therapeutic potential. Cuscuta reflexa is a parasitic weed plant having medicinal properties and have an important place in the Ayurveda. Cuscuta reflexa grows over the host plant and draws nutrients from host plant so the medicinal properties also depend on its host plant. Various chemicals have been isolated from this miracle plant having therapeutic potential possessing ethnomedical and pharmacological activities. This review represents a detailed survey on the studies of Cuscuta reflexa, its chemical constitution, ethnomedical uses and pharmacological activities.^[8]

The methodology section outline the plan and method that how the study is conducted. This includes Universe of the study, sample of the study, Data and Sources of Data, study's variables and analytical framework. The details are as follows;

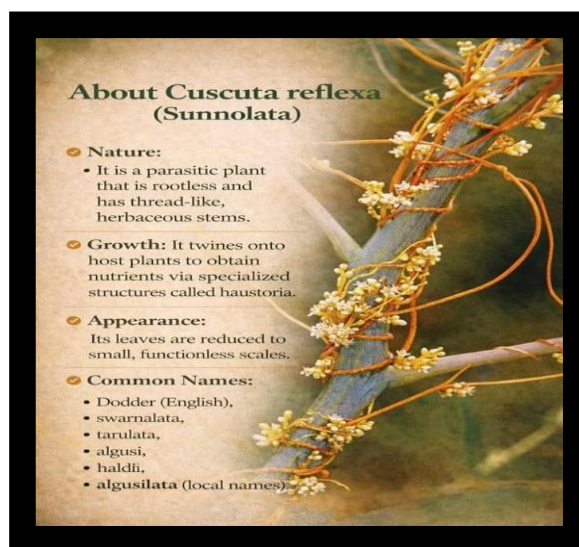


Fig No: 02

1.4 Objective and scope of the review

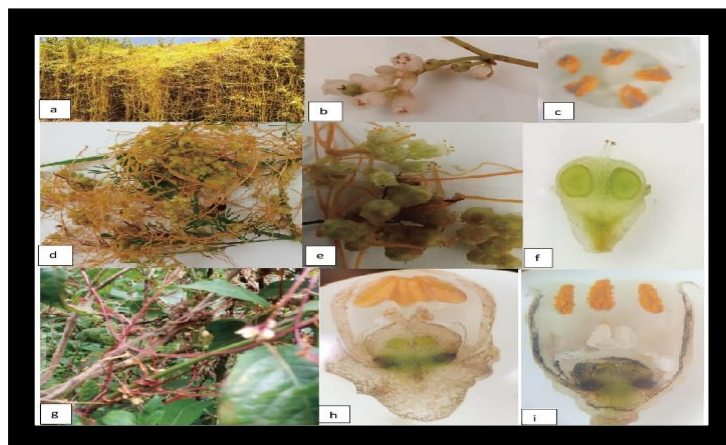
To review the traditional and ethnomedicinal uses of Cuscuta reflexa across different cultures. To analyze the pharmacological activities and bioactive compounds identified in Cuscuta reflexa. To evaluate current scientific research on its therapeutic potential and efficacy.

- Examine its traditional uses in Ayurvedic and folk medical systems, particularly in the areas of dermatology and hair care.
- **Phytochemical Profiling:** Identify and isolate active chemical constituents (e.g., flavonoids, alkaloids, glycosides, and sterols).
- **Therapeutic Validation:** Evaluate traditional ethnomedicinal claims through modern in vitro and in vivo pharmacological studies.
- **Mechanistic Insights:** Assess cellular and biochemical pathways responsible for antioxidant, anti-inflammatory, anti-urolithiatic, and anti-cancer properties
- **Agricultural Impact:** Document its nature as an obligate holoparasite affecting crop yields and ecosystem dynamics.
- **Traditional Systems:** Evaluation of its use in Ayurveda, Unani (Aftimoon), and folk medicine for jaundice, gout, and chronic

2. Botanical Characteristics & Haustorial Physiology

2.1 Taxonomy, distribution, and morphological features of *Cuscuta reflexa*

- Morphology of the *Cuscuta* species (a-c, h, i) *Cuscuta reflexa*
- species, (b) flowers, (c, h, i) anthers, (d-f) *Cuscuta campestris* (d) species, (e) flowers (f) capsule, (g-i) *Cuscuta Kilimanjari* species^[9].



Character	<i>Cuscuta reflexa</i>	<i>Cuscuta campestris</i>	<i>Cuscuta kilimanjari</i>
Stem	Branched, light brown to dark brown, thick and succulent stem	Branched, thin slender, green to yellow-brown	Branched, purple thick succulent stem
Stem colour	Greenish yellow	Yellowish orange	Purplish
Flowers	Large, white to cream, arranged in paniculate cymes, pedicellate, bracts leaf-like	Small white, usually of cymose clusters, actinomorphic	Large White
Style	Single thick and short	separate linear and slende	Short
Stigma	2 elongated and unequal	Capitate or rounded, brown	Round
Calyx Lobes	Five, fleshy, margin scarious, rounded, ovate-obtuse, deeply divided, overlapping at the base	Five, obtuse, 5, oval to orbicula	Five
Corolla lobes	Five, ivory white, obtuse, upright spreading, scales scarious	Triangular, oblong-elliptical	Five
Ovules	Four oblong and elliptical	Four, triangular or ovoid; capsule, circumscissile	Four of oblong
Ovaries	.Four white ovules different sizes, conical	Globular, fleshy, brown	
Stamens	Five, Linear filaments, fused	Five	Five
Anthers	Five, fused, oblong, thick	Five	Five
Capsule	Brown	Globose and membranous	oblong

Table NO : 01 ^[9]

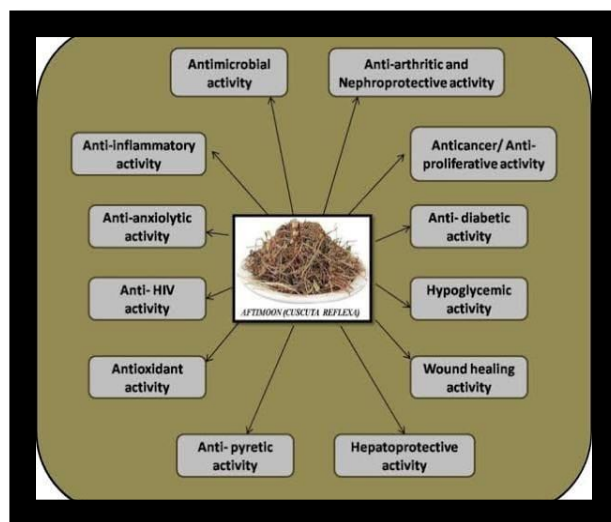


Fig No : 04

2.2 Botanical Profile

Character	Description
Scientific name	Cuscuta reflexa Roxb
Family	Convolvulaceae
Common Name	Amarbel, Akashbel, Dodder, Swarnalat
Habit	Leafless, twining, parasitic herb/vine
Root	Absent in the mature plan
Stem	Slender, yellowish to golden-yellow, thread-like and twining
Leaves	Highly reduced or scale-like
Flowers	Small, usually pale/whitish, occurring in clusters
Fruit	Small capsule containing seeds
Propagation	Mainly by seeds
Nature	Obligate stem parasite; obtains water and nutrients from the host through haustoria

Table No : 02 ^[10]

2.3 Key phytochemicals relevant to cosmeceutical applications of Cuscuta

Pythochemical	Potential cosmeceutical relevance
Quercetin	Antioxidant and anti-inflammatory potential; relevant to protection against oxidative stress
Kaempferol	Antioxidant and anti-inflammatory potential; relevant to protection against oxidative stress
Myricetin	Strong antioxidant potential and possible protection against oxidative damage.
Rutin	Flavonoid antioxidant; may support protection of skin from oxidative stress.
Luteolin	Reported antioxidant and anti-inflammatory activity.
Caffeic acid	Important phenolic compound with antioxidant activity
p-Coumaric	Phenolic antioxidant with potential skin-protective relevance

Gallic acid	Antioxidant phenolic compound commonly investigated in skin-care research.
Vanillic acid	Phenolic antioxidant with potential protective activity
Coumarins	Bioactive constituents with antioxidant and other biological activities.
β - Sitosterol	Plant sterol that may contribute to skin-conditioning and anti-inflammatory properties.
Oleanolic acid / α - amyrin	Triterpenoid constituents investigated for anti-inflammatory and skin-related biological activities.

Table no : 03

2.4 Extraction techniques for bioactive compounds

- Extraction of plant sample: Methanol extract of dried, plant material was prepared by in vitro hot extraction technique, with powdered plant material (100 g). Crude plant extracts, was prepared using methanol as a solvent at 10-20 °C with continue stirring for maximum yield. Then homogenate was filtered and cooled and then concentrated by vacuum distillation method using rotavap. The concentrated plant extract was further used for experimental procedures.^[11]
- Soxhlet extraction method was employed to extract phenolic compounds from *C. reflexa* stems. The effect of extraction time (1-4 h) and concentration of ethanol (45%, 60%, 75% and 90%) on the percentage of yield, total phenolic (TPC) and flavonoid content (TFC) was investigated. The functional groups of phenolic compounds were characterized by using Fourier Transform Infrared Spectrometry (FTIR). DPPH and ABTS•+ radical scavengers were used to evaluate antioxidant activity.^[12]
- Aqueous-methanol extraction
Aqueous methanol has also been used for extracting phenolic and flavonoid constituents, followed by HPLC analysis. This approach is useful when the objective is characterization of relatively polar bioactive compounds.^[13]
- Solvent Partitioning & Flash Column Chromatography: Sequential fractionation using n-hexane, chloroform, and ethyl acetate isolates specific terpenoids, alkaloids, and phenolic-enriched fractions
- Maceration with Stirring: Performed using cold or low-temperature methanol (10–20 °C) on dried, pulverized plant material to preserve thermolabile phytocomponents prior to GC-MS profiling.^[14]

2.5 Analytical methods for phytochemical profiling

- Specific Metabolomics Techniques: Highlights specific metabolomics techniques used for comprehensive metabolic profiling, such as Nuclear Magnetic Resonance (NMR), Gas Chromatography-Mass Spectrometry (GC-MS), and Liquid Chromatography-Mass Spectrometry (LC-MS).^[15]
- Utilizes the seeds of *Cuscuta chinensis* as a case study to demonstrate the effectiveness of the approach, achieving an orthogonality of 0.73 and an effective peak capacity of 4361 using a hydrophilic interaction chromatography (HILIC) and a reversed-phase chromatography (RPC) column configuration.^[16]
- Popular Analytical Platforms: Highlights common hyphenated analytical platforms for metabolomics, including NMR and MS coupled with chromatographic techniques such as liquid phase (HPLC and UPLC) and gas phase chromatography.^[17]
- UPLC-Q-TOF/MS Profiling: Employs Ultra-Performance Liquid Chromatography coupled with Quadrupole Time-of-Flight Mass Spectrometry (UPLC-Q-TOF/MS) for untargeted chemical and metabolic profiling of *Cuscuta* seeds.^[18]

3. Traditional Hair Care Uses

- Promoting Hair Growth & Density : The whole plant is crushed or boiled to extract active compounds thought to stimulate hair follicles, reduce thinning, and encourage faster hair regrowth.
- Preventing Hair Loss (Alopecia): Paste made from fresh stems is applied to areas with noticeable hair fall or patchiness to strengthen hair roots.
- Scalp Cleansing & Anti-Dandruff : Natural antimicrobial properties help combat scalp infections, reduce flaking, and soothe persistent itching.
- Preventing Premature Graying : Traditionally infused into base oils alongside herbs like Bhringraj or Amla to help retain natural hair pigmentation.^[19]

3.1 Ethnomedicinal & Historical Usage for Hair Care

- Traditionally, *Cuscuta reflexa* is recognized as a hair tonic, anti-hair loss agent, and scalp-purifying herb:
- Traditional Indications: Historically prescribed for Khalitya (alopecia/premature hair loss), Indralupta (spot baldness), dandruff (Darunaka), and scalp itching or fungal infections.^[20]
- a) Herbal Hair Oils : Stems are traditionally crushed, cooked, or infused into base oils—most commonly mustard oil, sesame oil, or coconut oil—and applied topically to the scalp to stimulate hair growth.
- b) Scalp Wash & Decoctions: Aqueous decoctions (kwath) or stem juices are used as a scalp rinse to cleanse dandruff and soothe scalp irritation.

- c) **Poultices:** Fresh stem pastes combined with other herbs (e.g., *Eclipta alba* or *Citrullus colocynthis*) are applied to patches of thinning or lost hair.^[21]

It is also used internally to treat prolonged fevers and externally to treat body aches and itchy skin. Additionally, used as a stimulant of hair growth is *Cuscuta reflexa*. As a blood purifier, seeds are claimed to be tonic, diaphoretic, and demulcent. In cases of discomfort and stomach ache, a cool infusion of^[22].

3.2 Application in managing Dandruff And Hair Loss

- Antifungal Action Against Malassezia :** Dandruff is primarily caused by an overgrowth of the yeast *Malassezia*. Flavonoids, kaempferol, and quercetin isolated from *C. reflexa* show antifungal activity that suppresses yeast proliferation on the scalp.
- Sebum & Flaking Control :** Herbal oil preparations (e.g., *C. reflexa* extracted in a mustard oil base) significantly reduce scaling, itching, and excessive flaking associated with chronic dandruff^[23]

➤ Hair Loss and Hair Growth Stimulation

1.5 α -Reductase Inhibition: Preclinical studies indicate that extracts of *Cuscuta reflexa* inhibit the enzyme 5 α -reductase, which converts testosterone to dihydrotestosterone (DHT)—the primary hormone driving androgenetic alopecia (pattern baldness).

2.Follicular Proliferation : Petroleum ether and ethanolic stem extracts have demonstrated a capability to convert resting (telogen) hair follicles into active growth (anagen) phases, increasing hair density and follicular counts.

3.Chemotherapy-Induced Alopecia : Research shows that *C. reflexa* extracts offer protective effects against hair follicle damage caused by cytotoxic agents like cyclophosphamide by reducing follicular apoptosis^[24]

3.3 Traditional preparations and modes of application

A) Fresh Stem Paste (Swarasa / Kalka)

Preparation: Freshly harvested stems are washed and ground into a fine paste, sometimes blended with a base oil (such as sesame oil) or water.

Mode of Application: Applied topically to inflammation, swollen joints (for gout and rheumatism), and skin infections or scabies. Herbal Scalp Oil (Keshya Taila)

Preparation : Fresh *Cuscuta reflexa* stem juice or paste is slow-boiled with a base oil (typically sesame or coconut oil) until the moisture evaporates, infusing the oil with the active phytoconstituents.

Mode of Application: Massaged into the scalp to treat hair loss, strengthen roots, and promote hair growth.^[25]

B) Decoction (Kwatha)

Preparation: Coarsely powdered dry stem (or fresh stem pieces) is boiled in water and reduced to one-fourth of its initial volume, then strained.

Mode of Application : Administered orally (typically 30–50 mL) to manage digestive disorders, diarrhea, irritable bowel syndrome, and respiratory issues like cough and asthma^[26]

4. Pharmacological Activities Supporting Cosmeceutical Potential

4.1Antioxidant Activity(Anti-Aging & Environmental Protection) Mechanism

Free radicals (ROS) generated by UV radiation and pollution lead to collagen degradation, lipid peroxidation, and skin aging. Phenolics, flavonoids (quercetin, kaempferol), and glycosides present in *C. reflexa* act as free-radical scavengers, reducing oxidative stress in skin cells (Adnan et al., 2020).

Cosmeceutical Application: Included in anti-aging creams, serums, and daily protective lotions to guard against photoaging and cellular damage.^[27]

4.2 Hair growth promoting and follicular nourishing effects

1.5 α -Reductase Inhibition : *Cuscuta reflexa* extracts inhibit the 5 α -reductase enzyme (specifically type II), which converts testosterone into dihydrotestosterone (DHT). Lowering local DHT levels prevents follicle miniaturization, a primary cause of androgenic alopecia.

2.Follicular Proliferation & Anagen Phase Induction : Phytoconstituents induce and prolong the anagen (growth) phase of the hair cycle while shortening the telogen (resting) phase. This leads to an increase in follicle density and hair count.

3.Scalp Microcirculation & Nourishment: The plant's active constituents improve blood flow to the dermal papilla cells, increasing the delivery of essential nutrients and oxygen required for active keratin synthesis.

4.Antioxidant & Anti-inflammatory Activity: High flavonoid content neutralizes reactive oxygen species (ROS) in scalp tissues, reducing lipid peroxidation and microbial inflammation that damage root structures.^[28]

5. Nutritious Components: Determines that *C. reflexa* is a potential rich source of protein and essential minerals (Ca, Cu, P, Fe, Zn) necessary for growth activities, suggesting its follicular nourishing potential for hair formulations.

6. Hair Growth Initiation: Demonstrates that topical application of the formulated herbal hair oils on experimental animals resulted in excellent initiation and completion of hair growth, comparable to controls, within a 28-day period.^[29]

5. Formulation Strategies in Modern Hair Care

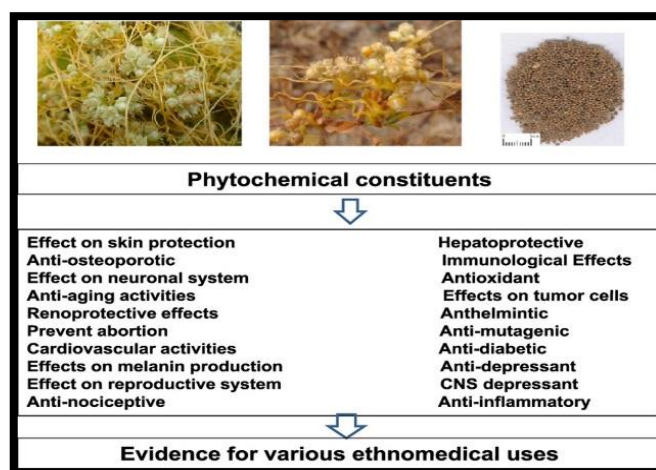


Fig No : 05^[30]

5.1 Conventional herbal formulations (oils, pastes, decoctions)

A. Herbal Oils (Taila)

Preparation & Usage : Stems of *Cuscuta. reflexa* are cooked or processed in a base oil (typically sesame oil or coconut oil) along with other herbs.

Indications : Applied topically to treat alopecia, promote hair growth, strengthen hair roots, and reduce dandruff. Warm oil preparations are also massaged onto joints to relieve arthritic pain, inflammation, and stiffness.

B. Pastes (Kalka / Lepa)

Preparation & Usage: Fresh whole plant stems are crushed with a small amount of water or sesame oil to form a smooth paste.

Indications : Applied externally over skin eruptions, eczema, open wounds, or inflamed joints to alleviate burning sensations, control localized bleeding, and reduce tissue swelling.

C. Decoctions (Kwath)

Preparation & Usage: Coarsely powdered dried stems (or fresh vines) are boiled in water—traditionally reducing 4 parts water to 1 part—and consumed orally.

Indications : Used as a blood purifier, a mild laxative for constipation, and to treat liver conditions, jaundice, flatulence, and fever.^[31]

5.2 Advanced delivery systems (nanoemulsions, liposomes, gels)

Develops a *Cuscuta chinensis* extract-loaded nanoemulsion-based gel and evaluates its wound care properties in rats, demonstrating a better wound contraction percentage than Fucidin cream. Nanoemulsion Characterization: Analyzes the *Cuscuta chinensis* extract-loaded nanoemulsions for physicochemical properties, reporting a small particle size, a narrow polydispersity index, and good stability.

Biological Activities: Examines the biological activities of the *C. chinensis* extracts, which include antioxidant, anti-inflammatory (reducing IL-1 β , IL-6, and TNF- α expression), and antibacterial effects.^[32]

5.3 Enhancing Hair Penetration And Bioavailability

1. Demonstrates that Minoxidil sulfate-loaded liposomes (MXS-LPSs) considerably increased drug accumulation in hair follicles compared to Minoxidil sulfate (MXS) solution, indicating enhanced follicular penetration.

Enhanced Dermal Deposition: Shows that MXS-LPSs significantly enhanced dermal drug deposition and facilitated targeted delivery to the hair follicles, thereby increasing local drug bioavailability.

Improved Hair Regrowth Efficacy: Finds that MXS-LPSs more effectively stimulate hair regrowth in androgenic alopecia model rats when compared to Minoxidil tincture, confirming improved therapeutic efficacy related to bioavailability.^[33]

2. Compares polymeric nanoparticles (PNPs) and nanostructured lipid carriers (NLCs) co-encapsulating minoxidil and betamethasone for topical application, aiming to reduce side effects and increase patient adherence.

Enhanced Follicular Penetration: Demonstrates that NLCs provided a tenfold increase in minoxidil penetration into hair follicles and delivered higher concentrations of betamethasone to hair follicles compared to both PNPs and the control.

Follicle Targeting Efficiency: Establishes that both PNPs and NLCs enhanced the targeting of minoxidil and betamethasone to hair follicles, with NLCs targeting approximately 74% of betamethasone delivery to the hair follicles.^[34]

5.4 Examples of patented and commercial formulations

- Explores the main applications of the genus *Cuscuta* described in patents, including polyherbal treatments for various symptoms, diseases, and cosmetic applications.
- **Extract Preparation Methods:** Indicates that 13% of the reviewed patents describe methods for preparing *Cuscuta* extracts and their pharmaceutical or medicinal uses, such as for skin-whitening, hair restoration, or neurotrophic effects.
- **Patent Development and Raw Material:** Reports that industry had a 49% participation in the development of these patents, and the main raw materials claimed were seeds and whole plants from different *Cuscuta* species.^[35]

6 Safety and Regulatory Considerations

6.1 Allergenic potential and sensitization concerns . Identifies oleosin H1 (Ses i 4) and oleosin L (Ses i 5) as allergens in white sesame seeds and analyzes their structure and function. Epitope Prediction: Predicts and maps ten potential B cell epitope peptides, including key epitopes B3 and B4 for oleosin H1, and B8 and B9 for oleosin L, using IgE binding simulations . Sensitization Mechanisms: Elucidates the sensitization mechanism by identifying critical residues, such as Glu135 and Phe102 in oleosin H1 and Leu120 in oleosin L, that are essential for binding stability through mutational analysis.^[36]

Determined the acute toxicity level, reporting an LD50 of over 5000 mg/kg for the water extract of *Cuscuta. chinensis* (CLW) and no mortality or severe toxicities in the sub-acute study up to 5000 mg/kg.

Physiological Effects: Identified that treatment with CLW caused a significant reduction in body weight and feed intake in mice, and affected organ coefficients of the brain, liver, lung, testis, and thymus.

Liver Toxicity Concern: Reported mild liver toxicity at the highest dose (5000 mg/kg), indicated by elevated levels of aspartate aminotransferase, alanine aminotransferase, and alkaline phosphatase, which suggests that liver toxicity from daily use may be a concern.^[37]

6.2 Current Regulatory Guidelines For Hair

India – Cosmetics Rules, 2020: Hair products such as hair colours, bleaching products, permanent waves, relaxers/straighteners and other hair/scalp products are regulated as cosmetic categories.

Hair dyes: In India, hair dyes containing certain dyes/pigments must carry prescribed caution statements and preliminary/patch-test instructions.

2026 Indian guidance: (CDSCO) has reiterated that imported and manufactured hair-colour cosmetics must comply with the Cosmetics Rules, 2020 and applicable BIS standards, including requirements for ingredients, warnings, patch testing and labeling.

United States – FDA/MoCRA: Hair-care cosmetics must be safe under labeled/customary use and correctly labeled. Under MoCRA, applicable manufacturers/responsible persons have requirements for facility registration, product listing, safety substantiation, and adverse-event reporting.^[38]

U.S. labeling: Cosmetic labels generally need the product identity, net quantity, responsible business information, and ingredient declaration; claims must be truthful and not misleading.

European Union: Hair products that fall within the cosmetic definition are governed by Regulation (EC) No. 1223/2009, which aims to ensure a high level of human-health protection.^[39]

7. Challenges and Future Prospects

7.1 Challenges in standardization and stability

Identifies that a key challenge in standardization is the difficulty in distinguishing *Cuscuta reflexa* from its common adulterant, *Cuscuta chinensis*, as both are traded under the same name and are morphologically similar in dried form.

Importance of Authentication : Explains that reliable identification and authentication of the herbal drug are crucial for quality and efficacy, especially since adulteration significantly decreases the drug's therapeutic value.

Molecular Solution for Quality Control: Describes the development of Sequence Characterized Amplified Region (SCAR) markers as a molecular method to efficiently discriminate the genuine drug from its adulterant for quality control and standardization in the herbal industry.^[40]

7.2 Scope for clinical validation

Pharmacological Studies Needed: Explains that extensive pharmacological studies are still necessary to fully understand the clinical relevance and applications of *Cuscuta reflexa* in preventing and treating severe diseases like hepatocellular carcinoma. Assessing Anticancer Potential: Suggests that to effectively assess the anticancer properties of *C. reflexa*, human clinical trials employing robust methodologies and thorough follow-up are required ^[41]

Efficacy Demonstrated: Demonstrates that the combination drug significantly increased skin moisture and elasticity and decreased pruritus and sleep disturbance in patients with atopic dermatitis, suggesting effective skin barrier reconstruction. Safety Profile: Reports temporary and mild side effects, such as anorexia and gastrointestinal problems, suggesting a generally safe profile for the treatment.^[42]

7.3 Opportunities for product development and market potential

Pharmaceutical Opportunity: Shows that herbal products, either as purified compounds or standard extracts, offer opportunities for new pharmaceutical products due to their chemical diversity . Therapeutic Potential: Explains that the presence of numerous valuable components, a broad range of biological attributes, and the plant's remedial value in folk medicine stimulate the discovery of new and more efficient therapeutic agents.^[43]

7.4 Integration with other botanicals for synergistic formulations of cuscuta reflexa

Specific Botanical Integration: Lists the specific botanical and mineral ingredients combined with *Cuscuta reflexa* in the Itrifal-e-Aftimoon formulation, including *Terminalia chebula*, *Embllica officinalis*, and *Plumbago zeylanica*. Synergistic Mechanism Potential: Explains that the polyherbal nature of the formulation suggests potential synergistic interactions among the constituents, which contribute to comprehensive cancer management by targeting multiple pathways.^[44]

Formulation Development: Explains that five herbs, including *Cuscuta reflexa*, were used to create in-house polyherbal formulations in varying ratios to evaluate hair growth activity. Synergistic Activity Findings: Reports that the polyherbal formulation F1, containing the combination of extracts, showed a significant increase in hair length and diameter and reduced hair growth initiation time compared to control, suggesting synergistic or complementary activity^[45]

7.5 Advantages and Disadvantage Of Cuscuta Reflexa

1. Advantage

May promote hair growth – An animal study found that *C. reflexa* extract increased hair-follicle density and promoted the active growth phase of hair.

May reduce hair fall – Traditionally, *C. reflexa* preparations have been used for hair fall. May have anti-androgenic activity – Its extract inhibited 5 α -reductase in laboratory experiments, an enzyme involved in the conversion of testosterone to DHT. Contains

bioactive compounds – *Cuscuta* species contain flavonoids, alkaloids, lignans, phenolics and other compounds with antioxidant and other biological activities.

2. Disadvantages / Limitations

Limited human evidence – The important hair-growth study was performed in mice, not humans, so the same results cannot be assumed in people.

Safety is not well established for hair use – Reviews specifically note that further research is needed to establish the safety profile of *Cuscuta* constituents.

Possible scalp irritation or allergy – Applying an unstandardized plant preparation directly to the scalp could potentially cause irritation or allergic reactions.

Preparation matters – The research used a specific petroleum-ether extract, so its results cannot automatically be applied to homemade juice, paste, oil, or other preparations. Should not replace proven hair-loss treatments – If hair loss is significant or persistent, the underlying cause should be evaluated rather than relying only on *Cuscuta reflexa*.^[46]

8. Conclusion

Cuscuta reflexa shows promising potential as a natural hair-growth-promoting agent. Experimental studies have found that its extracts may promote hair-follicle growth and reduce androgen-induced hair loss, possibly by inhibiting the 5 α -reductase enzyme involved in the formation of DHT.

However, most of the available evidence comes from animal and laboratory studies, so further clinical research in humans is needed to establish its effectiveness and safety.

Cuscuta reflexa is a medicinal plant that has been traditionally used for different health problems, including hair fall and hair-related conditions. Researchers have shown interest in this plant because it contains various natural compounds that may have antioxidant, anti-inflammatory, antibacterial and other beneficial properties. Some studies also suggest that it may help in promoting hair growth. *Cuscuta reflexa* is particularly interesting for hair care because experimental studies have shown that its extract may help improve hair growth. In one study conducted on mice with androgen-related hair loss, the extract increased the number of hair follicles and helped more hair follicles remain in the active growth phase. The study also found that the extract may inhibit 5-alpha-reductase, an enzyme involved in the formation of DHT, which is associated with certain types of hair loss. These findings suggest that *Cuscuta reflexa* may have potential in managing hair fall.

However, there are some limitations to the available research. Most importantly, the major study on hair growth was performed on mice rather than humans. Therefore, we cannot say with certainty that the same effects will occur in people. There are also limited clinical studies available on the safety and effectiveness of *Cuscuta reflexa* for hair loss. More research is needed to determine the proper dosage, method of preparation, effectiveness and long-term safety of the plant.

Cuscuta reflexa is a promising traditional herbal plant for hair care and may have the potential to support hair growth and reduce hair fall. The results from experimental studies are encouraging, but there is not yet enough human evidence to consider it a proven treatment for hair loss. Further studies and clinical trials are needed to confirm its benefits and safety. Therefore, *Cuscuta reflexa* can be considered a potential herbal ingredient for future hair-care products, but its use should be supported by proper scientific research.

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