

"Phyto therapeutic Potential of Seeds in Promoting Hair Growth and Reducing Alopecia"

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Abstract—Alopecia, or hair loss, is a prevalent condition affecting people worldwide. Increasing interest in natural treatments has led to the exploration of phototherapeutics derived from seeds, which contain bioactive compounds that support hair growth and help prevent hair loss. This review evaluates the potential of seed-based phototherapeutics in combating alopecia by analysing their active constituents, mechanisms of action, and clinical significance.

Index Terms—Alopecia, Phytotherapy, Seed-based therapy, Polyphenols, Hair growth, Essential fatty acids

I. INTRODUCTION

Hair loss is a multifaceted condition influenced by genetic factors, hormonal imbalances, aging, stress, inadequate nutrition, environmental pollutants, and medical conditions. It can have a profound impact on psychological well-being, affecting self-confidence and overall quality of life. Several forms of alopecia exist, including androgenetic alopecia, alopecia areata, telogen effluvium, and traction alopecia, each requiring distinct treatment approaches. Conventional pharmacological treatments such as minoxidil and finasteride are widely utilized; however, these medications often pose challenges, including potential side effects like scalp irritation, hormonal disruptions, and variable long-term effectiveness. Consequently, there is an increasing demand for safer, plant-based alternatives that offer therapeutic benefits without adverse effects. Plant-derived compounds have gained significant attention for their ability to promote hair growth, regulate pathways associated with hair loss, and improve scalp health. Among these, seeds are particularly rich in bioactive compounds, including polyphenols, essential fatty acids, vitamins, and amino acids, which have demonstrated potential in hair restoration. This review explores the role of seed-based phytotherapeutics in managing alopecia, focusing on their bioactive constituents, mechanisms of action, and clinical applications.

CHIA SEED (SALVIA HISPANICA L)



Fig 1

Promotes Hair Growth & Skin Health:

Omega-3 Fatty Acids: Nourish hair follicles, reduce inflammation, and support scalp health.

High in Antioxidants: Prevents skin aging and protects against sun damage.

Hydrating Properties: Retains moisture in the skin and scalp, preventing dryness.

Supports Heart Health:

Reduces Cholesterol & Triglycerides: Contains soluble fiber that lowers bad cholesterol.

Regulates Blood Pressure: High potassium and magnesium content help maintain heart health.

Boosts Digestive Health: Excellent Source of Fiber: Promotes gut health, prevents constipation, and aids digestion.

Prebiotic Effects: Supports beneficial gut bacteria growth.

Improves Bone Strength:

Rich in Calcium, Magnesium & Phosphorus: Strengthens bones and prevents osteoporosis.

Regulates Blood Sugar & Aids in Diabetes Management:

Controls Blood Sugar Spikes: Soluble fiber slows down sugar absorption.

Improves Insulin Sensitivity: Helps regulate glucose metabolism.

Helps in Weight Loss.

Expands in Water: Forms a gel-like texture in the stomach, keeping you full longer.

High in Protein & Fiber: Reduces cravings and supports fat loss.

Enhances Energy & Endurance:

Rich in Slow-Digesting Carbs: Provides

long-lasting energy, making it ideal for athletes.

PUMPKIN SEED (Cucurbita pepo or Cucurbita maxima)



Fig 2

Benefits for Hair & Skin:

Rich in Zinc: Promotes hair growth and prevents hair thinning. Also helps in collagen synthesis for healthy skin.

Omega-3 & Omega-6 Fatty Acids: Maintain scalp hydration and reduce hair fall.

High in Antioxidants (Vitamin E & Carotenoids): Protects hair and skin from oxidative damage, slowing aging and reducing wrinkles.

Supports Heart Health:

Lowers Bad Cholesterol (LDL): Rich in phytosterols and fiber that help reduce cholesterol.

Magnesium & Potassium: Regulate blood pressure and prevent heart disease.

Boosts Immunity:

High in Zinc & Iron: Strengthens immune function and prevents infections.

Anti-inflammatory Properties: Reduces inflammation, helping with conditions like arthritis.

Improves Prostate & Bladder Health:

Supports Prostate Health: Rich in zinc and antioxidants that reduce prostate enlargement (BPH).

Prevents Urinary Disorders: May help improve bladder control.

Enhances Mental Health & Sleep:

Rich in Tryptophan: A precursor to serotonin, which improves mood and promotes restful sleep.

Boosts Brain Function: Magnesium and antioxidants enhance cognitive function.

Aids in Weight Loss & Digestion:

High in Fiber: Keeps you full longer supports digestion, and prevents constipation.

Protein-Rich: Helps build muscle and control appetite.

Regulates Blood Sugar Levels:

Low Glycemic Index: Helps in diabetes management by preventing blood sugar spikes.

SUNFLOWER SEED (Helianthus annuus L)



Fig 3

Promotes Hair Health:

Rich in Vitamin E: Sunflower seeds are an excellent source of vitamin E, which improves blood circulation to the scalp, promotes hair growth, and prevents hair fall.

Contains Biotin: Biotin (Vitamin B7) in sunflower seeds strengthens hair strands, preventing breakage and split ends.

Omega-6 Fatty Acids: These essential fatty acids help maintain scalp moisture, reducing dandruff and dryness.

Supports Heart Health:

Lowers Bad Cholesterol (LDL): Sunflower seeds contain phytosterols and healthy fats that help reduce bad cholesterol levels, decreasing the risk of heart disease.

Rich in Magnesium: Magnesium helps regulate blood pressure and prevents hypertension.

Anti-inflammatory Properties: The antioxidants and healthy fats in sunflower seeds reduce inflammation in blood vessels, lowering the risk of cardiovascular diseases.

Boosts Immunity:

High in Zinc & Selenium: These minerals play a crucial role in enhancing immune function and protecting against infections.

Improves Brain Function:

Boosts Cognitive Function: Sunflower seeds contain choline, which supports neurotransmitter function, improving memory and concentration.

Reduces Stress & Anxiety: Magnesium helps in relaxing the nervous system and reducing stress-related disorders.

Aids Digestion:

Rich in Fiber: The high fiber content promotes digestion, prevents constipation, and supports gut health.

Supports Gut Microbiota: The prebiotic properties of sunflower seeds promote the growth of beneficial gut bacteria.

Regulates Blood Sugar Levels:

Balances Blood Glucose: The combination of fiber, protein, and healthy fats helps slow down sugar absorption, preventing blood sugar spikes.

Reduces Insulin Resistance: Magnesium and antioxidants play a role in improving insulin sensitivity.

Supports Bone Health:

High in Magnesium & Phosphorus: These minerals strengthen bones and reduce the risk of osteoporosis.

Contains Copper: Copper plays a vital role in bone mineralization and collagen formation.

Helps in Weight Management:

Keeps You Full Longer: The fiber and protein in sunflower seeds provide satiety, reducing unnecessary cravings.

Supports Metabolism: Healthy fats help improve metabolic rate, aiding in fat burning.

Reduces Inflammation:

Contains Anti-inflammatory Compounds: Sunflower seeds contain flavonoids and phenolic compounds that help combat inflammation, reducing the risk of chronic diseases like arthritis

FLAX SEED (Linum usitatissimum.)**Fig 4****Promotes Hair & Skin Health:**

Omega-3 Fatty Acids (ALA): Strengthens hair follicles, prevents breakage, and keeps the scalp hydrated.

Lignans & Antioxidants: Protect skin from aging and UV damage.

Vitamin B Complex: Supports skin elasticity and reduces dryness

Supports Heart Health:

Reduces LDL Cholesterol: Soluble fiber binds to cholesterol, lowering its levels.

Prevents Artery Hardening: Omega-3s help reduce inflammation in blood vessels.

Regulates Blood Pressure: Magnesium and potassium contribute to heart health.

Aids in Digestion:

Rich in Soluble & Insoluble Fiber: Improves bowel movements and relieves constipation.

Supports Gut Health: Acts as a prebiotic, feeding good gut bacteria.

Balances Hormones (Especially in Women):

Contains Lignans (Phytoestrogens): Helps regulate estrogen levels, reducing menopausal symptoms and supporting reproductive health

Helps in Weight Management:

High in Fiber & Protein: Keeps you full longer, reducing overeating.

Boosts Metabolism: Omega-3s help in fat metabolism and energy balance.

Regulates Blood Sugar Levels:

Slows Sugar Absorption: Fiber helps prevent sudden spikes in blood sugar.

Beneficial for Diabetes Management: Improves insulin sensitivity.

Fights Inflammation:

Omega-3s & Lignans: Reduce inflammation, benefiting conditions like arthritis and autoimmune disorders.

Bioactive Compounds in Seeds Beneficial for Hair Growth

Seeds contain a diverse range of phytochemicals that contribute to hair follicle stimulation and scalp health. Key bioactive constituents include:

- **Polyphenols:** Found in grape seeds and flaxseeds, polyphenols exhibit antioxidant properties that reduce oxidative stress, a known contributor to hair loss.
- **Essential fatty acids:** Omega-3 and omega-6 fatty acids from chia and flaxseeds support scalp hydration and hair follicle nourishment.
- **Phytoestrogens:** Present in fenugreek and sesame seeds, phytoestrogens modulate hormonal imbalances linked to androgenetic alopecia.
- **Amino acids and proteins:** Pumpkin seeds and sunflower seeds provide essential proteins that enhance keratin production.
- **Vitamins and minerals:** Zinc, selenium, and biotin, abundantly found in sunflower and sesame seeds, are crucial for hair follicle function and regeneration.

Polyphenols & Flavonoids: Antioxidant & Hair Cycle Regulators

Sources:

- **Grape Seeds (*Vitis vinifera*)** – Rich in proanthocyanidins
- **Flaxseeds (*Linum usitatissimum*)** – Contain lignans and flavonoids
- **Sesame Seeds (*Sesamum indicum*)** – High in sesamin and sesamol
- **Pumpkin Seeds (*Cucurbita pepo*)** – Contain phenolic acids and flavonoids

Mechanisms of Action:

- **Antioxidant Activity:** Neutralize **free radicals**, which cause **oxidative damage** to hair follicles.
- **Anagen (Growth Phase) Stimulation:** Proanthocyanidins in **grape seeds** activate the **Wnt/ β -catenin pathway**, which promotes **new hair follicle formation**.
- **Reduction in Inflammation:** Polyphenols **suppress inflammatory cytokines (IL-6, TNF- α)** that are linked to **hair follicle shrinkage**.
- **Anti-Apoptotic Effects:** Prevent **premature death of hair follicle cells**, allowing **longer anagen phase**.

Scientific Evidence:

Grape seed extract (Proanthocyanidins) enhanced anagen phase duration in a study on **androgenetic alopecia patients** (Kumar et al., 2021).

Flaxseed lignans reduced scalp inflammation and improved hair density in **telogen effluvium subjects** (Esfandiari et al., 2020).

Essential Fatty Acids (Omega-3 & Omega-6): Scalp Hydration & Follicle Nourishment

Sources:

- **Flaxseeds & Chia Seeds** – Rich in **Alpha-Linolenic Acid (ALA)**
- **Pumpkin & Sunflower Seeds** – Contain **Linoleic Acid (LA) & Oleic Acid (OA)**
- **Hemp Seeds** – Have **Gamma-Linolenic Acid (GLA)**, a potent anti-inflammatory compound

Mechanisms of Action:

- **Scalp Hydration & Sebum Regulation:** Omega-3s **prevent dry scalp** and **reduce dandruff** by maintaining the **lipid barrier**.
- **Anti-Inflammatory Properties:** Reduce **C-reactive protein (CRP)** and **prostaglandin E2 (PGE2)**, which are linked to **scalp inflammation and hair shedding**.
- **Increase in Hair Follicle Proliferation:** Fatty acids **stimulate the dermal papilla cells (DPCs)**, enhancing **hair regrowth**.
- **Protection Against Hair Follicle Miniaturization:** Linoleic acid **preserves follicle size** in individuals with **pattern baldness**.

Scientific Evidence:

- A **6-month study** on Omega-3 supplementation showed a **significant increase in hair density and reduction in hair shedding** (Pérez et al., 2017).
- **Gamma-linolenic acid (GLA) in hemp seeds** was found to **reduce scalp dryness and improve blood circulation to follicles**.

3. Phytoestrogens & Hormonal Modulation

Sources:

- **Flaxseeds & Sesame Seeds** – Contain **lignans**
- **Fenugreek Seeds (*Trigonella foenum-graecum*)** – Rich in **diosgenin**
- **Pumpkin Seeds** – Natural **5-alpha reductase inhibitors**

Mechanisms of Action:

- **Regulation of Estrogen and Androgen Levels:** Phytoestrogens **bind to estrogen receptors**, reducing the effects of **testosterone-related hair loss**.
- **DHT (Dihydrotestosterone) Inhibition:** Pumpkin seeds & flaxseed lignans **inhibit 5-alpha reductase**, preventing **conversion of testosterone into DHT**.
- **Reduction in Menopausal Hair Loss:** Lignans help **balance estrogen levels**, reducing **hormonal hair thinning** in women.

Scientific Evidence:

- **Pumpkin seed oil increased hair count by 40% in 24 weeks** in men with androgenetic alopecia (Cho et al., 2014).
- **Fenugreek seed extract improved hair thickness and reduced shedding** in individuals with **telogen effluvium** (Sharquie et al., 2019).

4. Amino Acids & Proteins: Building Blocks of Hair Structure**Sources:**

- **Pumpkin & Sunflower Seeds** – Contain **arginine, cysteine, and methionine**
- **Hemp Seeds** – Rich in **complete proteins**
- **Flaxseeds** – High in **proline and glycine**

Mechanisms of Action:

- **Keratin Synthesis:** Amino acids like **cysteine and methionine** are **precursors to keratin**, the primary protein in hair strands.
- **Collagen Production:** **Proline & glycine** in flaxseeds enhance **collagen formation**, strengthening **hair follicles and reducing breakage**
- **Improved Hair Follicle Vascularization:** **Arginine** promotes **vasodilation**, improving **oxygen supply to scalp tissue**.

Scientific Evidence:

- **Cysteine & methionine supplementation improved hair texture and reduced breakage** in a study on **nutritional deficiencies & hair loss** (Rushton et al., 2011).
- **Arginine improved scalp microcirculation**, leading to **stronger, more resilient hair growth**.

5. Vitamins & Minerals: Hair Growth Regulators**Sources:**

- **Sunflower Seeds** – High in **Vitamin E, Biotin, and Zinc**
- **Pumpkin Seeds** – Contain **Iron & Magnesium**
- **Flaxseeds & Chia Seeds** – Rich in **Selenium & Copper**

Mechanisms of Action:

- **Vitamin E (Antioxidant Protection):** Prevents **UV-induced scalp damage** and enhances **blood flow to hair follicles**
- **Zinc (Hair Follicle Regeneration):** Essential for **DNA synthesis & tissue repair**, preventing **hair thinning**.
- **Iron (Oxygen Delivery to Follicles):** Prevents **anemia-related hair shedding**.
- **Magnesium (DHT Regulation):** Inhibits **calcium buildup in follicles**, which is linked to **DHT-induced hair loss**.

Scientific Evidence:

- **Zinc deficiency is a major cause of telogen effluvium**, and supplementation showed significant **hair regrowth** (Kil et al., 2013).
- **Vitamin E supplementation improved scalp health and reduced oxidative stress-related hair loss** (Beoy et al., 2010).

Mechanisms of Action

Seed-derived phytotherapeutics promote hair growth through multiple mechanisms:

1. **Anti-inflammatory properties:** Reducing inflammation in the scalp to create a favorable environment for follicle health.
2. **DHT inhibition:** Pumpkin and flaxseeds contain compounds that inhibit dihydrotestosterone (DHT), a hormone implicated in androgenetic alopecia.
3. **Improved blood circulation:** Polyphenols enhance microcirculation in the scalp, ensuring optimal nutrient and oxygen supply.
4. **Antioxidant effects:** Scavenging free radicals to prevent oxidative stress-induced follicular damage.
5. **Moisturization and scalp nourishment:** Essential fatty acids maintain scalp hydration and barrier function.

Clinical Evidence and Traditional Use-

Seed Extract	Clinical Trial Findings	Reference
Pumpkin Seed Oil (PSO)	Increased hair count by 40% in 24 weeks for androgenetic alopecia patients	Cho et al., 2014
Flaxseed Lignan	Reduced DHT levels and improved hair regrowth	Esfandiari et al., 2020
Grape Seed Proanthocyanidins	Increased anagen phase duration and hair density	Kumar et al., 2021
Fenugreek Seed Extract	Improved hair thickness and reduced shedding in telogen effluvium patients	Sharquie et al., 2019

Numerous studies and ethnobotanical records underscore the effectiveness of seed-based treatments in promoting hair growth. Traditional healing systems such as Ayurveda and Traditional Chinese Medicine (TCM) have long incorporated seed extracts in hair loss remedies. Clinical research on fenugreek, pumpkin seed oil, and grape seed extract has demonstrated their potential to enhance hair density and strength.

Challenges and Future Directions

While findings are promising, additional research is needed to refine extraction techniques, determine optimal dosages, and ensure long-term safety. Further exploration into the bioavailability and synergistic interactions of seed-derived phytochemicals is crucial. Additionally, advancements in nanotechnology and formulation science could improve the potency and delivery of these natural compounds, increasing their therapeutic efficacy.

Conclusion-

Seed-based phototherapeutics represent a viable and natural approach to promoting hair growth and addressing alopecia. Their wide range of bioactive compounds supports scalp health, reduces hair loss, and encourages follicle regeneration through various mechanisms. Continued research and clinical studies will be essential for validating their effectiveness and incorporating them into mainstream dermatological treatments.

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