Herbal Remedies and Modern Theories for Alopecia Management

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***Abstract*—Alopecia, also referred to as baldness or hair loss, is a multifactorial dermatological condition that affects 0.2–2% of people worldwide. Alopecia areata, androgenetic alopecia, scarring alopecia, and traction alopecia are some of its manifestations, each having unique etiological and clinical features. Despite their clinical efficacy, conventional treatment drugs like finasteride and minoxidil are frequently hindered by side effects and low patient compliance. The use of herbal and plant-based formulations as safer, more sustainable, and multipurpose alternatives for treating alopecia has gained popularity in recent years.**

The physiology of hair growth, various forms of alopecia, and the therapeutic potential of a few medicinal plants—including Ginkgo biloba, Emblica officinalis, Aloe vera, Hibiscus rosa-sinensis, Cuscuta reflexa, and Glycyrrhiza glabra—are highlighted in this article. These herbs have a variety of pharmacological qualities, including as antioxidant, anti-inflammatory, antibacterial, and nutrient-enriching effects, all of which work together to support hair growth and follicular regeneration. Along with physicochemical and pharmacological evaluation parameters crucial for standardization and quality assurance, marketed herbal formulations incorporating combinations of these plants are also covered.

The herbal medicines present a promising supplement to contemporary therapy for alopecia, and that more scientific validation, phytochemical standardization, and clinical studies are necessary to determine their safety and effectiveness in managing long-term hair regrowth.

***Index Terms*—Alopecia, Alopecia areata, androgenetic alopecia, scarring alopecia, traction alopecia, herbal medicines.**

I. INTRODUCTION

One of the body's essential components, hair is made from the skin's ectoderm and serves as protection. appendages on the body and regarded as an integumentary accessory structure, in addition to sweat glands, nails, and sebaceous glands [1]

There are two kinds of hair: terminal hair and vellus hair. The fine, light-colored vellus hairs are Terminal and straight hairs are darker, thicker, and sometimes curly. Terminal hair in neonates are found on the scalp, as well as the area surrounding the eyebrows and eyelashes. They are also known as nonsexual hair, as it is not reliant on the level of androgen. As the degree of As plasma testosterone levels rise, ambisexual and sexual hair development takes place. [2]

II. EACH HAIR GROWS IN THREE CYCLIC PHASES

1. Anagen (growth phase): This stage can last anywhere from two to eight years. Typically, about 80% of hair is in the anagen phase.
2. Catagen (Involution): This stage, which lasts 10–14 days, is when hair transitions to the next phase and growth activity increases.
3. Telogen (Resting Phase): During the telogen phase, hairs transition into a resting state. The duration of this phase is 90–100 days. Generally speaking, 50–100 hairs are randomly shed each day. Although it may be transient, alopecia, or hair loss, is defined as an increase of more than 100 hairs per 6 [3,4].

In both cosmetic and clinical practice, alopecia, a dermatological condition known for over two millennia, is a common concern. It is estimated to impact between 0.2 and 2% of the world's population. Clinically, synthetic medications like minoxidil, a well-known vasodilator, are used to treat alopecia; however, their long-term use is limited by the unfavorable side effects they frequently cause.

Exploring compounds derived from plants as safer and more effective substitutes is therefore becoming more and more important. The purpose of this review is to gather and provide current scientific information on medicinal plants that show promise in preventing alopecia, as well as any potential mechanisms of action. Commonly known as baldness or hair loss, alopecia remains a serious therapeutic challenge that calls for long-term, safe treatment methods. [5,6,7]

III. TYPES OF ALOPECIA

1. One common autoimmune disease that causes hair loss on the scalp and other areas is alopecia areata (primary stage). One or more tiny, round, smooth, non-scarring patches are typically where it begins.
2. A patient who frequently experiences mild transient alopecia areata but never develops alopecia totalis or universalis is said to have mild transient alopecia areata.
3. Patients with transient alopecia areata are those who have the condition in its progressive stage; some of them go on to develop totalis or universalis.
4. Alopecia Ophiasis Areata: This kind of alopecia is characterized by band-like hair loss. Treatment is more difficult because the majority of medications have a delayed effect on the temporal or occipital regions of the scalp, which is where it mostly occurs.
5. Complete loss of hair on the scalp (alopecia totalis).
6. Eyelashes and eyebrows are among the body parts that lose hair due to alopecia universalis.
7. Scarring Alopecia: Any inflammatory process (burns, bacterial infections, ringworm, injury) that causes a permanent loss of follicles in the affected area is referred to as scarring alopecia.
8. Tricotilomania: The patient refers to this type of hair loss as compulsive pulling or self-repetitive pulling.
9. Traction Alopecia: This condition can result from tight hairstyles that cause excessive traction at the hair roots.
10. Chemotherapy and hair loss: Although it is the only treatment for cancer patients, chemotherapy also damages healthy cells and hair follicles. Anagen effluvium type alopecia is the term for this type of hair loss.
11. Excessive hair loss throughout the scalp without the formation of a patch is known as diffuse alopecia [8,9].

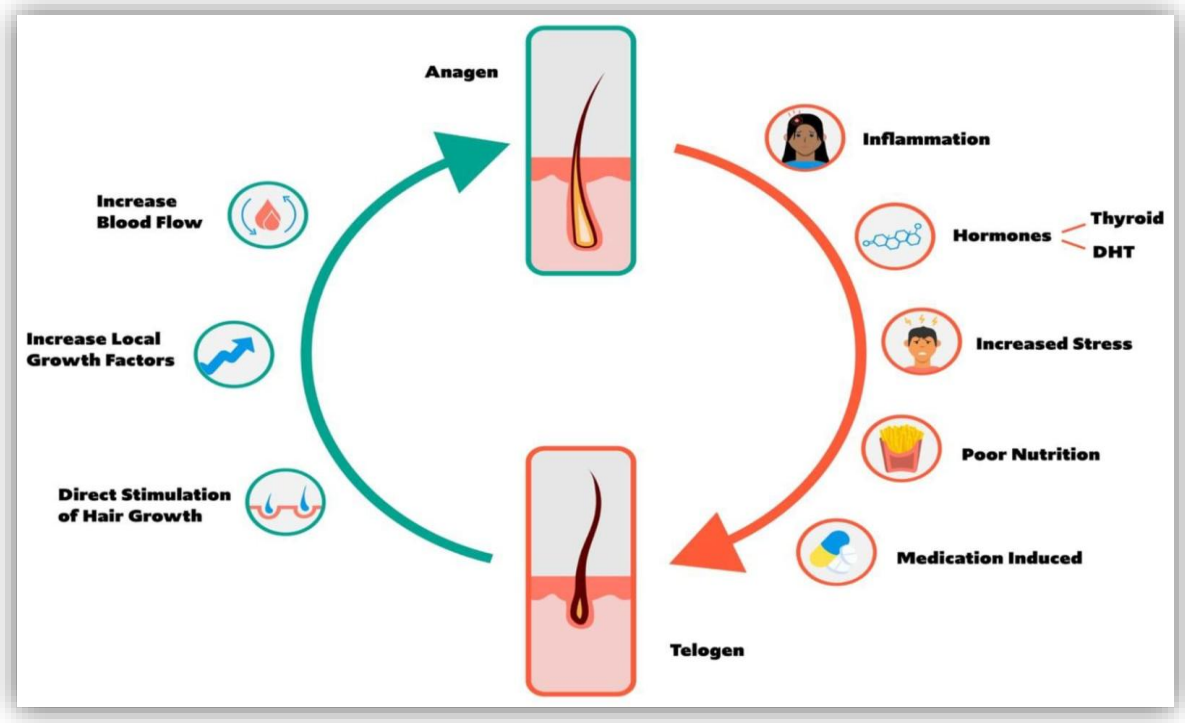

Fig. 1 : Growth cycle [10]

Female Pattern Hair Loss :

Androgenetic alopecia, sometimes referred to as female pattern alopecia or baldness, is the most prevalent form of hair loss in women. This is characterized by thinning hair, mostly on the sides and top of the head. Though it may start as early as puberty, it most frequently manifests after menopause and affects about one-third of all susceptible women.

Approximately 100 to 125 hairs fall out each day on average. Thankfully, these hairs grow back. When lost hair does not regrow or when the daily hair loss exceeds 125 hairs, it is considered true hair loss. Hair loss can be genetically inherited from either parent's side of the family. [11]

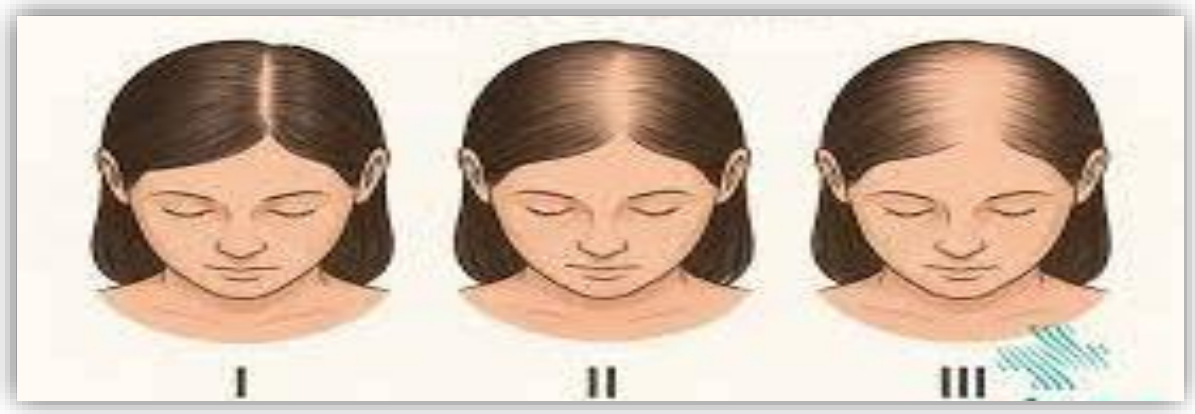

Fig. 2: Hair Loss In Female

Male pattern hair loss:

Alopecia is the term for thinning hair caused by hair loss. It is referred to as androgenetic alopecia when it is associated with genetics and hormones (androgens). Baldness occurs when an area of the scalp is depleted by androgenetic alopecia.

Hair loss on the top and front of the head, as well as a receding hairline, are characteristics of male pattern hair loss. [12]

Fig. 2 : Hair Loss In Male

IV. NATURAL PRODUCTS USE IN FORM OF HERBAL FORMULATION USED FOR ALOPECIA

Natural products with herbal formulations are used as growth promoters, hair conditioners, and hair tonics. treatments for lice and alopecia, as well as antidandruff and hair-cleaning products [13]. The ability of many herbal products to encourage hair growth has received praise [14].

1. Ginkgo biloba (Ginkgoaceae) :

- Used in part: Leaves
- Chemical components**:** 6% lactones Diterpenoids, Bilobalide-A, Ginkgolides A, B, and C, and Flavonols (24%). Lactones, anthocyanins, sitosterol, bioflavin, kaempferol, quercetin, and isorhamnetin [15].
- Application Method: The medication is dissolved in coconut oil and massaged for a minimum of two minutes.
- Reason**:** The medication is known to enhance cerebral microcirculation, which raises the availability of oxygen.

Fig. 3 : Ginkgo biloba Leaves

2. Emblica officinalis (Euphorbiaceae) :

- Part used: Fruits
- Components: calcium, iron, phosphorous, tannin, phyllemblin, and vitamin C
- Application Method**:** Indian gooseberry oil, which is made by boiling dried gooseberry pieces in coconut oil, is regarded as a useful hair tonic that promotes healthy hair growth. When used as a shampoo, a solution of equal parts fresh Indian gooseberry juice and lime juice promotes hair growth and inhibits hair loss.
- Reason: Red blood cells in your body need iron to be oxygenated. It is necessary for healthy hair maintenance and regular hair growth. Due to an oxygen shortage, hair loss will result from an iron deficiency if the amount of iron cannot be replenished by food intake.

Fig. 4 : Emblica officinalis Fruit

3. Aloe vera L. (Liliaceae)

- Part used: Leaves
- Chemical components : aloe-emodin, aloesone, hydroxyaloin (3%), barbaloin (15–40%), mucilage (glucose, galactose, mannose, and galacturonic acid), and alocutin A and B [16].
- Application method: Aloe vera gel, also known as A. barbadensis, has long been used to treat hair loss and promote hair growth in alopecia. Aloenin is the main ingredient that encourages hair growth without irritating the skin, according to Inaoka et al. [17].

Fig. 5 : Aloe vera Leaves

4. Hibiscus rosa-sinensis Linn (Malvaceae)

- Parts used: Leaves & Flowers
- Chemical components: flavonoids, anthocyanins, and quercetin-3,7-diglucoside, quercetin-3-diglucoside, cyaniding-3,5-diglucoside, and cyaniding-3-sophoroside-5-glucoside. [17]
- Application mode: Hibiscus rosa-sinensis leaf extract may help sustain hair growth in both in-vivo and in-vitro techniques, according to Adhirajan et al. [19].

Fig. 6 : Hibiscus rosa-sinensis Linn Leaves

5. Cuscuta reflexa Roxb (Convolvulaceae)

- Part used: Stems
- chemical components : kaempferol, bergenin, luteolin, -Sitosterol, Cuscutin, and Cuscutalin.
- Mode of application: Dixit et al. stem discovered that Cuscuta reflexa Roxb had hair growth activity through the recurrent transition of the hair follicle from the telogen to the anagen phase [20].

Fig. 7 : Cuscuta reflexa Roxb Stem

6. Glycyrrhiza glabra Linn. (Leguminosae):

- Part used**:** Roots
- Components: Glycyrrhizin, potassium, and calcium salts of glycyrrhizinic acid are the main components.
- Mode of Application**:** Another effective treatment for patchy baldness is liquorice paste, which is made by grinding the pieces in milk with a pinch of saffron. Before turning in for the night, coat the bald areas with this paste. [21]

Fig.: Glycyrrhiza glabra Linn Roots

V. HERBAL COMPONENTS OF MARKETED HERBAL FORMULATION

Table 1: Herbal components of marketed herbal formulation[22]

Sr. No.	Product Name	Manufacture	Formulation	Content
1	Chirayu herbal	Chirayu	Oil	Amla, Bhringgraj,brahmi
2	Hairbac	Bacfo	Tablets	Amla, nhriggraj. guduchi
3	Hairich	Capro	Capsule & Oil	H. roseus, E. alba, Osantun
4	Hairvit	Millennium	Oil	Brahmi, bhringgraj, brahmi
5	Hibril	Vital care	Oil	S. indicum, bhriggraj, bhrahmi
6	K-7 Taila	Ajmera	Oil	Amla jatamansi
7	Kesh Rakshe	JRK	Oil	Amla, bhringgraj
8	Kesh Vardan	Ratan	Capsule	Ashwagandha, shatawari
9	Keshmitra	Anjani	Tablets	Vacha, Jevanti
10	Keshmrit	Ajmira	Oil	Amla, bhriggraj

11	Medhavi	Ajmira	Oli	Amla, Bhriggraj, Brahmi
12	Nutrich	Ayulabs	Capsule	Bhriggraj, Godanti
13	Shyamla	Vasu	Shampoo	Amla, Heena
14	Saini Herbal Hair conditioner	Saini	Conditioner	Amla, Bhriggraj
15	Regrow	Avolado	Massage oil	Chamomile, Rosemary
17	Siddha Shampoo	Surya labs	Shampoo	Tulsi, Neem

VI. EVALUATION PARAMETERS

1) Physicochemical Evaluation :

a. Organoleptic properties: Evaluation of color, odor, consistency, and appearance of the formulation (oil, gel, lotion, etc.)

b. PH determination: ph should be close to the scalp natural range (4.5-6.5) avoid the irritation

c. Viscosity : Measured using a viscometer, ensure easy spreadability and proper absorbance

2) Pharmacological Evaluation :

a) Hair growth parameters :

i. Hair growth initiation Time : Number of days taken for first visible hair growth

ii. Hair growth completion Time : Time required for complete hair coverage in the shaved area.

iii. Hair density: Histological study of skin sections to count hair follicles per unit area

iv. Telogen Ratio : Ratio of active growing hair to resting hair higher ratio indicates better hair growth.

3) Standardization parameters :

a. Determination of Extractive Value and moisture content : To ensure the consistency in the extract yield and stability.

b. Qualification of active phytoconstituents : Use in the chromatographic methods including HPLC, TLC etc To confirm presence and quantity of active compounds.

c. Heavy metals and pesticides residue Test : identify the formulation safety as per WHO guidelines for herbal medicine.

VII. FUTURE SCOPE

1) Natural origin: Herbal formulations use plant derived in the ingredients such as Aloe vera, Bhriggraj, Amla and Hibiscus, that are the rich in the bioactive compounds like flavonoids, alkaloids, and tannins known to promote the hair growth.

2) Multifunctional action : Herbal components exhibit anti-inflammatory. Antioxidant, antimicrobial, and nutrient-enriching properties that collectively reduce hair fall and follicular activity

3) Synergestic effect : combine of multiple herbs are enhance the therapeutic efficacy through synergestic interactions of their phytochemicals

4) Research and development opportunities : Extensive scope for scientific validation, isolation of new hair growth- promoting phytoconstituents,

5) Pharmaceutical and cosmetic industry Application : Innovation in herbal hair oils, serum, gels, and shampoos for hair loss management

VIII. CONCLUSION

Globally, alopecia continues to be a serious dermatological and psychological issue that affects both men and women. Despite the widespread use of traditional treatments like finasteride and minoxidil, its drawbacks—such as side effects, recurrence following cessation, and inconsistent response rates—highlight the need for safer and more long-lasting substitutes. Because of their natural origin, biocompatibility, and diverse pharmacological activities, herbal medications present a viable supplementary and integrative approach to managing alopecia.

Through mechanisms involving antioxidant, anti-inflammatory, and nutrient-enhancing activities as well as stimulation of hair follicle cycling, medicinal plants like Ginkgo biloba, Emblica officinalis, Aloe vera, Hibiscus rosa-sinensis, Cuscuta reflexa, and Glycyrrhiza glabra have been shown to promote hair growth. Additionally, polyherbal preparations that include these botanicals show synergistic benefits that maximize medicinal efficacy while reducing side effects.

However, the majority of herbal treatments still lack solid clinical proof and standardization despite their traditional and preclinical confirmation. Therefore, in order to guarantee efficacy, safety, and quality control, future research should concentrate on isolating active phytoconstituents, clarifying their molecular mechanisms, and conducting clinical studies. Herbal treatments have enormous promise as safe, efficient, and environmentally friendly substitutes for the long-term treatment and prevention of alopecia as long as science and pharmaceutical innovation continue.

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