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BIOACTIVE SUBSTANCE OF MEDICINAL PLANTS EFFECTIVE AGAINST HAIR LOSS

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Abstract: Hair loss is a common problem worldwide that can impact people of all ages, both men and women. There are numerous conventional therapy choices available, but they may have various adverse effects, that is why interest of people is gradually increasing towards natural and herbal cures. The potential advantages of phytochemicals for hair growth, strength, and texture have led to an increase in their usage in hair care products. Since ancient times, people have employed natural products, which have been shown to be safe and to have minimal side effects. The use of plants and their extracts to encourage hair growth has been shown in a number of researches. Additionally, hair loss has been treated with commercial treatments made from these natural components. The review article discusses the advantages of using phytochemicals in hair care, such as their effectiveness to enhance scalp health, lessen dandruff, and encourage hair development. It will impart a concise overview of the effective phytochemicals in hair care and possible advantages for supporting healthy hair.

Keywords: Alopecia, Androgen, Hair loss, Medicinal plant, Natural cure, Rosemary, Sage weed.

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INTRODUCTION

For a long time, hair loss has been a concerning long-term problem. Genetically predisposed people with this chronic dermatological illness have increasing hair loss as a result of circulating androgens (Sasaki, 2018). It is possible that both maternal and paternal genes contribute to hair loss, which is a polygenic condition with varying penetrance (Verma, 2017). Sons of dads with androgenetic alopecia are five times more likely to have this ailment themselves, making those with a family history of it more susceptible. Regarding the pathophysiology of this condition, it is well known that dihydrotestosterone causes the hair follicle to shrink by binding to the androgenic receptors that are common in the scalp (Natarelli *et al.*, 2023). Alopecia, or hair loss, may indicate a systemic illness such as

infection, trichotillomania, systemic lupus erythematosus, or thyroid malfunction (Blume-Peytavi *et al.*, 2008). Despite not being a life-threatening disorder, alopecia can have an impact on a person's appearance, social interactions, and quality of life (Wells *et al.*, 1995). Additionally, androgenetic alopecia causes weight loss, acute stresses, and medication side effects (Danilenko *et al.*, 1996).

Conventional therapies for hair loss include finasteride and minoxidil. Despite being readily accessible, such therapies have been associated with a number of negative consequences, including increased risk for prostate cancer, sexual dysfunction, and irritation of the scalp, resulting in the increased demand for herbal and alternative therapies (Irwig, 2012). For centuries, individuals have relied on herbal therapies to stop hair loss and encourage hair growth (Nualsri *et al.*, 2016). These treatments are often perceived by consumers to have fewer side effects than conventional drugs, however, robust scientific evidence confirming their safety and efficacy is frequently lacking (Semalty *et al.*, 2011). The use of herbs and essential oils in cosmetics should not be intended to penetrate the outer layers of the skin or have any therapeutic benefits (Gyawali and Paudel, 2022).

Several researches have examined the possibility of herbal remedies for the treatment of hair loss disorder. Products that are now promoted as having natural components include hair tonics, conditioners, hair growth stimulants, and hair cleansers, which are intended to stop hair loss (Jain *et al.*, 2016). The non-toxic effects of plant-based formulations have been recognized since ancient times, and they have the benefit of being simple to create from inexpensive ingredients (Park and Lee, 2021). This review paper will present a concise overview of the application of phytochemicals in hair care and possible advantages for supporting healthy hair.

METHODOLOGY

Scopus, Google scholar, PUBMED, Web of Science research website were used to do a thorough literature search in order to find relevant articles published till December 2024. The following keywords were part of the search strategy: alopecia, hair loss, herbal therapies, hair growth, natural products, amloki, onion juice, rosemary, etc. Selected literatures and books were screened for analyzing, discussion and summarization (Fig. 1). Firstly, abstract are screened by one review then whole texts screened by double review to search all the findings and subjective information, which was gathered in concise way.

DIFFERENT TYPES OF HAIR LOSS

1. **Alopecia areata:** The common autoimmune disease alopecia areata results in hair loss on the scalp and other parts of the body. It usually starts in one or more small, round, smooth, non-scarring patches. Mild short alopecia areata or universalis is the term used to describe a patient who commonly has transient alopecia areata but never develops alopecia totalis (Pratt *et al.,* 2017; Pandey and Maury, 2022; Sebaratnam, 2024).
2. **Alopecia totalis:** Hair loss occurs throughout the entire scalp (Pundkar *et al.*, 2020).
3. **Androgenic alopecia:** Androgenetic alopecia, another name for genetic hair loss, is a common and hereditary disorder in which the hair follicles become reactive to androgens, resulting in gradual hair loss (Kelly *et al.,* 2016; Bin Rubaian *et al.*, 2024).
4. **Traction alopecia:** Adhesion alopecia and excessive traction at the hair roots can result from hairstyles that tie hairs excessively tightly (Samrao and Mirmirani, 2022).

CAUSES OF HAIR LOSS

Important causes of hair loss are as under (Pandey and Maury, 2022; Sebaratnam, 2024):

a) Autoimmune diseases.
b) Hair coloring chemicals.
c) Drugs and agents used in chemotherapy.
d) Genetical.
e) Postpartum hair loss.
f) Low quality hair styling products and gels.
g) Hairstyle methods.
h) Severe and symptomatic iron deficiency anemia.

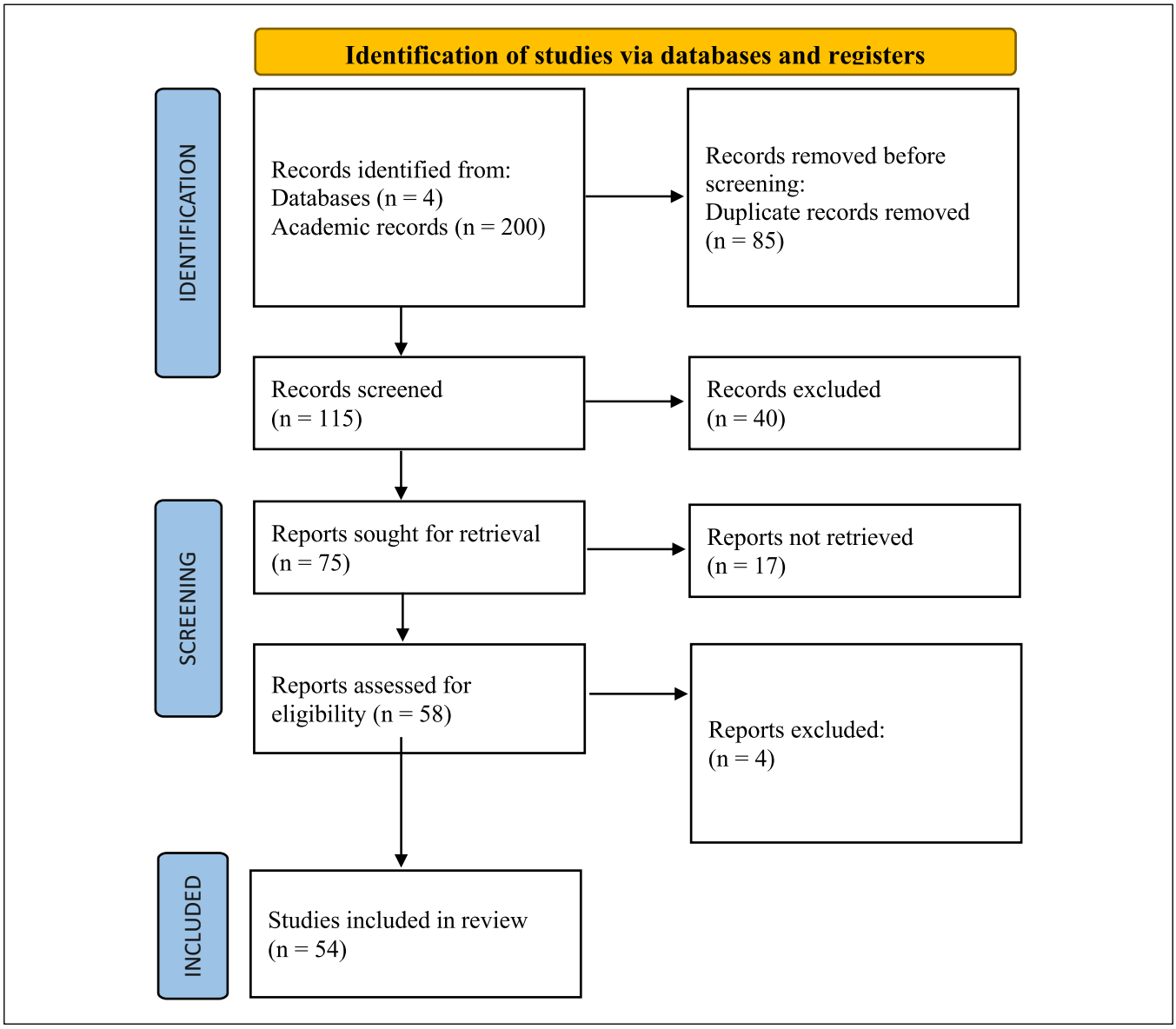

Fig. 1: PRISMA Flow Diagram to depict the study selection process. (Source: Page *et al.*, 2021)

i) Severe nutritional deficiencies, including protein-energy malnutrition, zinc deficiency, and biotin deficiency.
j) Chronic fungal diseases.
k) Damage to the scalp.
l) Exposure to specific heavy metals (e.g., thallium, mercury) or toxins (e.g., dioxins).
m) Inadequate blood flow to scalp.

HERBAL REMEDIES

By increasing blood circulation and vascularity as well as hair follicle regeneration, rosemary is proved effective in treating androgenic alopecia in a manner comparable to that of minoxidil (Panahi *et al.*, 2015; Hosking *et al.*, 2019). 100 male patients with androgenetic alopecia, aged 18 to 49, were randomly assigned to receive topical rosemary oil (N =50) or minoxidil 2% (N =50) for six months in a single-blind, randomised clinical study. At six months, the number of hairs in both groups increased significantly ($P < 0.05$). Regarding hair count, there was no discernible difference between the research groups ($P < 0.05$ and $P > 0.05$).

In contrast to the other group that received rosemary oil treatment, the minoxidil group had higher scalp irritation ($P < 0.05$) (Panahi *et al.*, 2015). Through the inhibition of testosterone 5-alpha- reductase, which is known to have an impact on controlling androgenic alopecia, a study was carried out using mice models to

examine the antiandrogenic activity of rosemary *Rosmarinus officinalis* leaf extract in comparison to finasteride and minoxidil. In contrast to finasteride at 250 nM, which showed 81.9% inhibition ($P < 0.01$), the study found that *Rosmarinus officinalis* had strong inhibitory effect on 5-alpha-reductase, with 82.4% and 94.6% at 200 and 500 mg/mL, respectively. Next, it prevents dihydrotestosterone from attaching itself to androgen receptors. Furthermore, it was found that the most potent inhibitory component is 12-methoxycarnosic acid (Panahi *et al*., 2015).

Animal research using a randomised controlled trial was conducted on mice to examine the possible effectiveness of peppermint essential oil in promoting hair growth (Oh *et al*., 2014). Histological analysis, hair growth, the enzymatic activity of alkaline phosphatase (ALP), which is present at higher levels during the anagen phase because it promotes insulin-like growth factor (IGF-1), a powerful biomarker known to promote hair growth and thickness, was used to evaluate the results. In the fourth week of the study, the peppermint oil group showed the most notable outcomes, including significant elongation of hair follicles into the subcutis, increased dermal thickness, increased hair follicle number in histologic analysis, and increased activity of (ALP) 192% compared to 90% in the minoxidil group (Oh *et al*., 2014).

Serenoa repens is another name for saw palmetto. It is taken from the berries of palm trees in the West Indies and along the North American Atlantic coast that are members of the Arecaceae family (Ufomadu, 2023). In addition to other components like sterols, the extracted oil from saw palmetto berries has an exceptionally high percentage of fatty acids (85-90%) (Ashique *et al*., 2020). There is little information on this herbal preparation's effectiveness in treating alopecia. However it has been shown to be successful in treating benign prostatic hyperplasia. Saw palmetto works by inhibiting 5 alpha-reductase, which lowers blood levels of dihydrotestosterone and promotes hair growth and prostate health (Ufomadu, 2023).
The purpose of such uncontrolled pilot trial was to look at the possible therapeutic benefits of products that include extract from *Serenoa repens* (in lotion and serum form) for the treatment of male androgenic alopecia. After using topical *Serenoa repens* products for 24 weeks, 50 males between the ages of 20 and 50 were examined. A hair count in a 2.54 cm^2 region for 24 weeks served as the main basis for the data' analysis. The hair restoration, photographic evaluation, the patients' appraisal, and the identification of adverse events evaluated from this study. In comparison to the baseline, the average and terminal hair counts rose at weeks 12 and 24 (Wessagowit *et al*., 2016).

Olive oil extracted from the fruit of the olive tree (*Olea europaea*), has been used for many years in medicine, cosmetics, and cookery. Olive oil is a lipid-rich extract, has garnered attention due to its potential benefits in promoting healthy hair and managing various hair-related conditions (Chaudhary *et al*., 2010). The olive oil has nourishing and moisturizing properties when added to hair care products, along with its potential impacts on hair development (Khare, 2008). Olive oil's antimicrobial and anti-inflammatory qualities can help relieve a sore scalp and lessen dandruff. Applying olive oil to the scalp improves blood flow, supporting hair development and a healthy scalp (Vishali *et al*., 2024). Olive oil works well to stop hair loss because it nourishes hair and lessens oxidative stress on the scalp. Because of its emollient qualities, the hair follicles are strengthened, ultimately promoting healthier and thicker hair.

One of the most notable characteristics of coconut oil, which is derived from the fruit of the coconut tree (*Cocos nucifera*), is its strong affinity for hair protein, which has led to its popularity as a natural hair care product. Nearly half of the fatty acid content of coconut oil is made up of lauric acid, which is the primary fatty acid component (Alvarez-Suarez *et al*., 2010). Rele and Mohile (2003) examined at how mineral, coconut, and sunflower oils may prevent hair damage. The lauric acid enters the hair shaft and prevents damage to the hair while also lowering protein loss.

Additionally, it is well-known for having antibacterial and antifungal qualities that maintain the health of the scalp (Keis *et al*., 2005). The researchers measured the quantity of protein lost while using coconut oils as grooming treatments before and after washing both damaged and healthy hair. The findings showed that coconut oil was the only oil that significantly reduces protein loss in both damaged and healthy hair (Rele and Mohile, 2003). They speculate that these benefits might be due in part to coconut oil's lubricating properties on the hair's surface. Furthermore, coconut oil has long been used as a home remedy for dandruff and other scalp irritations.

For generations, people have used amla, also known as *Phyllanthus emblica* L., as a traditional herbal treatment to cure and prevent a variety of conditions, including hair loss. The fruit of amla plant is a common component of many herbal preparations due to its well-known nutritional as well as therapeutic qualities (Khan, 2009). Numerous phytochemical substances, including tannins, mosaic acids, amino acids, alkaloids, flavonoid glycosides, phenolic glycosides, and terpenoids, are abundant in *P. emblica* (Dasaroju and Gottumukkala, 2014). It is thought that these bioactive substances promote therapeutic advantages, which may include improved hair health (Variya *et al*., 2016). The antioxidants in amla may theoretically help to stop premature greying and hair loss by shielding hair follicles from harm brought on by free radicals.

Ginger's scientific name, *Zingiber officinale*, belongs to the Zingiberaceae family. It is taken from the roots of *Zingiber officinale*. The Shogaols are well known for its nutraceutical qualities, and they contain zingiberene. One of ginger's active ingredients and antioxidants, gingerol, promotes blood flow to hair follicles by relaxing blood vessels. It also prevents hair thinning, may potentially encourages hair growth, and leaves hair feeling silky and glossy. Additionally, it helps with dandruff and irritated, itchy scalps. Ginger's inherent antibacterial and anti-inflammatory properties support clean, healthy skin (Penkar *et al*., 2023).

One hair care product used to moisture hair is hair conditioner that contains varieties of herbal extract, which is used after shampooing. Conditioning enables hair to be protected and revitalized. Conditioner is a type of therapy used to promote hair health. All hair types may be benefited from the product. Hair color changes and protein loss can be prevented by using a hair conditioner that contains strong antioxidants from plant sources.

It has been demonstrated that a variety of plants and their active ingredients stimulate hair growth (Fig. 2) both *in vivo* and *in vitro*. An overview of the biologically active plant components that prevent hair loss and encourage hair growth is given in table 1.

Table 1: Plant-based bioactive substances with therapeutic benefit to stimulate hair growth.

Biochemical compound	Plant source	Type of extract examined	Reference
12-methoxycarnosic acid	Rosemary	Ethanolic extract	(Murata *et al*., 2013)
Oleuropein	Olive tree	-	(Tong *et al*., 2015)
Sinapic acid	Lemon	-	(Woo *et al*., 2017)
Linoleic acid, sitosterol, bicycle (10.1.0) tridec-1-ene	Ginseng	Supercritical fluid	(Truong *et al*., 2017)
Hydroxysafflor yellow A	Safflower	Ethanolic extract	(Junlatat and Sripanidkulchai, 2014)
Shikimic acid	Anise tree	-	(Choi *et al*., 2019)
Anthraquinone, flavonoids, tannin, saponins	Lotus plant	Ethanolic extract	(Park *et al*., 2021)

Procyanidin B-3	Barley	Acetone extract	(Lim *et al*., 2005)
Liposomal honokiol	Magnolia-bark	-	(Lee *et al*., 2020)
Kaempferol, isoquercetin	Oriental arborvitae	Hot water extract	(Zhang *et al*., 2013)
Octaphlorethol A	Black rockweed	Ethanolic extract	(Kang *et al*., 2013)
Morroniside	Japanese cornel dogwood	-	(Zhou *et al*., 2018)
Avicequinone C	Sadabaen	Methanolic extract	(Jain *et al*., 2014)
Dieckol	Paddle weed	Enzymatic hydrolysis reaction	(Shin *et al*., 2013)
Corilagin, gallic acid	Siberian cranesbill	Methanolic extract	(Boisvert *et al*., 2017)
Mosaic acids, amino acids	Amloki tree	-	(Dasaroju and Gottumukkala, 2014)
Quercetin, sulfur	Onion	Ethanolic extract	(Dorrigiv *et al*., 2021)
Lauric acid	Coconut tree	-	(Rele and Mohile, 2003)
Alpha-tocopherol, vitamin E -sitosterol, linoleic acid, oleic acid	Peach	Seeds extract	(Zhou *et al*., 2020)
Myristoleic acid	Chinese mallow	Ethanolic extract	(Lee *et al*., 2016b)
Flavonoids, monoterpenoids sesquiterpenoids, diterpenoids	Sage weed	Methanolic extract	(Jin *et al*., 2020)
Vitamin E & C	Aloe vera	Leaves extract	(https://www.healthline.com/health/aloe-vera-for-hair)
Decursin	Purple parsnip	Ethanolic extract	(Lee *et al*., 2020)
Apo-9´-fucoxanthinone	Wakame seaweed	Ethanolic extract	(Kang *et al*., 2017)
L-maackiain	Lightyellowsophora	Methanolic extract	(Roh *et al*., 2002)
Alpha-mangostin	Mangosteen	-	(Sang *et al*., 2023)
Saponins	Acacia	Ethanolic extract	(Sang *et al*., 2023)
Quercetin, hydroxy-tyrosol, tyrosol	Neem	Ethanolic extract	(Niharika *et al*., 2010)
Saponins	Reetha or soapnut	Alcoholic extract	(Reetika *et al*., 2016)
Bacoside, flavonoids	Brahmi or thankuni	Leaves extract	(Kumar *et al*., 2016)
Vitamin E & C, oleic acid	Avocado	Oil extract	(Nam *et al*., 2019)
Hennotannic acid or 2-hydroxy1,4 naphthoquinone	Henna	-	(Zheng *et al*., 2019)
Oleic acid	Tea tree	Seeds extract	(Chaikul *et al*., 2017)
Nicotinic acid	Fenugreek	Seeds extract	(Faisal *et al*., 2024)
Murrastifolin-F, murrayanol, murrayagetin	Curry leaves	Root extract	(Dangare *et al*., 2023)
Linalool, linalyl acetate	Lavender	Lavender oil mixed with jojoba oil	(Lee *et al*., 2016a)

Fig. 2: Few locally used medicinal plants to prevent hair loss and promote hair health.

ADVANTAGES OF HERBAL BASED HAIR OIL

There is a lot of herbal hair oil used in different country and they possess many positive effects on scalp and hair growth (Deshpande and Deshpande, 2023), including:

a) encourage the development and thickness of hair
b) make our hair thicker and longer
c) they help to keep hair healthy and shiny
d) preserving natural color of hair
e) prevents dandruff
f) reduction of stress
g) nourishes scalp
h) repairs broken hair
i) strengthening of hair follicles
j) enhances the gloss and structure of hair
k) therapeutic benefits of aroma

CONCLUSION

The potential advantages of phytochemicals in enhancing hair strength, texture, and growth are becoming more widely acknowledged. A number of natural elements included in hair care products, such as plant extracts, essential oils, and herbs, are highlighted in this review article. Natural ingredients are becoming more and more well-liked as a viable substitute for chemical remedies. Certain substances, most notably rosemary oil, have been uniquely demonstrated to be a successful natural substitute. Using phytochemicals in hair care is a safe and has minimal side effects, all-natural way to support healthy hair. Future studies should concentrate on examining the mechanisms of action of phytochemicals and their potential for treating and preventing hair loss.

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