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Emerging Potential of Nutraceuticals in Hair Health

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ABSTRACT :

Hair health is influenced by various intrinsic and extrinsic factors which includes genetics, environmental exposure, nutrition, stress, age, chemical treatment on hairs for its beautification, lifestyle choices (smoking and drinking). In recent years the role of nutraceuticals bioactive compounds, micronutrients and synthetic supplements has taken a significant attention in the context of hair care. Mainly nutraceuticals have shown their action in supporting hair growth, strengthening hair follicles and reduces hair loss for example- biotin, zinc, vitamin C, Ω 3 fatty acids, vitamin D, curcumin, resveratrol etc. The antioxidant and anti-inflammatory properties of many nutraceuticals help to mitigate oxidative stress a critical factor in hair ageing and loss. While nutraceuticals offer a promising non-invasive approach to enhancing hair health and their efficacy often depends upon the formulations and individual's health status. This review explores the impact of nutraceuticals on hair health focusing on their mechanism of actions, clinical evidences and potential benefits. In coming years nutraceuticals may make a way for potent solutions for hair issue because of its safe and more effective, without side effect characteristics.

Keywords: Nutraceuticals, Haircare, Antioxidants, Micronutrients, Oxidative Stress.

Introduction :

Nutraceutical represents a rapidly growing category within beauty products and are among the fastest expanding segments in the nutritional supplements(Anunciato, T. P., & da Rocha Filho, P. A. 2012). This class of natural therapeutics derived from food and botanical contains phytochemical active compounds that support health and also helps in the treatment of various hair related disease and disorders. Nutraceuticals are gaining popularity due to rising beliefs inside out approach to health and beauty, and the thinking that these products are both safe and natural. Supplements and nutritional alternatives for hair health are some of the most sought after nutricosmetics. Since healthy hairs needs more than just balanced hair diet, many people dealing with hair issues turn to nutraceuticals for extra support(Guo, E. L., & Katta, R. 2017). Although hair does play a vital role in biological protection for humans, the impact of hair loss is significant, affecting individuals socially, psychologically, and emotionally. As a result, addressing hair loss and enhancing hair health has become essential.

The hair follicle can be categorized into three segments: lower, middle (isthmus), and upper (infundibulum). The lower segment contains the bulb and suprabulb regions, while the middle segment extends from the insertion point of the arrector pili muscle to the opening of the sebaceous gland duct. The upper segment spans from the sebaceous gland duct opening to the follicular orifice(Park, A. M., Khan, S., & Rawnsley, J. 2018). A significant number of people dealing with hair loss turn to nutraceuticals for potential solutions. This emerging field is characterized by the extraction and standardization of particular phytochemicals, which have shown therapeutic properties in clinical research. It is important to note, however, that while nutritional supplements are overseen by the FDA and FTC, they are not subject to the same strict regulatory requirements as pharmaceutical medications(Brown, A. C. 2016). Nutraceuticals with inconsistent dosing, lack of potent and pure ingredients, or containing phytoactive compounds that are not bioavailable may prove ineffective. Therefore, it is crucial for dermatologists to be well-informed and capable of advising their patients on selecting the right nutraceuticals (Gan, D. C., & Sinclair, R. D. 2005).

Mainly nutraceuticals are categorized into three:

1. Bioactive Compounds

These are naturally occurring compounds that have beneficial effects on health, particularly in promoting hair growth and health.

- **Polyphenols**: Found in green tea and berries, these compounds have antioxidant properties that can protect hair follicles from oxidative stress, potentially promoting healthier hair(Sun, M., Deng, Y., Cao, X., Xiao, L., Ding, Q., Luo, F., Huang, P., Gao, Y., Liu, M., & Zhao, H. 2022).
- **Flavonoids**: Present in various fruits and vegetables, flavonoids can improve circulation to the scalp and promote hair growth(Bassino, E., Gasparri, F., & Munaron, L. 2020).
- **Saponins**: Found in plants like fenugreek, these compounds may help stimulate hair growth and improve scalp health(Kora, A. J. 2023).
- **Sterols**: Such as beta-sitosterol, can help block the conversion of testosterone to DHT, a hormone linked to hair loss(Panicker, S. P., Ganguly, T., Consolo, M., Price, V., Mirmirani, P., Honda, K., & Karnik, P. 2012).

2. Micronutrients

These are essential vitamins and minerals that support various bodily functions, including hair health.

Vitamins:

- **Biotin (Vitamin B7)**: Crucial for keratin production, biotin supplementation can improve hair strength and reduce thinning(Patel, D. P., Swink, S. M., & Castelo-Soccio, L. 2017).
- **Vitamin D**: Plays a role in the hair growth cycle; deficiency is linked to hair loss(Almohanna, H. M., Ahmed, A. A., Tsatalis, J. P., & Tosti, A. 2019).
- **Vitamin E**: An antioxidant that helps improve blood circulation in the scalp and promotes healthy hair(Trueb, R. M. (2009).

Minerals:

- **Zinc**: Essential for hair tissue growth and repair; it helps maintain the oil glands around hair follicles(Lademann, J., Richter, H., Teichmann, A., Schanzer, S., Knorr, F., Meinke, M. C., & Darvin, M. E. 2011).
- **Iron**: Vital for oxygen transport to hair follicles; deficiency can lead to hair loss(Carvajal, J. J. 2019).

3. Synthetic Supplements :

These are manufactured compounds that aim to mimic or enhance natural nutrients and may support hair health.

- **Keratin Supplements**: Synthetic keratin can strengthen hair and improve its appearance by replenishing lost protein(Messenger, A. G., & Sinclair, R. D. 2006).
- **Biotin Supplements**: Often available in higher doses than found in food sources, these are popular for promoting hair growth (Ho, C. H., Sood, T., & Zito, P. M. 2023).
- **Amino Acid Formulations**: Products that contain synthetic versions of amino acids like L-cysteine and L-methionine can support keratin production and overall hair health(Suchonwanit, P., Thammarucha, S., & Leerunyakul, K. 2019).
- **Hormonal Supplements**: Some supplements aim to balance hormones that may impact hair loss, particularly in cases of androgenetic alopecia(Pierard-Franchimont, C., De Doncker, P., Cauwenbergh, G., & Pierard, G. E. 1998).
- **Mechanism of action of key nutraceuticals**

3.1 Biotin (Vitamin B7)

- **Mechanism**: Biotin plays a critical role in the synthesis of keratin, the main structural protein in hair. It helps convert nutrients into energy and supports the metabolic processes necessary for hair growth. Biotin also improves the overall strength and elasticity of hair, reducing breakage(Adil, A., & Godwin, M. 2017).

3.2 Zinc

- **Mechanism**: Zinc is essential for protein synthesis and cellular division, both of which are critical for hair follicle health. It also aids in regulating hormone levels and can help block the conversion of testosterone to dihydrotestosterone (DHT), a hormone linked to hair loss. Zinc's anti-inflammatory properties help maintain a healthy scalp environment(Zhang, X., Caulloo, S., Zhao, Y., Zhang, B., Liu, Y., & Zheng, Y. 2018).

3.3 Iron

- **Mechanism**: Iron is very important for the formation of haemoglobin, which transports the oxygen to hair follicles. A sufficient oxygen supply is necessary for promoting healthy hair growth. When iron levels are deficient, it can disrupt the metabolism of hair follicle, potentially leading to hair thinning or loss(McElwee, K. J., & Shapiro, J. S. 2012).

3.4 Omega-3 Fatty Acids

- **Mechanism**: Omega-3 fatty acids possess anti-inflammatory properties that promote a healthy scalp. They help nourish hair follicles and improve the health of the cell membranes, which can lead to increased hair density and growth(Rinaldi, F., Sorbellini, E., & Bezzola, P. 2013).

3.5 Vitamin D

- **Mechanism**: Vitamin D is involved in the creation of new hair follicles and regulates the hair growth cycle. It promotes the expression of genes associated with hair follicle cycling and stimulates the proliferation of keratinocytes, which are crucial for hair growth(Cho, H. R., Roh, M. R., & Choi, W. I. 2019).

3.6 Saw Palmetto

- **Mechanism**: Saw palmetto extracts inhibit the enzyme 5-alpha reductase, which converts testosterone into DHT. By reducing DHT levels, saw palmetto can help prevent hair follicle miniaturization and loss associated with androgenetic alopecia(Randolph, M., & Tosti, A. 2021).

3.7 Keratin

- **Mechanism**: Keratin supplements provide the hair with the structural proteins needed to strengthen hair strands. When ingested, keratin can support the formation of new keratin proteins in the hair shaft, improving strength and resilience(Olsen, E. A. 2001).

3.8 Amino Acids (L-Cysteine and L-Methionine)

- **Mechanism**: These sulfur-containing amino acids are precursors to keratin. They help form disulfide bonds that strengthen the hair structure. Supplementation can enhance hair thickness and reduce breakage by improving the overall integrity of the hair(Blume-Peytavi, U., Hillmann, K., Guarrera, M., Sattler, E., & Dietz, E. 2017).

4. Disorders that can be treated by nutraceuticals :

4.1 Alopecia areata

Alopecia areata is an autoimmune condition characterized by sudden hair loss at round, smooth patches(Hunt, N., & McHale, S. 2005). The hair follicles are attacked by the immune system, and the hair falls off(Higgins, C. A., & Christiano, A. M. 2014). This type may affect any individual irrespective of age or gender and can also be manifest as a complete loss of hair on the scalp (alopecia totalis) or entire body (alopecia universalis)(Paus, R., & Cotsarelis, G. 1999). The cause of this condition is not known, but inherited factors as well as environmental influences, such as stress, may be significant factors. The unpredictable nature of the condition makes patients experience great psychological stress(Stough, D., Stenn, K., Haber, R., Parsley, W. M., Vogel, J. E., Whiting, D. A., & Washenik, K. 2004).

Some of the nutraceuticals could help in treatment because, for example, biotin is a B vitamin known to support hair health and growth, therefore potentially helping restore hair in affected areas(Gupta, A. K., Mays, R. R., Versteeg, S. G., Shear, N. H., Piguet, V., & Piraccini, B. M. 2018). Zinc is important for maintaining the function of the immune system and should assist in healing hair follicles(Adil, A., & Godwin, M. 2017).

Treatment- Biotin

A few nutraceuticals may offer additional benefit in alopecia areata. Biotin is one of the B vitamins that play a key role in the growth of hair and enhancing the strength of strands(Kanti, V., Messenger, A., Dobos, G., Reygagne, P., Finner, A., Blumeyer, A., ... & Blume-Peytavi, U. 2018). Biostimulation of hair follicles through supplementation leads to enhanced health and thereby aids in the growth process. Zinc has a role in an improvement of immune function, among other functions, that helps in cellular repair(Rossi, A., Anzalone, A., Fortuna, M. C., Caro, G., Garelli, V., Pranteda, G., & Carlesimo, M. 2016). Its anti-inflammatory action may suppress the immune response that leads to hair follicle attack in alopecia areata(Fabbrocini, G., Cantelli, M., Masarà, A., Annunziata, M. C., Marasca, C., & Cacciapuoti, S. 2018). Inclusion of these nutraceuticals in a balanced regimen could be helpful to people suffering from this condition, and proper advice and comprehensive treatment plan from a healthcare provider are very important(Rinaldi, F., Pinto, D., & Sorbellini, E. 2017).

Telogen Effluvium

Telogen effluvium is a transient form of alopecia characterized by an excessive number of hair follicles entering the telogen or resting phase prematurely(Sinclair, R. 2015). It can be triggered by stress, hormonal imbalances like postpartum or menopause, diseases, or extreme deficiencies in nutritional intake(Van Neste, D. 2006). Individuals may thus experience a sudden rise in hair shedding months after the triggering event. Even though this type of hair loss is generally self-limiting, this can often be distressing and affect one's self-esteem(Rassman, W. R., & Bernstein, R. M. 2008).

For the treatment of telogen effluvium, supplementation with iron may prove useful in cases where there is a deficiency as iron is necessary for the oxygen transport and metabolism of energy, thus its deficiency can serve to cause hair loss(Avram, M. R., & Rogers, N. E. 2009). Vitamin D also functions in the cycling of hair follicles thus nutrient supplementation for healthier formation(Olsen, E. A., Dunlap, F. E., Funicella, T., Koperski, J. A., Swinehart, J. M., & Tschen, E. H. 2002).

Treatment – Vitamin D, Iron

For telogen effluvium, iron replacement is the most beneficial, especially if there exists a deficiency. It is an essential nutrient for the transport of oxygen and energy metabolism; its deficiency may increase shedding of hair(Rajput, R. J. 2010). Vitamin D also supports the hair growth cycle. It ensures support of the follicle and induces regrowth of the hair by adequate amounts in the body(Suchonwanit, P., Thammarucha, S., & Leerunyakul, K. 2019). Incorporation of these nutraceuticals can help manage telogen effluvium, but it would be much more preferable to consult a health care professional, obtain a plan of treatment that is individualized under the guidance of an expert, while searching for the cause(Blume-Peytavi, U., & Vogt, A. 2011).

Androgenetic Alopecia

It is also commonly known as male or female pattern baldness, which also belongs to the group of genetic disorders - androgenetic alopecia(Piraccini, B. M., & Alessandrini, A. 2014). It is defined by hair loss along with thinning of different regions of the scalp, which advances progressively(Jimenez, F., & Poblet, E. 2006). The basis of its pathogenesis involves both genetic predisposition and some form of hormonal influence, most often in the form of dihydrotestosterone - the active derivative of testosterone(Lolli, F., Pallotti, F., Rossi, A., Fortuna, M. C., Caro, G., Lenzi, A., & Lombardo, F. 2017). In men, it usually means a receding hairline and thinning at the crown. The women usually have a widespread thinning, but their hairlines are preserved(Whiting, D. A. 2001).

Treatment – Saw palmetto, Biotin, Ω-3 fatty acid

Nutraceuticals can help in the management of androgenetic alopecia. Saw palmetto may inhibit DHT, which slows down hair loss(Finsterer, J., & Kovacs, A. 2019). Biotin allows for more keratin production. Keratin is crucial in maintaining hair. Omega-3 fatty acids reduced the rate of inflammation on the scalp, making it healthier(Gupta, A. K., & Mays, R. R. 2019). Zinc also rejuvenates the hair tissue with the balance and functioning of the oil glands with respect to hair follicles. Vitamin D is involved in cycling of hair follicles, and therefore, deficiency in it must likely lead to hair loss(Fiedler-Weiss, V. C. 1987). N-acetylcysteine NAC is an antioxidant that diminished oxidative stress can affect the health of your hair; pumpkin seed oil contains compounds that might inhibit DHT(Schweiger, E. S., Boychenko, O., & Bernstein, R. M. 2010).

While nutraceuticals can complement hair health, it becomes most effective when accompanied by other treatments and lifestyle changes(Cash, T. F. 1992). And hence, consulting a healthcare provider will undoubtedly help decide on the best course of treatment for individuals who experience androgenetic alopecia(Price, V. H. 1999).

Psoriasis of the Scalp

Psoriasis of the scalp is a chronic autoimmune condition characterized by the rapid growth of skin cells, leading to thick, red patches covered with silvery-white scales(Stough, D., Stenn, K., Haber, R., Parsley, W. M., Vogel, J. E., Whiting, D. A., & Washenik, K. 2005). This condition can cause discomfort, itching, and inflammation, and it often extends beyond the scalp to other areas of the body(Tosti, A., & Duque-Estrada, B. 2009). The exact cause of psoriasis is not fully understood, but it is thought to involve a combination of genetic, immune, and environmental factors(Yazdabadi, A., Magee, J., & Sinclair, R. 2008).

Treatment- Vitamin D, Omega-3 fatty acid

Nutraceuticals can play a supportive role in managing scalp psoriasis. Omega-3 fatty acids are particularly beneficial due to their anti-inflammatory properties, which can help reduce the inflammation associated with psoriasis(Trueb, R. M. 2005). Vitamin D is also important, as it plays a role in skin cell regulation; supplements or topical treatments can help slow the growth of skin cells and promote healing(Messenger, A. G., & Sinclair, R. D. 2006). Additionally, antioxidants like vitamin E may help protect skin cells from oxidative stress, which can exacerbate psoriasis symptoms(Riedel-Baima, B., & Riedel, K. 2000).

Zinc is another valuable nutraceutical, known for its immune-supporting and skin-repairing properties, which can be beneficial in managing flare-ups. Some studies suggest that probiotics may help modulate the immune response and improve skin health, potentially reducing the severity of psoriasis(Ludwig, E. 1977).

While nutraceuticals can complement traditional treatments, it's important to consult a healthcare provider for a comprehensive approach tailored to individual needs in managing scalp psoriasis effectively(Hamilton, J. B. 1951).

Discussion :

The growing need for non-invasive, holistic hair care methods has drawn a lot of attention to the use of nutraceuticals in enhancing hair health. Bioactive substances obtained from food sources that offer health advantages beyond simple nourishment are known as nutraceuticals. Scientific study and commercial development are increasingly focusing on their function in resolving hair-related disorders like hair loss, thinning, and scalp health.

Important Elements of Nutraceuticals for Healthy Hair:

1. Minerals and Vitamins: Iron, zinc, vitamin D, vitamin E, and biotin are essential for preserving hair development, structure, and halting hair loss.
2. Amino Acids: Keratin production, the main protein in hair, depends on essential amino acids like cysteine and methionine.
3. Antioxidants: Polyphenols, flavonoids, and selenium are among the compounds that shield hair follicles from oxidative stress, a known cause of hair damage and aging.
4. Plant-Based Extracts: Due to their ability to regulate hair growth and block the hormone dihydrotestosterone (DHT), which is associated with hair loss, herbal extracts such as saw palmetto, green tea, and ginseng are well-liked.

Mechanisms of Action:

By improving the transport of nutrients to hair follicles, lowering inflammation, preventing oxidative stress, and controlling hormone imbalances, nutraceuticals promote the health of hair. One potential benefit over pharmaceutical treatments that only target one mechanism is their multi-targeted impact.

Consumer Demand and industry Trends:

The global nutraceutical industry is growing, and a sizable portion of it is devoted to hair care because of the rising incidence of hair-related problems brought on by stress, pollution, and dietary practices. Nutraceuticals are a popular option since consumers favor natural, non-invasive solutions.

Obstacles and Future Directions:

In spite of their potential, there are obstacles such as varying product formulations, inconsistent clinical evidence, and regulatory barriers. To confirm safety and efficacy, future studies should concentrate on carefully planned clinical trials. developments in genetically based tailored nutraceutical solutions.

Conclusion :

By addressing hormonal imbalances, oxidative stress, and nutritional inadequacies, nutraceuticals have great potential to improve hair health. Their all-natural, multi-targeted method provides a comprehensive and efficient remedy for hair-related problems. To fully achieve their potential and guarantee safety and effectiveness in long-term use, additional clinical research and standardized formulations are necessary.

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