



## NUTRICOSMECEUTICALS : A NOVEL APPROACH TOWARDS HEALTH

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### Abstract:

Nutritional supplements that enhance the natural beauty of the skin, nails, and hair are known as nutricosmeceuticals. They work from the inside out to encourage inner attractiveness. It is the newest development in the beauty sector. Due to its health benefits and healthy results the market size of nutricosmeceuticals is expanding especially in European countries, China and now around the globe. Today's consumers are extremely cautious about the foods they take into their bodies especially post-COVID, there is also a growing market for natural goods that can improve one's health and appearance without having any negative side effects. However, because of their long history of use many nutricosmetic products are regarded as effective. In this review, we have discussed about the etiology of hair weakening as there are many causes of hair weakening like poor nutrition, environment etc. Different causes of hair thinning their mechanism, existing therapies, characterisation of hair fibres and herbal drugs used in treatment of hairs are discussed.

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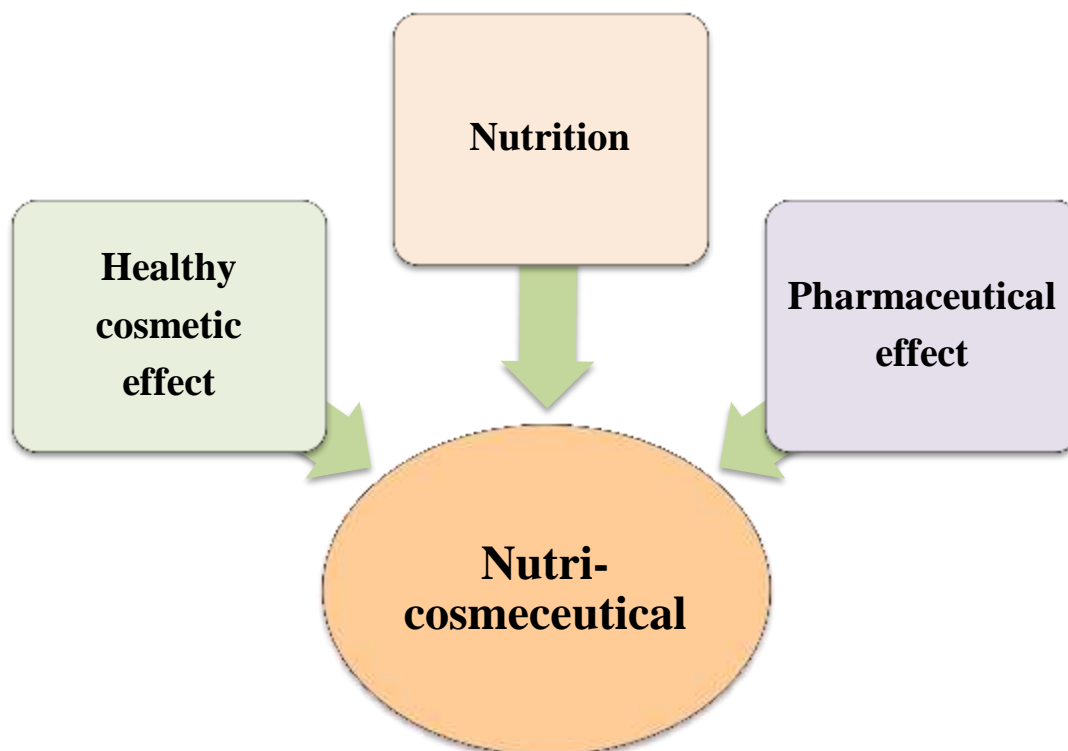
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### ❖ Introduction:

Nutricosmeceuticals are products that have the potential to improve skin, hairs, and nail's health by giving the body the nutrients needed for their growth. Nutraceuticals and cosmetics have been combined to create this notion. The term "Nutraceutical" was created in 1989 by Stephen DeFelice from the words "Nutrition" and "Pharmaceutical". It was first described as a food (or component of a food) that offers medical or health advantages, including the prevention and/or treatment of an illness (Kalra, 2003) There are many commercial Nutraceuticals in market like Calcirol D-3, Coral calcium, Wellife, Proteinex etc. (Chopra et al., 2022) Dr. Albert Klingman is credited with coining the word "cosmeceuticals," which is defined as a product that has both a medicinal and cosmetic effect on skin and hairs (Kligman, 2005). There are products available in market as Cosmeceuticals like Acne Kit, Anti-AcneGel, Cooling sun spirtz, Dr. Brandt Laser Tight etc. (Verma et al., 2016)

Although the FDA and EU legislation do not recognise them, the industry refers to supplements, functional foods, and beverages that include active components that might enhance

human attractiveness and health as "nutricosmeceuticals." (Laneri et al., 2019) These are substances that promote internal attractiveness by protective or responsive effects that promote personal cleanliness and/or beautification. By way of supplements or food fortification in both liquid and solid forms, nutricosmeceuticals are taken orally. The majority of nutricosmetics for antiaging and skin care are created as pills, while those for skin care and bodily health are offered in liquid form. The market for skin care products of nutricosmeceuticals is mainly focused. The world market for nutricosmeceuticals is significantly constrained by strict restrictions (Dini & Laneri, 2019). In order to promote endogenous antioxidant enzymes that may aid to internally manage oxidative stress and help to attain a healthy skin appearance from the inside out, nutricosmeceuticals offers nutritional antioxidant supplements. The antioxidant enzymes are used in delaying skin ageing, and the endogenous and exogenous antioxidants are used for lessen the effects of oxidative stress. (Madhere & Simpson, 2010)



**Figure 1 :** Nutricosmeceutical

#### ❖ **Biology of Human hair & Hair cycle**

Mammals have hair, which serves a variety of purposes, including camouflage, thermoregulation, sensory information gathering, protection from environmental stress, and defence against infection. Every individual has an estimated 5 million hair follicles (HF), 80,000-150,000 of which are on the scalp (Krause & Foitzik, 2006). One of the most intricate mini-organs in the human body that has the ability to recreate itself is the hair follicle. Hair follicles exhibit cyclic patterns of activity during postnatal life, with phases of active growth and hair production (anagen), apoptosis-driven involution (catagen), and relative rest phase (telogen)(Fuchs et al., 2001). Hair follicles go through cyclical active growth, or anagen, with this stage typically lasting 3–7 years on the scalp vertex. From the beginning of mitotic activity within the secondary hair germ (anagen-I) through the fully grown follicle that first appears beyond the skin surface (anagen-VI), anagen has historically been split into six stages of development. Before being shed, hairs go through a lengthy resting period called telogen after a brief transitional phase called catagen. Then, the process is repeated repeatedly. 85–90% of scalp hairs are in anagen at any given moment, with the majority of the remaining hairs being in telogen. The hair follicle grows roughly 0.5 mm

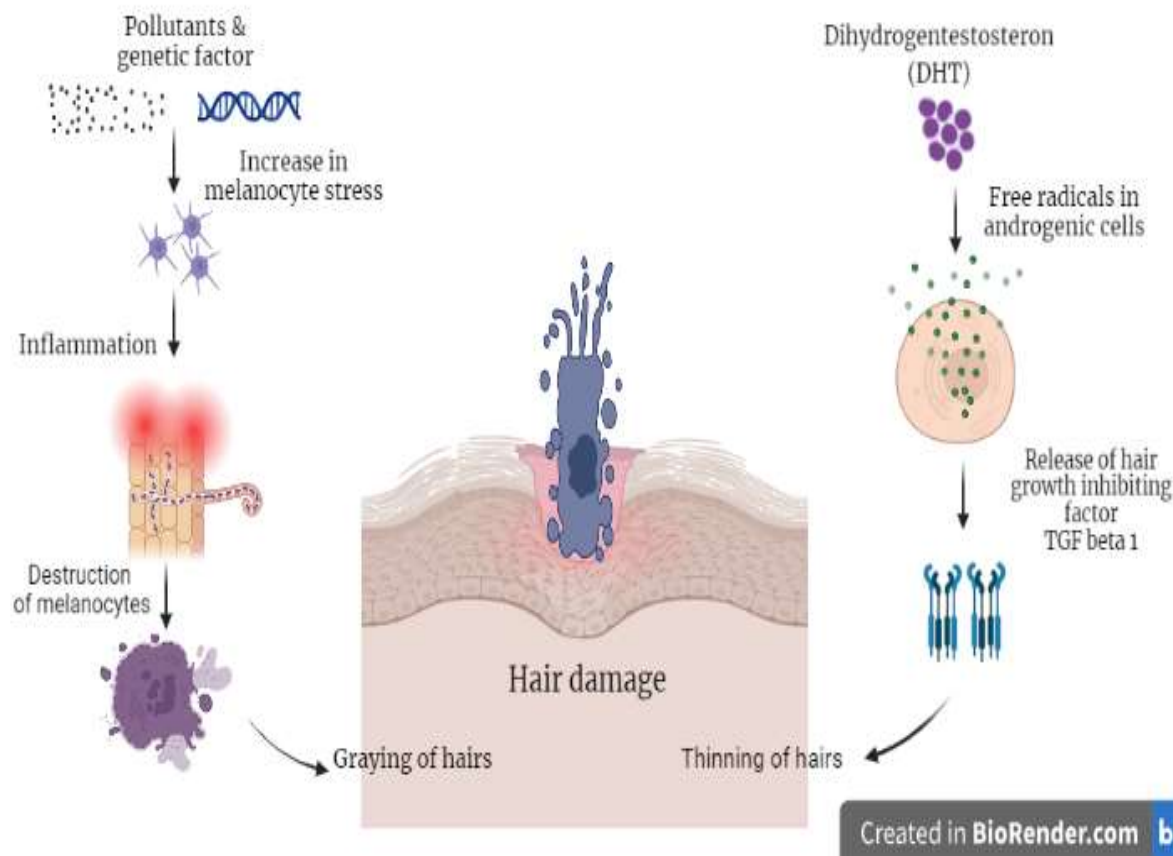
every day on average on the scalp vertex and a bit less at margins(Chamberlain & Dawber, 2003).

#### ❖ **Molecular structure of Hair**

Hair molecularly consists of keratin and the hair cuticle consists of almost 100 cells separated by membrane. The cell of hairs consists of microfibrils, nuclear remnants and pigment granules. Filaments have densely packed proteins known as filament proteins. Usually, filaments are less polar in nature having protein known as cystein. The major protein in hair shaft is alpha keratin. The keratin associated protein having ultrahigh cystein & high glycine tyrosine essential for stronger hair shaft with crosslinking of disulfide bond.(Akkermans & Warren, 2004)(Wu et al., 2008)

The alpha-keratin genes consist of 54 functional genes (type I genes -28 and 26 type II genes) that are grouped on chromosomes 12q13.13 and 17q21.2 that show distinct patterns of expression during hair development. Among 32 genes the 28 type I genes and 11 genes encode type I hair keratin protein ; similarly, among 26 type II genes, six genes encode hair keratins. Hair keratin forms the mid-bridge filament network by copolymerization of type I and II genes. (Schweizer et al., 2007)

### ❖ Mechanism of weakening of hairs



**Figure 2: Mechanism of weakening of hairs**

An ideology of treating hair loss only with DHT (dihydrotestosterone) blockers has developed as a result of the common strategy of treating any condition by eliminating its root cause. Dihydrotestosterone (DHT), the most potent androgen, is produced when testosterone is converted by the enzyme 5-reductase to dihydrotestosterone. DHT has an approximately five-fold higher androgen receptor (AR) affinity than testosterone (Premanand & Reena Rajkumari, 2018). The chemicals that prevent hair growth, such as dickkopf-related protein 1 (DKK-1), interleukin-6 (IL-6), and transforming growth factor (TGF-), are then upregulated by AR-bound DHT to promote hair follicle regression (Naseer et al., 2018)(Kwack et al., 2008). The enzyme 5'-reductase has three isotypes: type 1, type 2, and type 3 (SRD5A1, SRD5A2, and SRD5A3, respectively) (Yamana et al., 2010)(Madaan et al., 2018).

Prostate cancer cell line DU-145 (DU-145) expresses all SRD5A variants. In order to search for androgen antagonists for the prevention of hair loss, these cells have been employed as an in vitro model to study how herbal extracts or other substances affect the expression of the SRD5A gene. 2020 (Robitaille & Langlois, 2020).

Similarly, Human follicle dermal papilla cell (HFDPC) are used as an in vitro model to evaluate the cellular and molecular effects of hair growth-moderating substances as well as their effects on 5-reductase activity. HFDPC are specialised mesenchymal cells located at the base of hair follicles and are significant in hair follicle formation and postnatal hair growth cycles (Lourith et al., 2021). However, minoxidil, a medication that is frequently used to treat Androgenetic alopecia in both sexes, works through a number of different mechanisms (Katzner et al., 2019)(Semalty et al., 2011).

Testicular pain, erectile dysfunction, skin sensitivity, and scalp dryness are some of the side effects of these drugs (Nestor et al., 2021). These restrictions make it harder for some AGA sufferers to adhere to their hair loss therapies. Alternative therapies and natural herbal medicines have drawn interest because of their advantages, which include a variety of actions that promote hair development and inexpensive rates for long-term therapy of AGA's progressive hair loss (Dhariwala & Ravikumar, 2019).

### ❖ Genetic changes of Androgen in alopecia

It has been stated that the AR gene on the X

chromosome and the ectodysplasin A2 receptor (EDAR2) gene are related and that polymorphisms in this gene are associated with androgenic alopecia, but its exact role has not been fully defined. Androgenetic alopecia is associated with genetic alterations in the Wingless-related integration (WNT) signaling pathway, which regulates dermal papilla cells and androgen metabolism. Expression studies and epigenetic studies are limited, as scalp biopsy is difficult to obtain.

(Gokce et al., 2022) Overexpression of prostaglandin synthase (PGDS) and the PGDS product prostaglandin D2 (PGD2) restrict hair

development by generating an early catagen phase (Martinez-Jacobo et al., 2018)(Batrinos, 2014).

Other causes of Hair damage

- Nutritional deficiency
- Hereditary hair loss
- Age
- Alopecia areata
- Cancer treatment
- Childbirth
- Stress
- Hormonal imbalance
- Scalp infection
- Hair diseases

**Table 1:** Illustration of etiology of various hair diseases and their treatments.

Disease	Etiology	Clinical Features	Treatment	References
Anagen effluvium	Secondary to cytotoxic drugs like thallium, bismuth, arsenic, Cell division inhibition in hair follicle.	Loss of all hair on scalp	Scalp cooling	(Ghias et al., 2020)
Telogen effluvium	Shedding of telogen hairs (no scars), Secondary to Stress like high fever, surgery, crash diet	Uniform decrease in density all over scalp, Positive hair pull test	Shampoo less frequently. Can get up to years to grow back	(Rebora, 2019)
Alopecia Areata	Genetic Factor, Autoimmune disease	Circular patches of hair loss, Hairs grow back white.	Inject steroid (kenalog)	(de Berker, 2009)
Traction alopecia	Hair styling like Pony tails.		Hair grafts	(de Berker, 2009)
Androgenic Alopecia	Male and female pattern baldness	Beginning with bitemporal recession, bald patch	Rogaine (Minoxidil), Propecia (Finasteride), Transplants.	(Noor et al., 2020)
Trichotillomania	pulling hair out	Chronic, repetitive hair-pulling	Self-monitoring, Stimulus control, Habit-reversal training	(E. B. Lee et al., 2020)

As Nutricosmeceuticals aims in providing nutritional benefits, there are some nutrients discussed below which are essential for hair health (Rajput, 2018)(Verma et al., 2016).

➤ **Table 2:** List of Nutrients and their sources for healthy hair

Sr.No.	Nutrients essential for hair health	Sources	References
1	Biotin	Almond, Walnut Carrots, almonds, walnuts and oatmeal.	(Rajput, 2018)
2	Omega 3 fatty acid	Flax seeds, Sunflower seeds, walnuts, soybeans and canola oil.	(Verma et al., 2016)
3	Vitamin D	Soy milk, cheese and egg yolk	
4	Vitamin C	Lemon, Oranges, Grape fruit, Bell peppers, thyme, parsley, kale, Brussels and sprouts	(Saini & Mysore, 2021)
5	Zinc	Watermelon seeds, Fish, eggs, curd, berries Sunflower seeds, peanuts, pine nuts, beef, lamb, pork and cereals.	(Almohanna et al., 2019)
6	Iron	Spinach, eggs, tuna, soybeans, tofu and garbanzo beans.	(Mahdi & Mohammed, 2022)
7	Protein	Soyabean, eggs, cheese, tofu and quinoa	(Thompson et al., 2017)
8	Vitamin E	Peanuts, Pumpkin, Avacados Sunflower seeds, almonds and spinach	(Kareem et al., 2020)
9	Selenium	Cereals, eggs, brown rice, sunflower seeds, beans, mushroom, lentils, cashews and bananas.	(Lenz & Lens, 2009)

❖ **Herbal drugs used in promoting hair health:**

According to Ayurvedic Pharmacopoeia of India (Part1, Volume I-V) nature have tremendous

amount of herbs that can help us curing different ailments. Many herbs since years were used for hair care some of them are as follows :

**Table 3:** List of Herbal drugs and their uses in hair care.

Sr.No.	Herbal drug	Common name	Uses	References
1	<i>Emblica officinalis</i> Linn.	Amla	Promotes hair growth	(Amit et al., 2010)
2	<i>Bacopamonnieri</i> Linn.	Brahmi	Promotes hair growth	(Brimson et al., 2021)
3	<i>Trigonella foenumgraecum</i> Linn	Methi / fenugreek	Hair lengthening	(Bhavsar et al., 1980)
4	<i>Ecliptaalba(L) hassak.</i>	Bhringaraj	Promotes hair growth Hair growth	(Regupathi & Chitra, 2015)
5	<i>Allium cepa</i> L.	Onion/pyaz	Dandruff	(Ladeska et al., 2020)
6	<i>Nardostachys jatamansi</i> DC	Jatamansi	Hair strengthening	(Gupta et al., 2012)
7	<i>Camellia sinensis (L.) Kuntze</i>	Green tea	Hair growth	(Aryanti et al., 2021)
8	<i>Allium sativum</i> L.	Garlic / lehsun	Hair health	
9	<i>A.barbadensis</i> Mill.	Aloe vera	Hair strengthening	(Batiha et al., 2020)
10	<i>Glycyrrhiza glabra</i> L.	Mulethi	Increase blood circulation in scalp , nourishes roots and condition hairs.	(Sharrif Moghaddasi M, 2011) (Chandran et al., 2022)

### Herbal drugs used topically in different traditional formulations is are as follows :

**1. *Prunus dulcis*:** The *Prunus dulcis* tree yields the almond oil. 78% of fat is found in almond oil. Super-unsaturated Omega-3 essential fatty acids are present in extremely tiny quantities in this oil (Davrieux et al., 2010). It softens and strengthens the hair and proves to be highly nourishing. Additionally, almond oil shows to be an excellent cleaner. Even before it became widely used as a commercial agro-product, almond oil has been used for many millennia (K. G. Lee & Shibamoto, 2002).

**2. *Cocos nucifera*:** The coconut palm tree, a member of the Arecaceae family, produces coconut oil in the form of fruit or seed. Coconut oil has a melting point of 24 to 25°C (75-76°F), making it easy to use in both liquid and solid forms. It is frequently used in baking and cooking. As a moisturiser and softener, coconut oil works wonders on the skin. Extra virgin coconut oil is safe and effective as a moisturiser, according to a study, and there are no negative side effects. (Sumit et al., 2012).

**3. *Eclipta prostrata* :** False Daisy or Bhringaraj are two common names for *Eclipta prostrata* L. It is a herb that seeks moisture and is typically seen growing along roadsides and in waste areas. It is also commonly referred to as "King of Hairs" and is also used as hepatoprotective medication in traditional systems of medicine. It is an annual, small-branched plant with a long history of usage in traditional medicine, particularly in tropical and subtropical areas.

The plant is well-known for its healing abilities and has been used for its analgesic, antibacterial, and responsible for certain activities like antihepatotoxic, antihemorrhagic, antihyperglycemic, antioxidant, immunomodulatory. It is also

said to be a good rejuvenator. (Sharma, 2017)

**4. *Hibiscus rosa-sinensis*:**The herb *Hibiscus rosa sinensis* Linn is a glabrous shrub that is extensively grown as a decorative plant in the tropics and comes in a variety of variants with different coloured flowers. The flowers and leaves aid in the healing of sores and encourage the growth of new hair. Beta-sitosterol, campesterol, stigmasterol, ergosterol, flavonoids, glycosides, lipids, citric and oxalic acids, and taraxeryl acetate are all present in it. In mice, *Hibiscus rosa-sinensis* leaf extract lengthens hair and raises the anagen/telogen ratio of hair follicles (Adhirajan et al., 2003). *Eclipta alba* Hassk, *Hibiscus rosa sinensis* Linn, and *Nardostachys Jatamansi* are all good hair growth promoters that work primarily by lengthening the anagen phase and increasing follicular size (Thorat et al., 2009).

**5. *Polyporus umbellatus* :** A saprophytic mushroom called *Polyporus umbellatus* grows on the roots of dying beech and maple trees. Polysaccharides and steroidal chemicals make up the majority of the active ingredients. 3, 4-dihydroxybenzaldehyde was identified as the active ingredient in ethanol extract, which was claimed to stimulate hair growth in mice (Inaoka et al., 1994).

Acetosyringone, polyporusterone A, and B were three compounds that later research isolated to promote hair development (Ishida et al., 1999). When *P. umbellatus* extract was tested in-vitro using organ cultures of human scalp hair follicles, it was discovered that low doses of the extracts (1.28 and 6.4 g/ml) significantly increased hair growth and prolonged the period of hair growth, while high doses of mixture extracts (4 and 20 mg/ml) severely impede hair growth and shortened the growth span of hair growth (Sun et al., 2005).



**6. *Rosmarinus officinalis*** : Rosemary is a widespread, scented, evergreen plant that is grown all over the world. Historically, it was used as a medication to alleviate painful menstruation and renal colic. *Rosmarinus* also contains stearic, palmitic, elaidic, oleic, and alpha-linolenic acids (Shimizu et al., 2000). This plant's leaves contain an extract that possesses very potent 5 $\alpha$ -reductase inhibitory action, which may be caused by the presence of a number of particular fatty acids. The most effective dose and receptor affinity were contrasted with finasteride. The extract shows substantial inhibitory impact on the 5  $\alpha$ -reductase receptor in this analysis, however it was less pronounced than the effect displayed by finasteride (Randall & Ebling, 1991).

**7. *Ginkgo biloba* Linn.** : *Ginkgo biloba* widely used herbal medicine with several health advantages. One of them is its part in enhancing blood flow to the brain and skin, which results in a greater supply of oxygen. Ginkgolides A, B, C, J, and M, bioflavin, sitosterol, lactones, and anthocyanins are the main components. Ginkgo extracts and hormones worked together to promote the growth of human hair (Patel et al., 2015). Glycerrhizinate extracts of *Liquiritia officinarum* (3–35%) and *Ginkgo biloba* (5–40%) have both been effective in hair treatments. Ginkgo extracts and stearyl glycyrrhizate both promoted hair development. Through its combined effects on cell proliferation and apoptosis in the hair follicle, *ginkgo biloba* leaf extract promotes hair development, suggesting potential as a hair tonic (Kobayashi et al., 1993).

**8. *Ginseng radix*** : The steamed and dried root of *Panax ginseng* is known as ginseng radix. It is a significant crude medication that has been used for centuries to promote hunger, boost vigour, and lessen excessive cold sensitivity.

It also improves constitutional predisposition to poor body condition. Ginsenosides, essential oil, sesquiterpenes, polyacetylenes, polysaccharides, peptidoglycans, steroids, choline, vitamin B, C, and E, as well as fatty acids, carbohydrates, and amino acids, make up the majority of its chemical composition. According to a study using mouse vibrissal follicles in organ culture, the 70% methanolic red ginseng extract promotes hair development. (Matsuda et al., 2003), the saponin component of ginseng is responsible for the action. According to studies, ginseng inhibits the enzyme 5  $\alpha$  reductase (Liu et al., 2000) (Prager et al., 2002). Based on their inhibitory

effect against 5  $\alpha$  reductase in the androgenetic alopecia model, ginsenosides promote hair re-growth in vivo (Murata et al., 2012).

**9. Procyanidin** : Apples are a source of procyanidin B-2 (epicatechin-(4b-8)-epicatechin) (Takahashi et al., 1999). It was proposed that protein kinase C (PKC) isozymes, particularly PKC $\beta$ I and - $\beta$ II, are crucial for the progression of the hair cycle and that procyanidin B-2's hair-growing mechanisms are at least partially connected to its suppression of PKC isozymes or its inhibition of the translocation of PKC isozymes to the particulate fraction of hair epithelial cells.

According to reports, procyanidin treatment may promote hair growth in men who have male pattern baldness. 0.7% apple procyanidin oligomers were applied externally to cure male pattern baldness (Kamimura & Takahashi, 2002). Procyanidin B-2 and Procyanidin C-1, which specifically inhibit protein kinase C, vigorously increase anagen induction in vivo and boost hair epithelial cell proliferation in vitro. (Takahashi et al., 1999), some procyanidins show weak protein kinase C and A activity. Procyanidin B-3 from barley has the capacity to increase anagen induction in vivo, counteract the growth-inhibiting impact of TGF  $\alpha$ -1 in vitro, and directly boost hair epithelial cell development in vitro (Kamimura & Takahashi, 2002).

**10. *Tridax procumbens* Linn:** *Tridax procumbens*, also known as "Ghamra" in Hindi and "coat buttons" in English, has been widely employed in the Ayurvedic medical system to treat a variety of illnesses. Alkaloids, tannin, luteolin, glucoluteolin, quercetin, and isoquercetin are some of the primary components, along with flavonoids, procumbenetin, fumaric acid, and beta-sitosterol. Its leaves are used to cure dysentery, diarrhoea, and bronchial catarrh as well as to stop hair loss.

*Tridax procumbens* has been shown to promote hair development (Saraf et al., 1991). *Hibiscus rosa sinensis*, *Trigonella foenum graecum*, and *Embilica officinalis* were all included in a formulation that shown synergistic benefits by significantly increasing hair growth activity (Sabarwal et al., 2009).

There are certain therapies currently been used for treating hair damage.

### ❖ Existing therapies for Hair loss :

#### ➤ Drug protein therapy :

**1. Hair growth stimulators :** Many firms concentrate on developing products that stimulate hair growth through a variety of mechanisms, including a) a liquid drug that targets the prostamide E2 (PGE2) receptor, b) a topical and oral PAI-1 small-molecule inhibitor, c) signalling molecules that promote hair follicle regeneration, d) a therapeutic that targets Secreted Frizzled Related Protein 1 regulation, e) wounding devices and topical drug application, f) monoclonal antibodies that target the Prolactin receptor, g) Topical microcucle for hair growth.

Dermaliq Therapeutics, Eirion Therapeutics, Amplifica, Omega Therapeutics, Follica, Hope pharmaceuticals, TechnoDerma pharmaceuticals, etc are some of the companies that make these stimulators.(Michelet et al., 1997)

**2. Androgen blockers :** Antiandrogens are a class of medications that stop androgens like testosterone and dihydrotestosterone (DHT) from mediating their biological effects in the body. They are sometimes referred to as androgen antagonists or testosterone blockers.

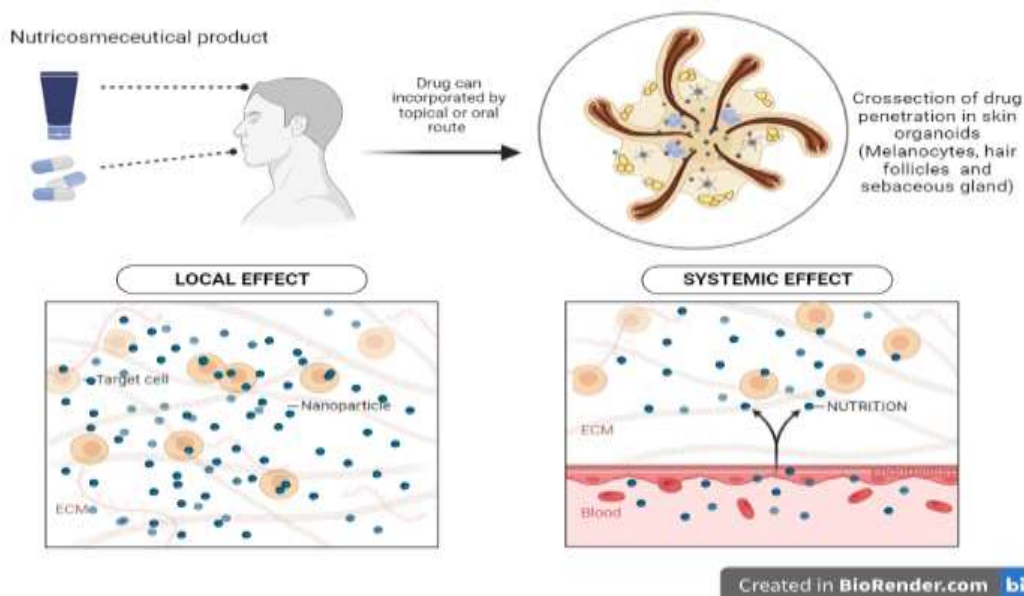
They function by reducing or decreasing androgen synthesis as well as blocking the androgen receptor (AR). (1989; Mowszowicz)(2006) (Brueggemeier, 2006) Following are the mechanisms through which many commercially available products operate. a) topical AR inhibitor, b) siRNA targeting AR, c) AR RNAi-mediated suppression d) Topical AR antagonists e) gene editing using CRISPR/Cas9.

Bioneer/si RN Agen, Cassiopea/Cosmo Pharmaceuticals, Kintor Pharmaceuticals, Olix Pharma, Moogene Medi, and others are the major producers.(Castro et al., 2023)

#### ➤ Cell therapy :

**1. Cellular reprogramming :** Using patient-specific induced pluripotent stem (iPS) cells, cellular reprogramming is a method that makes pathological studies accessible. As supplies for transplantation therapy, iPS cells are also anticipated to be a rising star in the field of regenerative medicine (K. Takahashi, 2014). Products for hair loss from dNovo and Stemson Therapeutics work by a) reprogramming skin, blood, or fat cells into hair follicle stem cells and b) employing autologous cell therapy with iPSC-derived follicular cells.(Xiao et al., 2016) (Castro et al., 2023)

**2. Unedited cells :** Manufacturers like RCH-01 of Replicel works on autologous cell therapy using dermal sheath cup cells, EPI-001 of EpiBiotech focuses on allogeneic dermal papilla cell therapy, SHT of TissUse focuses on Neopapillae Smart Hair Transplant, and Hairclone focuses on expression of Microinjection of expanded autologous DP cells into the scalp miniaturised area. (Castro et al., 2023)



**Figure 3 : Mechanism of Nutricosmeceuticals**

The Nutricosmeceuticals can be applied externally as well as taken internally through oral route. The drugs when taken shows both systemic and local effect. Systemically it enters into the hair cells, melanocytes and hair follicle for its action while, locally it hydrates the skin and repair external damage due to chemical treatments, external factors like pollutants etc. Some dosage form of nutricosmetic domain currently marketed by different Pharmaceutical brands are discussed further.

#### ❖ Nutricosmeceutical dosage forms :

- **Tablet:** Tablet is the most common solid dosage form used for giving herbal drugs. The herbal drugs along with magnesium stearate and other additives are used as lubricants, HPMC as a binder, and natural drugs were prepared using the direct compression and wet Granulation Method..(Gulati, 2014)(Swapnali, 2021)

- **Powder:** Nutricosmeceutical powder or supplement are used widely as the entire drug in powdered form were given. It is commercially available in the form of rejuvenators, powder for nutritional purposes. Some examples are protein suppliments and calcium suppliments.(P. et al., 2017)(Taiwade et al., 2019)(Bhardwaj et al., 2022)

- **Capsule :** Granules (pills and tablets) are a convenient form of storage, and capsuling has been recognised as the best and most adaptable of all dosage forms, enclosing one or more medicinal/herbal and inert ingredients in a tiny shell or container that is usually composed of gelatin or gluten.(Reddy et al., 2012)(Al-Tabakha, 2010) To produce certain physicochemical and functional features (such as optical, rheological, stability, and release), it is crucial to monitor particle characteristics like composition, charge, and size. (Garti & McClements, 2012)

- **Oro dispersible film :** Oral films are thin, mucoadhesive polymeric films that can be single or multilayered. Oro dispersible films are a revolutionary formulation that will have a significant future in the pharmaceutical and nutraceutical industries. A variety of active medicinal substances, film-forming polymers, flavours, colours, and sweeteners are used in the formulation of the oral films. ODFs are a particular class of formulations that are frequently made with hydrophilic polymers, allowing for quick dissolving when in contact with saliva. The two most common types of orally disintegrating drug delivery systems are oral disintegrating

tablets (ODTs) and oral disintegrating films (ODFs).(Dhaila & Tangri, 2022)

- **Nanosuspension:** Nanotechnology is emerging rapidly in pharmaceutical sector as the advantages of nanotechnology increased the intrest of scientists to produce rapid drug delivery systems.The nanosuspension or nanoparticles have been used to cross all the barriers. The herbal drugs were given in nano suspension form to increase its bioavailability. (Zafar et al., 2020)

- **Nanoemulgel:** The drawback of traditional topical dose forms including cream, ointments, and pastes is that they are sticky to apply to the skin and have a low drug permeability. Transparent gels are frequently employed in pharmacological and cosmetic formulations as a result. Drugs are incorporated into the hydrophilic or aqueous liquid of the gelling agent network to create gels. They work best for water-soluble medications rather than hydrophobic medications, which are challenging to mix into aqueous gel bases. (Panwar et al., 2011)(El- Leithy et al., 2017)

#### ❖ Nutricosmeceutical Market overview

The ageing population spends billions of dollars annually on antioxidants, botanical extracts, vitamins, and minerals in an effort to preserve the skin's youthful appearance and advance general wellbeing. Reactive oxygen species (ROS), which can possibly harm cell membranes, proteins, and DNA, are produced by hormonal imbalance, inflammation, smoking, exposure to UV radiation, and environmental stresses. Free radicals and an excess of oxidative stress can eventually destroy collagen and connective tissues, releasing chemicals that cause cellular and molecular ageing symptoms like wrinkles, uneven skin tone, dyspigmentation, inflammation, immunosuppression, photoaging, photocarcinogenesis, and sagging skin.(Madhere & Simpson, 2010)

The strong economy and rising elderly population are both very beneficial to the nutricosmetics business. The global market for nutricosmetics will grow at a compound annual growth rate (CAGR) of 5.0 percent from 2017 to 2025, reaching US\$7.93 billion. The nutricosmetics market is segmented into three groups: region, application (skin, hair, and nail care), and ingredient type. Although it has been acknowledged that the United States is the country with the biggest impact on the region, it is projected that as the average age in Europe rises, cosmeceuticals for the elderly will become more popular there. The market for skin care is



projected to reach \$194 961 million in 2024, growing at a 4.5% compound annual growth rate (CAGR). The need for natural cosmetics has increased the market for snail beauty products (snail extracts, snail mucus, snail oil, snail serum, or snail filtrate). Many individuals enjoy eating snails as a meal. (A.K Johnson, 2021)

To monitor the effect of nutricosmeceuticals on hairs different hair fibre characteristics studies have been done to identify the structural and molecular changes occurs before & after the treatments.

#### ❖ **Nutricosmeceutical growth drivers :**

##### • **Nutraceuticals' health advantages are a significant factor in the market's expansion.**

Customers like dietary supplements as healthy supplements since they provide a variety of health advantages. A balanced diet and nutricosmetics are thought to be the best nutritional allies for sustaining a generally healthy lifestyle. Nutricosmetics include advantages like maintaining beauty, preventing photoaging, and offering sun protection. They also have advantages like smoothing out wrinkles and increasing skin elasticity. They promise visible effects with relatively little effort and are simple to include into daily routines and cosmetic regimens. Additionally, collagen peptide-containing nutricosmetics can aid in the reduction of wrinkles around the eyes. (Lentjes, 2019)

Photoaging, which happens when the skin is exposed to UV light, is a major factor in the development of brown spots and deep wrinkles, two of the most obvious indications of ageing. Antioxidants found in nutricosmetics, including the vitamins C and E, lycopene, green tea polyphenols, beta carotene, and cocoa flavanols, shield the skin from UV damage. To stall the ageing process, collagen in the skin must be maintained. For the treatment of arthritis and to maintain healthy joints, nutraceuticals were used as ingredient in diet. Because of the advantages of nutricosmetics and many health advantages, more public will be attracted, which will quicken the market's growth pace over the projection period. (Pandel et al., 2013)

##### • **Increased demand for dietary and nutritional supplements:**

Consumers today are more likely to utilise natural rather than synthetic formulations for skin care and good health. Leading cosmetic companies are using herbal ingredients more frequently to create cosmetics and dietary supplements which is fueling the expansion of the nutricosmetics industry. The natural sources of

the components utilised in nutricosmetic products make them good for the skin and health. The ageing population is expanding, and many of them are highly sensitive of how they look and desire to change their lifestyles to look younger. Consumer awareness of the relationship between nutrition and health, including how one looks, is a key factor in the market's expansion. (Gomes et al., 2020)

##### • **Growing need in the healthcare industry**

The industry is greatly impacted by women's rising desire for nutricosmetics for their skin, hair, and facial beauty. Omega-3 fatty acids, vitamin A, and vitamin D are crucial for skin care. The idea of beauty-from-within appears when the intersection of health and beauty rapidly develops. Nowadays, people are more likely to have skin-related disorders including wrinkles, hair loss, and scalp concerns linked to vitamin deficiencies, thus they want to go towards certain preventive healthcare management measures. The market for nutricosmetics can expand due to all of these considerations. (Mostafa & Hegazy, 2013)

##### • **Increase in misleading advertisements by some spurious brands**

The idea of combining cosmetics and nutraceuticals, or Nutricosmetics, originated within the industry. Therefore, some firms utilise fraudulent marketing, false promises that mislead consumers, and several well-known faces to promote their products in order to generate demand for these goods. There are no laws or rules in place to control these products. Therefore, such requirements are necessary to streamline the production of Nutricosmeceutical products and oversee the regulation of fraudulent practises. (O'Neill et al., 2022)

#### ❖ **Leading companies in the global nutricosmetics market :**

The "Global Nutricosmetics Market" study report will offer insightful analysis with a focus on the international market, and will feature some of the key players therein, including BASF, Activ'Inside, Amway, Beiersdorf AG, Blackmores Limited, Pfizer Inc., Bayer AG ADR, Fit & Glow Healthcare Private Limited, Functionalab, GlaxoSmithKline PLC, GliSODin Skin Nutrients, Herbalife Nutrition etc. (A.K Johnson, 2021)

#### ❖ **Hair fibre Characterisation techniques :**

##### 1. **X-Ray diffraction**

X-ray spectrum of the hair fibre was generally observed to understand the crystalline nature of hairs. In this study, the peaks in the spectrum of

hair fiber (HF) were studied, using Bruker XRD SSD160 with Cu-K $\alpha$  monochromatic radiation at an angle of incidence of 5 °/min in  $2\theta = 10^\circ - 80^\circ$  ( $2\theta$  range), where  $\theta$  represents the angle of diffraction of X-rays within a crystalline material, known as Bragg angle.(Udhayakumar et al., 2023)

### 2. Fourier transform-infrared spectroscopy

The FTIR analysis was generally used to study the functional group modifications on the surface of hair fibre due to any treatment or external factors, using PES RXI FTIR spectrometer in the range of 400 to 4000 cm<sup>-1</sup> resolution (Udhayakumar et al., 2023)

### 3. Thermo-gravimetric analysis

The thermal stability of hair fibres was carried out to know its properties like toughness, elasticity etc by use of thermo-gravimetric analyzer in which the stability of hair fibres were measured. The initial readings were taken using JS thermal analyzer STA 449 F3 in the range 28–600°C with the heating temperature of 10°C/ min in presence of Nitrogen.(Oliver et al., 2020)

### 4. Surface roughness

The surface roughness of the hair fibres is one of the major parameter which can be measured using a 3D non-contact profiler (Talysurf CCI MP, UK). Three samples were measured at three different location on each sample and the measured average values are reported. Surface roughness was measured for a minimal fiber span length of 50 mm and it was carried out along the length of the fiber. In this surface roughness study, the surface roughness is measured from the availability of maximum fiber length of 70 mm SHF. During measurement the fiber is holding both ends as 10 mm and the remaining 50 mm span length is used for measurement of the surface roughness of sheep hair fiber.(Park et al., 2018)

### 5. Hair elasticity

Hair fibre is elastic and can be stretched moderately while wet or dry. Hair elasticity is a parameter which tends to show the strength of hair to stretching. Stretching is a hair property caused when force applied and the thread recuperate to its original state when the force ends to exist. When dry, the hair strand may stretch 20-30% of its length; when wet, this may increase to 50%. It becomes more elastic when exposed to ammonia. Chemical and physical treatments, sun exposure, and the use of electric dryers and heated plates all have an impact on its property..(Velasco et al., 2009)

### 6. Static load

Surface electric load develops when a comb moves over the hair due to friction and the high electric resistance of the hair, causing combing difficult. The static load dispersion is determined by the conductivity or electric resistance of the fibre. Long chain quaternary ammonium salts boost conductivity on the thread surface and reduce friction. The load potential is affected by elements such as the condition of the hair surface, because the presence of an oily coating caused by sebum or a cosmetic product reduces or eliminates the static electricity effect. Thread electric loads flow more better on wet hair than on dry hair due to the decrease in electric resistance. Thus, hair becomes more rough and dry when exposed to environment. (Velasco et al., 2009)

### 7. Resistance to stretching

Stretching is a parameter which shows the elastic nature of hairs. To identify the elastic properties this method is used. The average weight required to break the hair fibre were measured. Around 50-100 gm is required to break natural hairs. The resistance to rupturing is a function of the diameter of the thread, of the cortex condition, and it is affected by chemical treatments. Breaking of hair is characterised by three regions a) Hookean's region or pre-recovering b) Recovering region c) After-recovering region. The elongation of hair is the parameter study for hair damage due to chemical and heating treatments applied externally.(Velasco et al., 2009)

### 8. Hydrophilic power

Hair absorbs water as Keratin has the ability to absorb up to 40% of its own weight in water. Temperature rises, pH changes, and any polar solvents that break hydrogen bonds promote hydration. The pliability of the fibre can differ as a result of hydration. Water absorption in the hair causes swelling, an increase in thread diameter, and an increase in length. The mean pH influences both absorption and swelling. In general, alkaline pH promotes swelling. Other polar solvents that have a comparable impact on hair threads include urea solutions, acetamide, and lithium bromide.(Velasco et al., 2009)

### ❖ Future aspects of Nutricosmeceuticals

The shifting of Pharmaceutical market towards the synthesis of natural or herbal formulations occurs due to the abundant advantages of herbal drugs and its use traditionally.

The growing demand of herbal drugs in the form of nutraceuticals, cosmeceuticals or

nutricosmetics increasing the market growth worldwide. According to one of the mechanism discussed the healthy skin and hairs can also be maintained by these suppliments and also these preprations are progressively using in treatment of diseases. The major growth driven population of different countries contributed towards the establishment of many international companies supplying herbal drugs and cosmetics which rapidly occupying the global market.

### ❖ Conclusion

Nutricosmeceuticals are making revolutionary changes in healthcare system by enhancing beauty from within. China and Europe were using this concept from years by using traditional herbs. The market of Nutricosmeceutical products for skin and hairs increasing rapidly with years and Cosmetic industries are more likely to manufacture such products. Hairs are essential part of body not only for overall appearance but also for maintaining the thermostasis. Hair loss is multifaceted and there are various factors like nutrition, stress, environment etc causing hair loss. Baldness is not occurs due to hairloss but, because of irreplacement with new hairs as the hair growth cycles often disrupted or discontinued. Researchers found that by combating side effects we can fight against hairloss without using medications by strengthening the hair roots and promoting better hair growth. Research shows that changed immunity, inflammation, hormonal imbalance and dysregulation of hair growth cycles can be cured by providing nutritional support. Androgen blockers is not the only basis of treating hair loss.. There is evidence that the action of DHT is mediated through ROS and can be successfully blocked with antioxidants. There are many potential herbal drugs which are scientifically proven to be effective in Hair loss.

### ➤ References

1. A.K Johnson. (2021). Nutri-Cosmeceuticals. *Journal of Nutraceuticals and Food Science*, 6(6), 0–30.
2. Adhirajan, N., Ravi Kumar, T., Shanmugasundaram, N., & Babu, M. (2003). In vivo and in vitro evaluation of hair growth potential of *Hibiscus rosa-sinensis* Linn. *Journal of Ethnopharmacology*, 88(2–3). [https://doi.org/10.1016/S0378-8741\(03\)00231-9](https://doi.org/10.1016/S0378-8741(03)00231-9)
3. Akkermans, R. L. C., & Warren, P. B. (2004). Multiscale modelling of human hair. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 362(1821). <https://doi.org/10.1098/rsta.2004.1395>
4. Al-Tabakha, M. M. (2010). HPMC capsules: Current status and future prospects. In *Journal of Pharmacy and Pharmaceutical Sciences* (Vol. 13, Issue 3). <https://doi.org/10.18433/J3K881>
5. Almohanna, H. M., Ahmed, A. A., Tsatalis, J. P., & Tosti, A. (2019). The Role of Vitamins and Minerals in Hair Loss: A Review. In *Dermatology and Therapy* (Vol. 9, Issue 1). <https://doi.org/10.1007/s13555-018-0278-6>
6. Amit, G., Rishabha, M., Prakash, S. T., & Kumar, S. P. (2010). Indian medicinal plants used in hair care cosmetics: A short review. In *Pharmacognosy Journal* (Vol. 2, Issue 10). [https://doi.org/10.1016/s0975-3575\(10\)80110-5](https://doi.org/10.1016/s0975-3575(10)80110-5)
7. Aryanti, R., Perdana, F., & Syamsudin, R. A. M. R. (2021). Telaah Metode Pengujian Aktivitas Antioksidan pada Teh Hijau (*Camellia sinensis* (L.) Kuntze). *Jurnal Surya Medika*, 7(1). <https://doi.org/10.33084/jsm.v7i1.2024>
8. Batiha, G. E. S., Beshbishy, A. M., Wasef, L. G., Elewa, Y. H. A., Al-Sagan, A. A., El-Hack, M. E. A., Taha, A. E., Abd-Elhakim, Y. M., & Devkota, H. P. (2020). Chemical constituents and pharmacological activities of garlic (*Allium sativum* L.): A review. In *Nutrients* (Vol. 12, Issue 3). <https://doi.org/10.3390/nu12030872>
9. Batrinos, M. L. (2014). The endocrinology of baldness. In *Hormones* (Vol. 13, Issue 2). <https://doi.org/10.1007/bf03401334>
10. Bhardwaj, S., Bhatia, S., Gupta, P. S., Singh, S., & Badal, S. (2022). Development of cucurbititrin based nutraceutical formulation: A potential adjuvant herbal therapy in the management of hypertension. *Indian Journal of Natural Products and Resources*, 13(3). <https://doi.org/10.56042/ijnpr.v13i3.54840>
11. Bhavsar, G. C., Kapadia, N. S., & Patal, N. M. (1980). Studies on *Trigonella foenumgraecum* (Linn.). *Indian Journal of Pharmaceutical Sciences*, 42(2).
12. Brimson, J. M., Brimson, S., Prasanth, M. I., Thitilertdecha, P., Malar, D. S., & Tencomnao, T. (2021). The effectiveness of *Bacopa monnieri* (Linn.) Wettst. as a nootropic, neuroprotective, or antidepressant supplement: analysis of the available clinical data. *Scientific Reports*, 11(1). <https://doi.org/10.1038/s41598-020-80045-2>
13. Brueggemeier, R. W. (2006). Sex Hormones (Male): Analogs and Antagonists. In *Encyclopedia of Molecular Cell Biology and*

- Molecular Medicine.  
<https://doi.org/10.1002/3527600906.mcb.200500066>
14. Castro, A. R., Portinha, C., & Logarinho, E. (2023). The booming business of hair loss. In Trends in Biotechnology. <https://doi.org/10.1016/j.tibtech.2022.12.020>
  15. Chamberlain, A. J., & Dawber, R. P. R. (2003). Methods of evaluating hair growth. In Australasian Journal of Dermatology (Vol. 44, Issue 1). <https://doi.org/10.1046/j.1440-0960.2002.t01-1-00631.x>
  16. Chandran, A., Syam R J, Jerone, J. J., & V, S. K. (2022). Ethnopharmacological study about Glycyrrhiza glabra L. (Licorice) based on Ayurveda, An Indian System of Traditional Medicine- A Review. International Journal of Ayurvedic Medicine, 13(3). <https://doi.org/10.47552/ijam.v13i3.2867>
  17. Chopra, A. S., Lordan, R., Horbańczuk, O. K., Atanasov, A. G., Chopra, I., Horbańczuk, J. O., Józwick, A., Huang, L., Pirgozliev, V., Banach, M., Battino, M., & Arkells, N. (2022). The current use and evolving landscape of nutraceuticals. In Pharmacological Research (Vol. 175). <https://doi.org/10.1016/j.phrs.2021.106001>
  18. Davrieux, F., Allal, F., Piombo, G., Kelly, B., Okulo, J. B., Thiam, M., Diallo, O. B., & Bouvet, J. M. (2010). Near infrared spectroscopy for high-throughput characterization of shea tree (Vitellaria paradoxa) nut fat profiles. Journal of Agricultural and Food Chemistry, 58(13). <https://doi.org/10.1021/jf100409v>
  19. de Berker, D. (2009). Nails and hair. In Medicine (Vol. 37, Issue 6). <https://doi.org/10.1016/j.mpmed.2009.02.014>
  20. Dhaila, H. S., & Tangri, P. (2022). A review on formulation of nutraceutical products in the form of Oro dispersible film . 4, 908–918.
  21. Dhariwala, M. Y., & Ravikumar, P. (2019). An overview of herbal alternatives in androgenetic alopecia. In Journal of Cosmetic Dermatology (Vol. 18, Issue 4). <https://doi.org/10.1111/jocd.12930>
  22. Dini, I., & Laneri, S. (2019). Nutricosmetics: A brief overview. In Phytotherapy Research (Vol. 33, Issue 12). <https://doi.org/10.1002/ptr.6494>
  23. El-Leithy, E. S., Makky, A. M., Khatlab, A. M., & Hussein, D. G. (2017). Nanoemulsion Gel Of Nutraceutical Co-Enzyme Q10 As An Alternative To Conventional Topical Delivery System To Enhance Skin Permeability And Anti-Wrinkle Efficiency. International Journal of Pharmacy and Pharmaceutical Sciences, 9(10). <https://doi.org/10.22159/ijpps.2017v9i11.21751>
  24. Fuchs, E., Merrill, B. J., Jamora, C., & Dasgupta, R. (2001). At the Roots of a Never-Ending Cycle. In Developmental Cell (Vol. 1, Issue 1). [https://doi.org/10.1016/S1534-5807\(01\)00022-3](https://doi.org/10.1016/S1534-5807(01)00022-3)
  25. Garti, N., & McClements, D. J. (2012). Encapsulation technologies and delivery systems for food ingredients and nutraceuticals. In Encapsulation Technologies and Delivery Systems for Food Ingredients and Nutraceuticals. <https://doi.org/10.1533/9780857095909>
  26. Ghias, M. H., Amin, B. D., & Kutner, A. J. (2020). Albendazole-induced anagen effluvium. JAAD Case Reports, 6(1). <https://doi.org/10.1016/j.jcdr.2019.08.010>
  27. Gokce, N., Basgoz, N., Kenanoglu, S., Akalin, H., Ozkul, Y., Ergoren, M. C., Beccari, T., Bertelli, M., & Dundar, M. (2022). An overview of the genetic aspects of hair loss and its connection with nutrition. In Journal of preventive medicine and hygiene (Vol. 63, Issue 2). <https://doi.org/10.15167/2421-4248/jpmh2022.63.2S3.2765>
  28. Gomes, C., Silva, A. C., Marques, A. C., Lobo, J. S., & Amaral, M. H. (2020). Biotechnology applied to cosmetics and aesthetic medicines. In Cosmetics (Vol. 7, Issue 2). <https://doi.org/10.3390/COSMETICS7020033>
  29. Gulati, A. K. Palu. N. B. (2014). Formulation and evaluation of nutraceutical tablet using herbal drurs by direct compression method. Journal of Drug Delivery and Therapeutics, 4(2). <https://doi.org/10.22270/jddt.v4i2.789>
  30. Gupta, R. K., Disket, J., & Mann, S. (2012). A Review on Spikenard (Nardostachysjatamansi DC.)- An ‘Endangered’ Essential Herb of India. International Journal of Pharmaceutical Chemistry, 2(2). <https://doi.org/10.7439/ijpc.v2i3.716>
  31. Inaoka, Y., Shakuya, A., Fukazawa, H., Ishida, H., Nukaya, H., Tsuji, K., Kuroda, H., Okada, M., Fukushima, M., & Kosuge, T. (1994). Studies on Active Substances in Herbs Used for Hair Treatment. I. Effects of Herb Extracts on Hair Growth and Isolation of an Active Substance from Polyporus umbellatus F. Chemical and Pharmaceutical Bulletin, 42(3). <https://doi.org/10.1248/cpb.42.530>
  32. Ishida, H., Inaoka, Y., Shibatani, J. I., Fukushima, M., & Tsuji, K. (1999). Studies of the active substances in herbs used for hair treatment. II. Isolation of hair regrowth



- substances, acetosyringone and polyporusterone A and B, from polyporus umbellatus fries. *Biological and Pharmaceutical Bulletin*, 22(11). <https://doi.org/10.1248/bpb.22.1189>
33. Kalra, E. K. (2003). Nutraceutical - Definition and introduction. *AAPS PharmSci*, 5(3). <https://doi.org/10.1208/ps050325>
34. Kamimura, A., & Takahashi, T. (2002). Procyanidin B-2, extracted from apples, promotes hair growth: A laboratory study. *British Journal of Dermatology*, 146(1). <https://doi.org/10.1046/j.0007-0963.2001.04558.x>
35. Kareem, J. B., Yser, H. T., Turab, M. K. A., & Makki, U. M. (2020). Effect of malnutrition, hormones disturbance and malondialdehyde on hair loss in women: patients at al-sader educational hospital, basrah governorate, iraq - a case study. *Biochemical and Cellular Archives*, 20(2).
36. Katzer, T., Leite Junior, A., Beck, R., & da Silva, C. (2019). Physiopathology and current treatments of androgenetic alopecia: Going beyond androgens and anti-androgens. In *Dermatologic Therapy* (Vol. 32, Issue 5). <https://doi.org/10.1111/dth.13059>
37. Kligman, A. (2005). The future of cosmeceuticals: an interview with Albert Kligman, MD, PhD. Interview by Zoe Diana Draelos. *Dermatologic Surgery: Official Publication for American Society for Dermatologic Surgery [et Al.]*, 31(7 Pt 2). <https://doi.org/10.1111/j.1524-4725.2005.31737>
38. Kobayashi, N., Suzuki, R., Koide, C., Suzuki, T., Matsuda, H., & Kubo, M. (1993). Effect of leaves of Ginkgo biloba on hair regrowth in C3H strain mice. *Yakugaku Zasshi*, 113(10). [https://doi.org/10.1248/yakushi1947.113.10\\_718](https://doi.org/10.1248/yakushi1947.113.10_718)
39. Krause, K., & Foitzik, K. (2006). Biology of the Hair Follicle: The Basics. In *Seminars in Cutaneous Medicine and Surgery* (Vol. 25, Issue 1). <https://doi.org/10.1016/j.sder.2006.01.002>
40. Ladeska, V., Rindita, Amyra, N., & Dwi Veranthy, T. (2020). Physicochemical Analysis and Antioxidant Activity of Onion Bulbs (*Allium cepa* L.). *Jurnal Jamu Indonesia*, 5(2). <https://doi.org/10.29244/jji.v5i2.170>
41. Laneri, S., Di Lorenzo, R., Sacchi, A., & Dini, I. (2019). Dosage of bioactive molecules in the nutricosmeceutical *Helix aspersa* muller mucus and formulation of new cosmetic cream with moisturizing effect. *Natural Product Communications*, 14(8). <https://doi.org/10.1177/1934578X19868606>
42. Lee, E. B., Homan, K. J., Morrison, K. L., Ong, C. W., Levin, M. E., & Twohig, M. P. (2020). Acceptance and Commitment Therapy for Trichotillomania: A Randomized Controlled Trial of Adults and Adolescents. *Behavior Modification*, 44(1). <https://doi.org/10.1177/0145445518794366>
43. Lee, K. G., & Shibamoto, T. (2002). Determination of antioxidant potential of volatile extracts isolated from various herbs and spices. *Journal of Agricultural and Food Chemistry*, 50(17). <https://doi.org/10.1021/jf0255681>
44. Lentjes, M. A. H. (2019). The balance between food and dietary supplements in the general population. *Proceedings of the Nutrition Society*, 78(1). <https://doi.org/10.1017/s0029665118002525>
45. Lenz, M., & Lens, P. N. L. (2009). The essential toxin: The changing perception of selenium in environmental sciences. *Science of the Total Environment*, 407(12). <https://doi.org/10.1016/j.scitotenv.2008.07.056>
46. Liu, W. K., Xu, S. X., & Che, C. T. (2000). Anti-proliferative effect of ginseng saponins on human prostate cancer cell line. *Life Sciences*, 67(11). [https://doi.org/10.1016/S0024-3205\(00\)00720-7](https://doi.org/10.1016/S0024-3205(00)00720-7)
47. Lourith, N., Kanlayavattanukul, M., & Chaikul, P. (2021). Para rubber seed oil: The safe and efficient bio-material for hair loss treatment. *Journal of Cosmetic Dermatology*, 20(7). <https://doi.org/10.1111/jocd.13843>
48. Madaan, A., Verma, R., Singh, A. T., & Jaggi, M. (2018). Review of Hair Follicle Dermal Papilla cells as in vitro screening model for hair growth. In *International Journal of Cosmetic Science* (Vol. 40, Issue 5). <https://doi.org/10.1111/ics.12489>
49. Madhere, S., & Simpson, P. (2010). A market overview of nutricosmetics. In *Cosmetic Dermatology* (Vol. 23, Issue 6).
50. Mahdi, S. A.-H., & Mohammed, H. A.-A. (2022). Effect of zinc, ferritin, and vitamin B12 deficiency on hair loss in pregnant women. *International Journal of Health Sciences*. <https://doi.org/10.53730/ijhs.v6ns4.12005>
51. Martinez-Jacobo, L., Villarreal-Villarreal, C. D., Ortiz-López, R., Ocampo-Candiani, J., & Rojas-Martínez, A. (2018). Genetic and molecular aspects of androgenetic alopecia. In *Indian Journal of Dermatology, Venereology and Leprology* (Vol. 84, Issue 3).

- [https://doi.org/10.4103/ijdv.IJDVL\\_262\\_17](https://doi.org/10.4103/ijdv.IJDVL_262_17)
52. Matsuda, H., Yamazaki, M., Asanuma, Y., & Kubo, M. (2003). Promotion of hair growth by Ginseng Radix on cultured mouse vibrissal hair follicles. *Phytotherapy Research*, 17(7). <https://doi.org/10.1002/ptr.1241>
  53. Michelet, J. F., Commo, S., Billoni, N., Mahe, Y. F., & Bernard, B. A. (1997). Activation of cytoprotective prostaglandin synthase-1 by minoxidil as a possible explanation for its hair growth-stimulating effect. *Journal of Investigative Dermatology*, 108(2). <https://doi.org/10.1111/1523-1747.ep12334249>
  54. Mostafa, W. Z., & Hegazy, R. A. (2013). Vitamin D and the skin: Focus on a complex relationship: A review. In *Journal of Advanced Research* (Vol. 6, Issue 6). <https://doi.org/10.1016/j.jare.2014.01.011>
  55. Murata, K., Takeshita, F., Samukawa, K., Tani, T., & Matsuda, H. (2012). Effects of ginseng rhizome and Ginsenoside RO on testosterone 5 $\alpha$ -reductase and hair re-growth in testosterone-treated mice. *Phytotherapy Research*, 26(1). <https://doi.org/10.1002/ptr.3511>
  56. Nestor, M. S., Ablon, G., Gade, A., Han, H., & Fischer, D. L. (2021). Treatment options for androgenetic alopecia: Efficacy, side effects, compliance, financial considerations, and ethics. In *Journal of Cosmetic Dermatology* (Vol. 20, Issue 12). <https://doi.org/10.1111/jocd.14537>
  57. Noor, N. M., Nazri, N. Z., Mohamad-Salam, N. A., Abdul-Rasid, Z. I., Hasham, R., & Abdul-Aziz, A. (2020). The potential of androgenic alopecia management from plant derivatives. *Food Research*, 4. [https://doi.org/10.26656/fr.2017.4\(S2\).S09](https://doi.org/10.26656/fr.2017.4(S2).S09)
  58. O'Neill, E., Clarke, P., Fido, D., & Vione, K. C. (2022). The Role of Future Time Perspective, Body Awareness, and Social Connectedness in the Relationship Between Self-efficacy and Resilience. *International Journal of Mental Health and Addiction*, 20(2). <https://doi.org/10.1007/s11469-020-00434-6>
  59. Oliver, M. A., Coderch, L., Carrer, V., Barba, C., & Marti, M. (2020). Ethnic hair: Thermoanalytical and spectroscopic differences. *Skin Research and Technology*, 26(5), 617–626. <https://doi.org/10.1111/srt.12842>
  60. P., V., I.D., A., C., B., C., G., D., M.C., M., G., S., A., L., Villa, P., Amar, I. D., Bottoni, C., Cipolla, C., Dinoi, G., Moruzzi, M. C., Scambia, G., & Lanzone, A. (2017). The impact of combined nutraceutical supplementation on quality of life and metabolic changes during the menopausal transition: a pilot randomized trial. *Archives of Gynecology and Obstetrics*, 296(4).
  61. Pandel, R., Poljšak, B., Godic, A., & Dahmane, R. (2013). Skin Photoaging and the Role of Antioxidants in Its Prevention. *ISRN Dermatology*, 2013. <https://doi.org/10.1155/2013/930164>
  62. Panwar, A., Upadhyay, N., & Bairagi, M. (2011). Emulgel: a review. *Asian Journal of Pharmacy and Life Sciences*, 1(3).
  63. Park, K. H., Kim, H. J., Oh, B., Lee, E., & Ha, J. (2018). Assessment of hair surface roughness using quantitative image analysis. *Skin Research and Technology*, 24(1), 80–84. <https://doi.org/10.1111/srt.12393>
  64. Patel, S., Sharma, V., Chauhan, N., Thakur, M., & Dixit, V. K. (2015). Hair Growth: Focus on Herbal Therapeutic Agent. *Current Drug Discovery Technologies*, 12(1). <https://doi.org/10.2174/1570163812666150610115055>
  65. Prager, N., Bickett, K., French, N., & Marcovici, G. (2002). A Randomized, Double-Blind, Placebo-Controlled Trial to Determine the Effectiveness of Botanically Derived Inhibitors of 5- $\alpha$ -Reductase in the Treatment of Androgenetic Alopecia. *The Journal of Alternative and Complementary Medicine*, 8(2). <https://doi.org/10.1089/acm.2002.8.143>
  66. Premanand, A., & Reena Rajkumari, B. (2018). Androgen modulation of Wnt/ $\beta$ -catenin signaling in androgenetic alopecia. In *Archives of Dermatological Research* (Vol. 310, Issue 5). <https://doi.org/10.1007/s00403-018-1826-8>
  67. Rajput, R. (2018). A Scientific Hypothesis on the Role of Nutritional Supplements for Effective Management of Hair Loss and Promoting Hair Regrowth. *Journal of Nutritional Health & Food Science*, 6(3). <https://doi.org/10.15226/jnhfs.2018.001132>
  68. Randall, V. A., & Ebling, F. J. G. (1991). Seasonal changes in human hair growth. *British Journal of Dermatology*, 124(2). <https://doi.org/10.1111/j.1365-2133.1991.tb00423.x>
  69. Reborá, A. (2019). Telogen effluvium: A comprehensive review. In *Clinical, Cosmetic and Investigational Dermatology* (Vol. 12). <https://doi.org/10.2147/CCID.S200471>
  70. Reddy, B. V., Deepthi, A., & Ujwala, P. (2012). CAPSULE PRODUCTION – INDUSTRIAL VIEW. *Journal of Global Trends in Pharmaceutical Sciences*, 3(4).

- 71.Regupathi, T., & Chitra, K. (2015). In Vitro Antioxidant Properties of Eclipta Alba ( L .) Hassk . and Lippia Nodiflora Linn. International Journal of Pharmaceutical and Pharmacological Research, 4(40).
- 72.Robitaille, J., & Langlois, V. S. (2020). Consequences of steroid-5 $\alpha$ -reductase deficiency and inhibition in vertebrates. In General and Comparative Endocrinology (Vol. 290). <https://doi.org/10.1016/j.ygcen.2020.113400>
- 73.Sabarwal, N., Varghese, D., Barik, R., Khandelwal, A., Jain, A., & Jain, S. (2009). Development and evaluation of polyherbal formulations for hair growth activity. Pharmacognosy Journal, 1(2).
- 74.Saini, K., & Mysore, V. (2021). Role of vitamin D in hair loss: A short review. In Journal of Cosmetic Dermatology (Vol. 20, Issue 11). <https://doi.org/10.1111/jocd.14421>
- 75.Saraf, S., Pathak, A. K., & Dixit, V. K. (1991). Hair growth promoting activity of Tridax procumbens. Fitoterapia, 62(6).
- 76.Schweizer, J., Langbein, L., Rogers, M. A., & Winter, H. (2007). Hair follicle-specific keratins and their diseases. In Experimental Cell Research (Vol. 313, Issue 10). <https://doi.org/10.1016/j.yexcr.2007.02.032>
- 77.Semalty, M., Semalty, A., Joshi, G. P., & Rawat, M. S. M. (2011). Hair growth and rejuvenation: An overview. In Journal of Dermatological Treatment (Vol. 22, Issue 3). <https://doi.org/10.3109/09546630903578574>
- 78.Sharma, S. (2017). Phytochemical and anatomical screening of Eclipta prostrata L. An important medicinal herb from Chandigarh. ~ 255 ~ Journal of Medicinal Plants Studies, 5(2).
- 79.Sharrif Moghaddasi M, S. K. V. (2011). Aloe vera their chemicals composition and applications : A review. International Journal of Biological & Medical Research, 2(January).
- 80.Shimizu, K., Kondo, R., Sakai, K., Shoyama, Y., Sato, H., & Ueno, T. (2000). Steroid 5 $\alpha$ -reductase inhibitory activity and hair regrowth effects of an extract from boehmeria nipononivea. Bioscience, Biotechnology and Biochemistry, 64(4). <https://doi.org/10.1271/bbb.64.875>
- 81.Sumit, K., Vivek, S., Sujata, S., & Ashish, B. (2012). Herbal Cosmetics : Used for Skin and Hair. Inventi Journals, 2012(4).
- 82.Sun, A., Chia, J. S., Chiang, C. P., Hsuen, S. P., Du, J. L., Wu, C. W., & Wang, W. B. (2005). The Chinese herbal medicine Tien-Hsien liquid inhibits cell growth and induces apoptosis in a wide variety of human cancer cells. Journal of Alternative and Complementary Medicine, 11(2). <https://doi.org/10.1089/acm.2005.11.245>
- 83.Swapnali, K. (2021). Formulation and Evaluation of Nutraceutical Tablet Using Clove Drugs by Wet Granulation Method. International Journal for Research in Applied Science and Engineering Technology, 9(12). <https://doi.org/10.22214/ijraset.2021.39517>
- 84.Taiwade, R., Walke, S., Pise, S. A., Pise, A. G., & Mahajan, U. (2019). Formulation and evaluation of nutraceutical rejuvenator for sports persons. Research Journal of Pharmacy and Technology, 12(8). <https://doi.org/10.5958/0974-360X.2019.00672.3>
- 85.Takahashi, T., Kamiya, T., Hasegawa, A., & Yokoo, Y. (1999). Procyanidin oligomers selectively and intensively promote proliferation of mouse hair epithelial cells in vitro and activate hair follicle growth in vivo. Journal of Investigative Dermatology, 112(3). <https://doi.org/10.1046/j.1523-1747.1999.00532.x>
- 86.Thompson, J. M., Mirza, M. A., Park, M. K., Qureshi, A. A., & Cho, E. (2017). The Role of Micronutrients in Alopecia Areata: A Review. In American Journal of Clinical Dermatology (Vol. 18, Issue 5). <https://doi.org/10.1007/s40257-017-0285-x>
- 87.Thorat, R. M., Jadhav, V. M., & Kadam, V. J. (2009). Development and evaluation of polyherbal formulations for hair growth-promoting activity. International Journal of PharmTech Research, 1(4).
- 88.Udhayakumar, A., Mayandi, K., Rajini, N., Devi, R. K., Muthukannan, M., & Murali, M. (2023). Extraction and Characterization of Novel Natural Fiber from Cryptostegia Grandiflora as a Potential Reinforcement in Biocomposites. Journal of Natural Fibers, 20(1). <https://doi.org/10.1080/15440478.2022.2159607>
- 89.Velasco, M. V. R., De Sá Dias, T. C., De Freitas, A. Z., Júnior, N. D. V., Pinto, C. A. S. D. O., Kaneko, T. M., & Baby, A. R. (2009). Hair fiber characteristics and methods to evaluate hair physical and mechanical properties. Brazilian Journal of Pharmaceutical Sciences, 45(1). <https://doi.org/10.1590/S1984-82502009000100019>
- 90.Verma, A., Gautam, S. P., Devi, R., Singh, N., & Singh, L. (2016). COSMECEUTICALS: ACCLAIMING ITS MOST FASCINATING POSITION IN PERSONAL CARE

- INDUSTRY. In *Indian Research Journal of Pharmacy and Science* (Vol. 8).
91. Wu, D. D., Irwin, D. M., & Zhang, Y. P. (2008). Molecular evolution of the keratin associated protein gene family in mammals, role in the evolution of mammalian hair. *BMC Evolutionary Biology*, 8(1). <https://doi.org/10.1186/1471-2148-8-241>
92. Xiao, B., Hui Ng, H., Takahashi, R., & Tan, E. K. (2016). Induced pluripotent stem cells in Parkinson's disease: Scientific and clinical challenges. In *Journal of Neurology, Neurosurgery and Psychiatry* (Vol. 87, Issue 7). <https://doi.org/10.1136/jnnp-2015-312036>
93. Yamana, K., Fernand, L., Luu-The, V., & Luu-The, V. (2010). Human type 3 5 $\alpha$ -reductase is expressed in peripheral tissues at higher levels than types 1 and 2 and its activity is potently inhibited by finasteride and dutasteride. *Hormone Molecular Biology and Clinical Investigation*, 2(3). <https://doi.org/10.1515/HMBCI.2010.035>
94. Zafar, F., Jahan, N., Khalil-Ur-Rahman, Asi, M., & Zafar, W. U. I. (2020). Nanosuspension enhances dissolution rate and oral bioavailability of Terminalia arjuna bark extract in vivo and in vitro. *Asian Pacific Journal of Tropical Biomedicine*, 10(4). <https://doi.org/10.4103/2221-1691.280293>