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HERBAL COSMETICS IN THE MANAGEMENT OF SKIN DISEASE

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ABSTRACT

Skin conditions constitute one of the major burdens globally, and many individuals are plagued by skin disorders such as acne, eczema, psoriasis, hyperpigmentation, wounds, and aging processes. Traditional cosmetics and medicine have proven inadequate in combating the aforementioned skin diseases due to their side effects, inefficacy, and resistant nature. Herbal cosmetics, on the other hand, have become popular due to their safety and naturalness as per tradition. This comprehensive review highlights the potential of herbal cosmetics in addressing common skin disorders, which includes their definition, history, chemical composition

including polyphenols, terpenoids, and essential oils, and various forms of formulation like creams, gels, serums, and face masks. This review article highlights the potential of herbal cosmetics in managing skin diseases such as acne vulgaris, atopic dermatitis, psoriasis, melasma, scars, and photoaging. The chemical properties and modes of actions of different herbal components, such as Aloe vera, tea tree oil, turmeric, green tea, Calendula, Centella asiatica, and newer herbal components like liquorice and neem, will be elaborated in this review. Despite such encouraging results, there are still challenges facing in the areas of standardization, quality control, toxicology, and clinical application. Future research will focus on nanotechnology in order to improve delivery systems, customization, and testing to fill the evidentiary gap. Through combining ancient knowledge with contemporary scientific advances, herbal cosmetics represent a practical and holistic approach to dermatology, which could minimize the use of artificial treatments.

Keywords: Herbal Cosmetics; Skin Disease; Personalised Formulation; Nanotechnology.



1. INTRODUCTION

Skin disorders constitute one of the most common categories of health problems encountered by individuals from all age groups, social strata, and regions, which greatly affect their overall quality of life and psychological wellbeing. The developments made in the field of epidemiology modelling and Global Burden of Disease studies have revealed that a specific set of skin disorders significantly contribute to a significant share of the non-fatal disease burden, characterized by relatively higher Disability Adjusted Life Years (DALYs) along with lower mortality figures. Simultaneously, in the last couple of decades, there has been an immense rise in the popularity of herbal cosmetics and cosmeceuticals both at the level of consumers and clinicians, owing to a growing preference for natural or organic ingredients, apprehensions related to the harmful effects of chemical-based products, and a resurgence in ancient medicinal practices like Ayurveda, Traditional Chinese Medicine, and Ethnobotany ¹.

1.1 Prevalence and Burden of Skin Diseases

The recent research conducted by the GBD organization points out that skin diseases still remain one of the most common sources of non-lethal global burden of disease, which

affects billions of people. It should be noted that among all skin conditions, the standardized prevalence of fungal skin infections is the highest one, with acne vulgaris being the second most common cause of the burden of skin diseases. The most significant contribution to the burden of dermatological disorders in highly developed countries is made by atopic dermatitis. Such skin diseases as psoriasis, urticaria and non-melanoma skin cancers make up a considerable portion of the burden of skin diseases as well ².

Apart from these persistent inflammatory and immune-related disorders, viral skin diseases also represent a significant yet overlooked aspect of dermatological disorders. In a global study carried out recently, an estimation was made for more than 84 million new cases and about 130 million prevalent cases of viral skin disease in the year 2021, leading to a loss of over 4 million DALYs, where adolescents and young adults (ages 10-19) were found to be especially affected, with regional variations noted in East Asia, Sub-Saharan Africa, and regions with high sociodemographic index. This information clearly indicates that the overall effect of dermatological disorders is much more than just their cosmetic aspects; they include issues such as chronic itching, pain, secondary infections, deformities,



insomnia, anxiety, depression, and social stigma among others ³.

In relation to health care, the prevalence of skin disorders is linked to numerous visits to clinics for consultations, to dermatological specialists, and also to high pharmaceutical costs in terms of drugs prescribed by physicians. For developing nations, the shortage of dermatologists and treatment expenses might prompt people to try out alternative methods of treatment along with using traditional botanical extracts that find applications in herbal cosmetics. In contrast, for developed nations, the motivation behind herbal cosmetics use can be attributed to skin conditions caused by long-term habits, such as adult acne, photoaging, and sensitive skins; fears regarding other cosmetics ingredient usage; and necessity of cosmetic products with medical benefits as well as aesthetic properties ⁴

1.2 Rise of Herbal Cosmetics in Dermatological Care

Herbal cosmetics, referred to by other names such as herbal cosmeceuticals, consist of preparations that contain plant-based components that apart from cleansing and beautification purposes, also generate a marked biological activity on the skin such as anti-inflammatory activity, antioxidant properties, antimicrobial effects, sun protection, wound healing and much more.

In ancient times, herbal formulas consisting of plants like the Aloe Vera plant juice, turmeric paste, herbal oil have been used to cleanse, lighten and treat skin conditions. Modern day herbal cosmetics can be viewed as the scientific form of these time-honoured practices. Developments in the field of extractions and formulations have made the isolation of phytochemicals relatively easy ⁵.

The market study reveals that herbal cosmetics constitute one of the most lucrative segments in the worldwide beauty care industry, which is valued at several billion dollars and anticipated to grow with a compound annual growth rate (CAGR) of 5-7% over the next few years. The rationale behind this trend can be attributed to numerous reasons, ranging from consumers' knowledge about the irritancy and health implications associated with certain synthetic preservatives, fragrances, and colorants found in cosmetic products to their preference for chemical-free, vegan, and environmentally friendly products and the safety of herbal ingredients in relation to humans. Additionally, the dermatological sciences' support for certain herbal ingredients, like the use of Aloe vera in wound healing, green tea extracts in sun protection, and turmeric or neem for acne-prone skin, has been often mentioned in



marketing material to justify the use of herbal ingredients in dermatologic products⁶.

Moreover, several technological innovations have also proved to be an integral part of facilitating the growth of herbal cosmetics owing to their capacity for providing further customization of these products and making them fall into the category of wellness products. The reason behind this phenomenon is that with the help of technology, personalized skin care routines often feature a range of herbs that are effective against concerns like acne, dark spots, and sensitivity, among others. Simultaneously, the use of sustainable materials, organic products, and ethically sourced ingredients from countries like India, Brazil, and Indonesia, which boast great biodiversity, have become a major distinguishing factor in the global herbal cosmetics industry⁷.

2. Herbal Cosmetics: Definition and Classification

Herbal cosmetic is defined as any cosmetic and cosmeceutical formulation wherein one or more herb-based components and/or its extracts are mixed with a common cosmetic carrier system to give cosmetic and physiological effects to the skin. These types of cosmetic products have been found to represent a junction between ancient

medicinal science and modern dermatology. Herbal cosmeceutical is a term given to those formulations which are both cosmetically appealing and have strong pharmacological effects⁸.

2.1 Historical Evolution and Traditional Uses

The practice of using plant products for beauty and skincare is not a recent invention but has a very long tradition in civilizations dating back from time immemorial when there were written documents and prescriptions of beauty and skincare products like oils, resins, and plants extract found on papyri, manuscripts, and inscriptions. There are numerous examples where prescriptions of herbs for beauty and skin care have been recorded in history such as the Ebers papyrus from Egypt (1550 BCE), which had prescriptions of ointment preparations from various herbs and spices for skin treatments⁹.

In India, the study of Kaumudi, cosmetology, evolved alongside the development of Ayurveda and gave rise to various herbal preparations like ubtans (herbal face cleansing pastes), herbal oils, and herbal face masks for the cleansing and whitening of the skin, as well as for the prevention of infections. Likewise, in ancient Chinese medicine, herbal pastes and herbal oils were utilized for complexions and age reversal,



thereby emphasizing the empirical use of herbs for beauty and skin care ⁸.

While the industrialization of cosmetics over the last two hundred years favoured synthetic compounds, consumer interest in "natural" and "chemical-free" products has once again brought herbal cosmetics into the spotlight. Modern herbal cosmetics therefore draw from age-old knowledge, but are increasingly backed by phytochemical analysis, in vitro tests, and clinical trials ¹⁰.

2.2 Key Ingredients: Phytochemical Profiles (e.g., Polyphenols, Terpenoids, Essential Oils)

The basis of herbal cosmetics are various types of phytochemical compounds with distinct biological activities derived from different plants. Among them are polyphenols, terpenoids (or terpenes in essential oil), flavonoids, tannins, saponins, alkaloids, and fatty acids. These ingredients provide antioxidant, anti-inflammatory, antimicrobial, and wound healing activity.

Polyphenols (catechins, quercetin, anthocyanins, for example) are extremely abundant in green tea, grapes, and plants containing resveratrol. They act as scavengers of reactive oxygen species and as metal chelators, reducing oxidative stress on the skin. Polyphenols also prevent photodamage and hyperpigmentation resulting from exposure to UV rays. One

such compound used in green tea cream and serum is epigallocatechin gallate or EGCG. It has been found that EGCG inhibits the release of matrix metalloproteinases (MMP) and pro-inflammatory cytokines, thereby protecting collagen and elastin¹¹.

Terpenoids and compounds of essential oils are yet another important class of phytoconstituents and include monoterpenes (for example, limonene, linalool, α -pinenes), sesquiterpenes, and diterpenes. They can be identified in citrus essential oils, lavender, eucalyptus, and rosemary, and are strong anti-inflammatory, antimicrobial agents and even possess a weak analgesic effect. As an example, tea tree oil, which is abundant in terpinen-4-ol compound, is extensively employed in herbal products for acne treatment owing to its extensive antimicrobial efficacy against *Propionibacterium acnes* and other skin microbes ¹².

Fixed plant oils (for example, jojoba, almond, olive, and coconut oils), plant waxes, plant gums, and polysaccharides (including aloe polysaccharides and konjac glucomannan) are utilized as emollients and moisture-retaining agents in the formulation of creams and gels. Altogether, these natural ingredients enable herbal cosmetic products to surpass basic cosmetic effects and be efficient "medicines for skin" ¹³.



2.3 Formulation Types (Creams, Gels, Serums, Masks)

Herbal cosmetic products are generally categorized depending on their dosage forms as well as the location where they are applied. In the context of dermatology, however, it is important to consider creams, gels, serums, and masks.

2.3.1 Creams and Lotions

The herbal cream formulations typically contain either oil-in-water (O/W) or water-in-oil (W/O) bases, which are mixed with herb extracts, fixed oils, and emulsifiers like stearic acid, glycerine, and waxes. Such creams are made to have moisturizing, occlusive, and phytochemical delivery benefits, and thus are very effective for dry skin types, eczemas, and aged skin types. For example, cold and disappearing creams can be made using herb extracts like those of aloe vera, calendula, and shea butter ¹⁴.

2.3.2 Gels

Gels are semisolid, water or alcohol-based preparations containing herbal extracts in addition to gelling agents like carbomers, tragacanth, xanthan, or natural gums. Since herbal gels are less viscous and not occlusive, these are usually considered ideal for use on acne-prone or oily skin as they allow application of antibacterial or Sebo regulating herbal substances like neem, tea tree, or witch hazel without leaving a greasy

film on the skin. Hydrogels transparent in nature containing aloe vera or green tea extracts are also employed in after-sun care routines and formulations intended for sensitive skin ⁸.

2.3.3 Serums

Serums have high actives content and low viscosity along with being light weight. Usually, herbal extracts and isolated phytochemicals are used in a higher concentration in serums due to their ability to penetrate the epidermis layer and even the upper dermis layers quickly and effectively, which makes them ideal for use in melanogenesis, oxidative stress, or fine lines formulation. For instance, there could be brightening serums made using glabridin-rich licorice extracts or anti-inflammatory antioxidants serums formulated from curcuminoids from turmeric. Solvent system selection plays a major role in their availability and stability¹⁵.

2.2.4 Masks and Packs

Herbal masks are mostly semi-solid and/or paste-like in nature and have short usage time span. These may include clay, milk, or oil-based pastes mixed with the powder of certain herbs such as turmeric, sandalwood, neem, basil, aloe, etc. These are normally used for cleansing, exfoliation or applying highly concentrated extract of herbs on the skin. They are used to treat various skin



ailments such as acne, come done extraction and skin brightening. It is said that application of turmeric lactate-based face mask improves skin quality due to its antioxidant and exfoliating characteristics ¹⁶.

3. Common Skin Diseases Addressed by Herbal Cosmetics

Cosmetics based on herbs have been widely used in the treatment of skin diseases that are common, including acne, eczema, psoriasis, pigmentation diseases, injuries, and effects of aging. The major advantage of these cosmetics is the use of anti-inflammatory, antioxidant, antibacterial properties, and wound healing characteristics of herbs while ensuring reduced toxicity.

3.1 Acne Vulgaris

Acne vulgaris is an ongoing condition that occurs due to inflammation of the pilosebaceous unit and involves formation of comedowns, papules, pustules, and nodules in severe cases, and most often affects teenagers and young adults around the globe. Commonly used topical treatments like benzoyl peroxide and retinoids are effective; however, they have issues regarding irritation, dry skin, and the possibility of antimicrobial resistance because of the prolonged usage of antibiotics. Cosmeceuticals for treating acne are usually made using herbs that act as bactericidal, anti-inflammatory, and sebum regulation substances in the form of gels, creams, foams, and leave-on lotions as represented in fig. 1 ¹⁷.



Fig 1: Acne Vulgaris

Herbal cosmetic preparations containing tea tree oil (*Melaleuca alternifolia*) represent the most popularly used herbals for mild to moderate cases of acne due to their action on

Cuti bacterium acnes, *Staphylococcus* spp., comedolytic property, and anti-inflammatory action. Literature review of herbs used in the treatment of acne has found scientific studies



where tea tree oil used topically, individually or in association with lavender, has shown fewer numbers of inflammatory lesions and improvement in global acne severity when compared to baseline values or placebo, despite small sample sizes and weak designs. Aloe vera gel can add to the effect of other active ingredients in cosmetic preparations by its moisturizing, anti-inflammatory, and protective actions; for example, the addition of Aloe vera gel with *Ocimum gratissimum* oil showed better results in acne when compared to *Ocimum gratissimum* oil ¹⁸.

3.2 Atopic dermatitis and eczema

Atopic dermatitis (AD), along with other eczematous conditions, is a chronic relapsing inflammatory dermatosis associated with itching, dryness and poor barrier integrity that significantly affect the quality of life. The standard treatments of AD include moisturizers, topical steroids, and calcineurin inhibitors; however, fears associated with steroid dependence, adverse side effects caused by prolonged use, and necessity of constant administration of these therapies contribute to the development of alternative therapies in the form of complementary herbal cosmetics.

Herbal cosmetics used in AD treatments are based on plant extracts possessing anti-inflammatory, immunomodulatory and barrier enhancing properties, including

flavonoid-enriched extracts, low concentration essential oils, and mucus and polysaccharides-containing gels used as components of creams and ointments. A systematic review of Asian herbal medicines for atopic dermatitis revealed a number of studies where extracts from *Ficus carica* and other plants were found to reduce severity according to SCORAD and EASI score, as well as relieve pruritus and increase skin hydration. Despite the fact that many of these treatments cannot be considered as pure "cosmetics" from a regulatory perspective, their topical application as creams and ointments is quite similar to herbal cosmeceuticals ¹⁹.

3.3 Psoriasis

Psoriasis is an autoimmune disorder that manifests itself in skin cell hyperproliferation, red scaly patches, and other medical conditions. The treatment options for the condition include topical steroids, calcitriol, and light therapy. Although conventional topical drugs are efficient, they can cause undesirable side effects, including skin atrophy and tachyphylaxis. They are often used in combinations to achieve better results. Herbal cosmetics for psoriasis come in cream, ointment, and bath oil formulas and contain anti-inflammatory, anti-proliferative,



and antioxidative plant components as represented in fig 2 ²⁰.



Fig2: Psoriasis

The findings from a systematic review and meta-analysis of multiple herbal formulations in topical form for psoriasis vulgaris revealed that these multiple herbal formulations were superior to topical placebo and conventional ant psoriatic pharmacotherapy in terms of overall clinical effectiveness, which was measured by more than a 50% decrease in severity. Some common herbs used in these formulations include *Sophora flavescens* and *Lithospermum erythroidine*, whose laboratory data reveal anti-inflammatory, antiangiogenic, and tissue repair properties that can explain their potential clinical effectiveness. In newer systematic reviews of herbal medicine in treating psoriasis, other herbs, including *Mahonia Aquifolium*, *Indigo Naturalis*, and turmeric, among others, have been highlighted as promising herbs for further investigation ²¹.

3.4 Wound healing and scarring

Acute and chronic wounds, which may include minor cuts, abrasions, and post-surgical wounds, are common cases where over-the-counter topicals are applied, and patients seek out natural creams or gels that would help in promoting wound healing while reducing scar formation. Wound healing is a complex multi-stage procedure comprising of processes like haemostasis, inflammation, proliferation, and remodelling, and herbal compounds can influence these phases by acting as antioxidants, anti-inflammatory agents, promoting angiogenesis, and collagen production. Herbal cosmetics used for wound treatment usually come in the form of creams, gels, sprays, hydrogels, and include botanical ingredients like *Aloe vera*, *Centella asiatica*, *Calendula officinalis*, and others as represented in fig. 3 ²².



Fig3: Wound healing and scarring

A survey on creams based on plants to enhance wound healing indicated several scientific and clinical studies, where extracts from plant medicines have shown improvement in wound contraction, epithelialization, and tensile strength. As one such instance, topical application of a cream made of *Eupatorium glandulosa* extract, with 10% concentration, showed significant wound contraction within 8 days of application, indicating high efficacy in wound healing that can be utilized in cosmetics meant for small wounds. Extracts of *Centella asiatica*, commonly referred to as 'coca' creams, have strong antioxidant action with biologically active triterpenoids, which promote collagen formation and dermal matrix structure, hence widely being used in scar cosmetics²³.

4. Key Herbal Ingredients and Their Mechanisms

Ingredients from herbs play a fundamental role in the production of cosmetics that treat skin diseases by using active components such as polyphenols and terpenoids to achieve specific physiological effects. This part discusses some important herbs used in skincare together with their principal active ingredients^{55,57}.

4.1 Aloe vera (Anti-inflammatory, Moisturizing)

Aloe vera gel is extracted from the leaves of the plant known as *Aloe barbadensis* miller and is made up of mucopolysaccharides, glucomannans, vitamins (A, C, E), enzymes, and anthraquinones, which give it the ability to fight inflammation and hydrate. These active ingredients help in binding moisture to the skin, triggering fibroblasts in producing collagen and elastin and softening hard skin cells²⁴.



Mode of action of Aloe vera:

Anti-inflammatory effects are achieved through inhibition of enzymes called cyclooxygenase, leading to low levels of prostaglandin E2, an inflammatory mediator. Brady kinase also helps in reducing inflammation. Furthermore, the metallothionein enzyme ensures that other enzymes, such as superoxide dismutase, are not inhibited by free radicals produced by ultraviolet or gamma radiations²⁵.

4.2Tea Tree Oil (Antimicrobial)

The major constituent responsible for TTO antimicrobial activity is terpinen-4-ol which has antiseptic, antibacterial, antiviral, and antifungal properties. The mechanism of action involves disruption of membrane integrity resulting in rapid disintegration of cell membranes.

TTO is active against transient skin microflora like staphylococci and does not cause any disturbance in the normal microbiota making it ideal for use in treating acne and other infections. TTO demonstrates high activity against multi-resistant organisms, which was evident in a study involving wounds where there was faster healing when using TTO compared to saline²⁶.

The use of a 5% TTO body wash has been found to be efficacious in the management of

MRSA infections among intensive care unit patients, which is helpful in preventing hospital-acquired infections. In the treatment of acne vulgaris, TTO is equally efficacious to benzoyl peroxide²⁶.

4.3Turmeric (Curcumin: Antioxidant, Anti pigmentary)

The curcumin, a phenolic compound from *Curcuma longa*, possesses antioxidant and anti-inflammatory actions via NF-κB and Phosphorylase kinase (PhK). Curcumin has scavenging properties towards ROS, prevents melanogenesis as well as blocks the formation of inflammatory cytokines²⁸.

The therapeutic potential of curcumin in plaque psoriasis lies in its capability to decrease the number and size of the plaques caused due to the proliferation of keratinocytes mediated via PhK. According to a 2011 study conducted on 647 individuals, 72.2% showed resolution of all symptoms after 16 weeks of use of a 2% curcumin gel treatment²⁹.

4.4Green Tea (Polyphenols: Photoprotective)

Epigallocatechin Gallate (EGCG), the major catechin found in green tea (*Camellia sinensis*), acts as a photo protectant by eliminating UV-induced free radicals, blocking H₂O₂ production and lipid



peroxidation reactions, and replenishing antioxidants such as Glutathione Peroxidase. EGCG prevents UV-induced suppression of the immune response and inhibition of ROS-producing CD11b⁺ cells that protect against photodamage, photoaging, wrinkles, and cancer development. Moreover, EGCG's anti-melanogenic effect aids in preventing hyperpigmentation. EGCG's ability to replenish enzymes in the epidermis after³⁰.

4.5 Emerging Herbs (e.g., Licorice, Neem)

The glycoside known as glabridin from Licorice (*Glycyrrhiza glabra*) acts as an inhibitor of tyrosinase to induce depigmentation in cases of melasma and hyperpigmentation, as well as providing an anti-inflammatory property through the

inhibition of cytokines in acne and eczema. It also helps reduce redness by acting as a free radical scavenger³¹.

The Neem tree (*Azadirachta indica*) provides azadirachtin and nimbidin which give it wide spectrum antimicrobial properties, helpful in dealing with acne, psoriasis, and fungal conditions such as ringworm. It is also known for its immune regulatory and epithelial regeneration properties that prevent secondary infections in wounds^{32,54}.

These emerging agents show promise: liquorice in whitening cosmetics and neem tinctures in controlling bacterial proliferation, backed by phytochemical analyses and observational studies³³.

Table:1 Key Herbal Ingredients and Their Mechanisms

S.No.	Herb / Ingredient	Primary bioactive(s)	Main dermatological effects	References
1.	Aloe vera (<i>Aloe barbadensis</i>)	Polysaccharides (ace Mannan), glycoproteins, vitamins	Anti-inflammatory, moisturizing, wound healing, skin-barrier support	47
2.	Tea tree oil (<i>Melaleuca alternifolia</i>)	Terpinen-4-ol, γ -terpinene, α -terpinene	Antimicrobial, anti-acne, anti-inflammatory	48



3.	Turmeric / Curcumin (<i>Curcuma longa</i>)	Curcuminoids (curcumin)	Antioxidant, anti-inflammatory, antipigmentary, anti-acne	49
4.	Green tea (<i>Camellia sinensis</i>)	EGCG, polyphenols	Antioxidant, photoprotective, anti-aging, anti-inflammatory	50
5.	Licorice (<i>Glycyrrhiza glabra</i>)	Glycyrrhizin, glabridin, liquiritin	Depigmenting, anti-inflammatory, soothing of sensitive/eczematous skin	51
6.	Neem (<i>Azadirachta indica</i>)	Azadirachtin, nimbin, flavonoids	Antimicrobial, anti-acne, anti-inflammatory, skin-healing	52

5. Safety, Stability, and Regulatory Considerations

Herbal cosmetics provide natural options for skincare products; however, they need to be studied for their safety because they may be toxic and cause allergies. The main stability problems occur due to the phytochemical matrix present, while regulatory policies may differ across countries.

5.1 Toxicity and Allergic Potential

Herbal products are often considered completely safe because of their natural

origin, although this opinion ignores the fact that there are many cases where toxic effects have been recorded. Tea tree oil, among other herbal products, may lead to contact dermatitis, an irritant reaction, or even systemic toxicity when consumed in large amounts, especially in more vulnerable groups, including children or patients with atopic skin. Aloe Vera, which is widely known for its moisturizing effect, was found to induce allergic contact dermatitis due to anthraquinones present in the latex-contaminated gel preparations; this was



confirmed through patch tests in 10-20% of cases³⁴.

Neem and licorice essential oils carry more risk as *Melaleuca alternifolia* (tea tree) oil tends to cause allergic reactions through oxidative products from terpenes, where limonene and linalool seem to be the main allergens under labelling regulations in Europe. Calendula derivatives that have wound-healing properties have been shown to sometimes cause photo allergies because of sesquiterpene lactones when exposed to UV light. In preclinical data, cytotoxic effects have been reported in keratinocytes from high doses of polyphenol content found in green tea extracts. However, the biggest concern remains the lack of standardization as the inconsistent composition of phytochemicals increases the risk of sensitization; there is 1-5% of adverse events compared to 0.5% for synthetic cosmetics³⁵.

5.2 Herb-Drug Interactions in Topical Use

However, topical herbal cosmetics pose a relatively lower risk of systemic interactions than their oral counterparts. Nevertheless, when skin absorption takes place, it becomes clinically relevant, especially if the skin is damaged. St. John's Wort used in anti-aging cosmetics tends to stimulate CYP3A4 enzymes, thus making topical corticosteroids, like hydrocortisone, ineffective when used in anti-eczema

cosmetics. On the other hand, tea tree oil used in acne cosmetics interacts with antibiotics, like mupirocin, through microbial action inhibition. The 1,8-cineole compound present in tea tree oil makes it absorb glucocorticoids percutaneously, resulting in side effects.

Nevertheless, topical herbal cosmetics have a relatively lower risk of systemic interactions when compared to their oral counterparts. However, with skin absorption, it may become clinically relevant, especially if the skin integrity is compromised. For example, St. John's Wort used in anti-aging cosmetics stimulates CYP3A4 enzymes, hence rendering topical corticosteroids like hydrocortisone ineffective in anti-eczema cosmetics. Likewise, tea tree oil used in acne cosmetics interacts with antibiotics like mupirocin because of microbial action inhibition. The 1,8-cineole constituent in tea tree oil results in glucocorticoids' percutaneous absorption^{36,59}.

5.3 Stability in Cosmetic Formulations

Herbal cosmetics are equally unstable as they contain active ingredients that are easily oxidized, hydrolysed, photolyzed, and decomposed through enzyme action. The polyphenolic compounds present in green tea and the curcumin present in turmeric are unstable in an alkaline environment (pH>7) or temperatures above 40°C; there is 50-70%



loss in effectiveness within three months without the use of antioxidants like tocopherol. The terpenoid present in essential oil is unstable because of volatilization, and the emulsion present in cream separates due to the hydrophilic-lipophilic imbalance caused by the crude extracts of herbs. Moisture ingress causes the hydrolysis of glycoside in aloe vera, resulting in microbial growth with changes in pH from 4.5 to 6.0 within six months³⁷.

Accelerated stability testing (40°C/75% RH) shows organoleptic effects: darkening due to Maillard reaction in licorice-based products and rancid smell due to lipids' oxidation in neem oil. Microencapsulation and freeze-drying increase the period of storage; for example, supercritical CO₂ extraction of arnica keeps sesquiterpene lactones stable for one year compared to six months when extracted using ethanol. Buffering of pH (4.0-5.5) and chelating agents such as EDTA reduce metal-induced oxidation in gels made of Centella. According to ICH Q1A regulations, real-time (25°C/60% RH) and stress testing should be performed; however, the variability of herbs requires the use of phytochemical fingerprints through HPLC³⁸.

5.4 Global Regulatory Frameworks

Regulatory oversight for herbal cosmetics is a fine line between innovations and safety considerations; whereby herbal cosmetics are

viewed as cosmetics and not drugs unless there are claims that require them to be classified as drugs. Herbal cosmetics are regulated in the US by the FDA according to the Modernization of Cosmetics Regulation Act (MoCRA). This Act requires reporting of adverse events and facility registration, but there are no pre-market approvals required. In the herbal ingredients, however, GRAS and cosmetic data are required, but not for tea tree oil due to its vulnerability to adulterations. Under EU's Cosmetics Regulation (EC) No 1223/2009, there are stringent safety evaluations carried out by Responsible Persons, 1,376 substances prohibited because they are dangerous herbs, like thuja, and labelling of any nano ingredient. Annex II gives allergens like oakmoss absolute³⁹.

The AYUSH Ministry of India regulates the Ayurvedic cosmetics through the Drugs and Cosmetics Act (1940) requiring Good Manufacturing Practices (GMP) and Schedule T conformity to ensure the authenticity of the products based on pharmacopoeia standards; heavy metal levels (less than 10 ppm lead) reduce risks of contamination within turmeric-based products. WHO's Guidelines for Good Agricultural and Collection Practices (GACP) promote quality control through traceability across the globe. The Ministry of



Health in Japan imposes quasi-drug regulations on functional herbals such as Koei extracts with stability dossiers. Harmonization using ICH M7 focuses on genotoxic impurities in herbal products; post-marketing surveillance (RAPEX EU) leads to the recall of neem formulations due to their instability⁴⁰.

6. Standardization and Quality Control

The major drawback that faces the use of herbs in cosmetic products is the process of standardization due to differences in composition among herb materials, which depend on a variety of factors such as soil, climate, harvesting, and post-harvesting processes. The use of herbs in cosmetics is different from chemical-based cosmetics since they contain a fixed amount of chemicals, whereas herbs contain different amounts of bioactive components, such as polyphenols and terpenoids, making it hard to achieve reproducibility. According to WHO, the main focus is on macroscopic, microscopic, and chromatographic standards⁴¹.

Authentication of herb materials that can be adulterated is performed using DNA barcoding and metabolomics methods, whereas microbial and heavy metal analysis are performed based on the guidelines of the

United States Pharmacopoeia and International Conference on Harmonization, respectively. Stability studies using the guidelines of the International Conference on Harmonization Q1A reveals that herb extracts are unstable under heat or light conditions, thus antioxidants such as tocopherols are incorporated into the formulation, or alternatively specific packaging material is employed. Even with these developments, local companies in some developing nations like India are unable to adhere to GMP requirements, thereby resulting in the rejection of cosmetic products formulated from herbs by exporting countries⁴².

6.1 Nanotechnology and Novel Delivery Systems

Nanotechnology tackles problems of low bioavailability and skin penetration of herbal components by means of their incorporation into various carriers such as liposomes, nano-emulsions, and solid lipid nanoparticles in sizes of 10-200 nm. For example, inclusion of curcumin into liposomes improves the anti-inflammatory efficacy of turmeric in psoriasis preparations through increased permeability through the stratum corneum by up to five times. Volatile terpenoids of nano emulsified tea tree oil increase antimicrobial efficacy against acne pathogens without causing irritation^{43,56,58}.



Polymers such as chitosan and PLGA facilitate targeted release of aloe polysaccharides, which extend moisturizing properties in atopic dermatitis products. Moreover, Ethosomes and transferosomes, containing edge activators, improve transdermal delivery of green tea catechins used for photoprotection. Cytotoxicity and scalability are issues of nanomaterials; however, FDA-approved nano-cosmetics, including those using chitosan as carrier molecules, demonstrate safety^{44,53}.

6.2 Personalized Herbal Cosmetics

Personalized herbal cosmeceuticals use pharmacogenomics, skin microbiomics, and artificial intelligence-powered diagnostics to create formulations according to personal genetic makeup, skin types, and environmental factors. The technologies of 3D printing of the skin and biosensor patches identify biomarkers such as sebum lipids or cytokine levels to personalize serums by creating herb ratios suitable for individual patients. Apps combining selfies and machine learning can predict hyperpigmentation risks and suggest neem-calendula mixture⁴⁵. Personalized cosmeceuticals using at-home DNA samples provide skin microbiome-matched probiotics together with herbs as prebiotics, dealing with variations in eczema.

Regulatory challenges remain because personalized cosmeceuticals fall into the Gray zone between cosmetics and pharmaceuticals according to EU MDR rules, which means that each item requires approval individually. In pilot programs, the efficiency of interventions against aging has already been increased by 30-50%⁴⁶.

Conclusion

Herbal cosmetics may become a new revolutionary concept in dermatology management as they combine centuries-old knowledge and contemporary technology. This review is aimed at proving their efficiency in dealing with various widespread skin problems such as acne, eczema, psoriasis, hyperpigmentation, wounds, and aging. Active components like Aloe vera, tea tree oil, turmeric, green tea, Calendula, and Centella asiatica have anti-inflammatory, antimicrobial, antioxidant and wound-healing effects with a higher level of safety compared to synthetic analogues.

Despite the evidence of their efficacy based on historical and chemical data, the only scientifically proven advantages can be mentioned concerning widely studied plants, which requires further standardization of products, innovative technologies (e.g., nano formulations), and personalization of treatment. As far as safety issues are concerned, potential allergies, poor stability



and other risks should be taken into consideration, but modern FDA/EU/AYUSH regulatory frameworks allow dealing with these concerns.

It goes without saying that herbal cosmetics present an effective tool for addressing the current skin problems across the globe. Thus, more research, quality control measures and innovations may result in wider application of herbal cosmetics in dermatological practice.

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