Review Of Herbal Sheet Mask

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***Abstract*—Customers' growing desire for natural and eco-friendly skincare products is driving growth in the market for herbal cosmetic formulations. Herbal face mask sheets have gained popularity among them due to their ease of use, effective distribution of bioactive ingredients, and lack of negative side effects compared to their synthetic counterparts. Occlusion, hydration, and enhanced skin penetration of herbal active ingredients are the mechanisms through which these sheet mask's function. The review identifies a number of herbal ingredients used in sheet mask formulations for skin protection and rejuvenation that have proven pharmacological benefits. These include Centella asiatica (wound-healing, collagen synthesis), Moringa oleifera, Punica granatum, Ocimum sanctum, Melaleuca alternifolia (antibacterial, anti-acne), Curcuma longa (anti-inflammatory, antioxidant), and Coffea arabica. Natural Fibers such as cotton, bamboo, or sheets of bio cellulose impregnated with hydrogel or serum bases containing humectants, essential oils, and herbal extracts are typically used in formulation design. Among the evaluation factors are tests for skin compatibility, stability, moisture content, pH, viscosity, and microbiological load. Recent studies have demonstrated that using sheet masks made of herbal ingredients can significantly improve skin tone, hydration, and the reduction of pigmentation or acne (2019–2025). Future prospects include the use of nanocarrier systems (liposomes, Nano emulsions), customized formulations based on skin type or aromatherapy principles, and biodegradable hydrogel sheets. The review emphasizes the need for more clinical validation, safety evaluation, and widespread commercialization in order to fully realize the medicinal and cosmetic potential of herbal sheet masks.**

***Index Terms*—Curcuma longa skincare beneficently, Centella asiatica wound healing, Tea tree oil antimicrobial properties, Pomegranate peel extract antioxidant, Moringa oleifera skin benefits, green coffee extract skincare, Rose water hydrating properties, Glycerine humectant properties, Tulsi extract antibacterial, binoculuses mask substrate.**

I. INTRODUCTION

Face masks have evolved from traditional clay and poultice treatments to sophisticated delivery systems that deposit active ingredients and restore skin homeostasis. Modern mask forms have developed to include creams, gels, hydrogel patches, bio cellulose, and the widely used single-use sheet mask in order to optimize contact duration, occlusion, and targeted component delivery. Masks are an essential adjunct in cosmetic dermatology for targeted treatment, hydration, and barrier repair because of recent studies showing how advancements in substrate materials (like hydrogel and bio cellulose) and mask engineering have improved adhesion, moisture retention, and transdermal active delivery.[1]

Meanwhile, there have been notable sales and research trends for herbal and eco-friendly skincare products. Botanicals are preferred by consumers and formulators due to their perceived naturalness, multifunctional bioactivity (antioxidant, anti-inflammatory, and antibacterial), and often lower environmental impact when obtained responsibly. [2]The distinct phytochemicals that each of these botanical extracts curcuminoids, terpinen-4-ol, Asiatic sides, punicalagins, isothiocyanates, chlorogenic acids, flavonoids, and eugenol/unsolid acids, respectively bring make them desirable for topical cosmetic application.[3] These consist of tulsi (Ocimum spp.), pomegranate peel, moringa, green coffee, tea tree oil (Melaleuca alternifolia), turmeric (Curcuma longa), and rose preparations. The functions of these herbs in wound healing, inflammation reduction, antioxidant protection, and sebum/antimicrobial regulation are becoming more and more supported by preclinical and clinical data.[3]

Sheet masks offer several advantages over conventional creams or gels when it comes to applying herbal active ingredients in cosmetic procedures. The occlusive/semi-occlusive microenvironment enhances skin hydration and can temporarily improve stratum

corneum permeability to actives; they provide close, consistent skin contact that enhances percutaneous penetration and prevents volatile actives from evaporating quickly; single-use sheet formats enable the incorporation of delicate botanical extracts, lowering the risk of contamination and preservatives and making it easier to standardize dosage per application; and new substrates, like hydrogel and biocellulose, can be created to control release kinetics and comfort for different skin types. When these qualities are combined, sheet masks offer a convenient and efficient method of combining multiple herbal actives (like glycerin, turmeric, Centella, and rose water) in one application.[4]

The purpose of this review. This review compiles formulation strategies, claimed and evidence-based benefits, and evaluation methods for herbal sheet masks that contain pomegranate peel, moringa, turmeric, tea tree oil, Centella asiatica (Gotu kola), green coffee, rose water/rose extracts, glycerin, tulsi, and pomegranate peel.[5] We give a summary of the following: (a) why these botanicals were chosen; (b) practical formulation considerations for sheet-mask vehicles (substrate selection, serum composition, stability, and preservative strategy when using botanicals); (c) frequently used in-vitro and in-vivo evaluation endpoints (antioxidant assays, hydration/TEWL, irritation/patch testing, antimicrobial and clinical efficacy endpoints); and (d) gaps and future directions for standardization and evidence generation.[5]

II. CONCEPT OF THE HERBAL SHEET

A. Definition

Herbal sheet masks are single-use topical facial treatments of a pre-cut sheet substrate soaked in a hydrating, active-rich serum that usually contains botanical extracts (like tulsi, aloe vera, turmeric, and Centella asiatica) and functional excipients (like humectants, film formers, and preservatives). The sheet creates a controlled, occluded microenvironment that holds and delivers water-soluble and some lipophilic plant actives to the skin's surface.[6]

B. Mechanism of action

1. Occlusion and increased skin hydration: The sheet reduces transepidermal water loss (TEWL), increases stratum corneum permeability, and improves skin surface hydration by forming a semi-occlusive barrier over the skin that facilitates the diffusion of active molecules into the superficial layers of the skin. Short-term occlusion caused by sheet masks has been linked to increased hydration and the activation of water-transport proteins (AQP3, for example). On the other hand, prolonged or inappropriate occlusion may temporarily damage the skin barrier in sensitive individuals.[7]

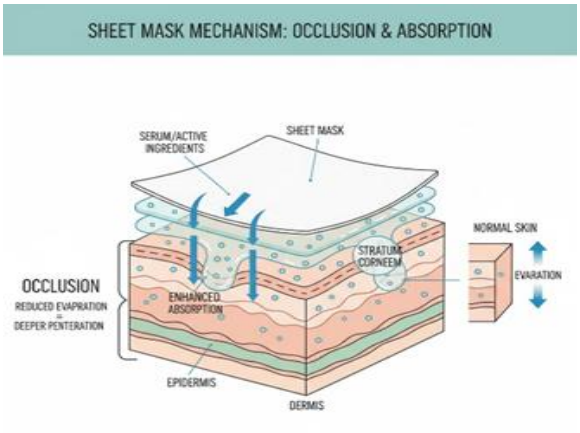

Fig1. Sheet mask mechanism

2. Enhanced delivery of the active ingredient: The combination of intimate sheet skin contacts and a high serum load prolong the duration of residence of the actives on the skin and promotes their absorption, in contrast to a similar leave-on cream applied without occlusion. Biocellulose and other advanced substrates can store large amounts of serum while facilitating reliable active ingredient transfer.[8]

3. Physical-chemical facilitation: Humectants (like glycerin and hyaluronic acid) in the serum draw water into the stratum corneum; low-molecular-weight botanical actives can also penetrate the stratum more easily thanks to penetration enhancers and the loosening of corneocyte packing caused by hydration.[8]

C. Types of mask materials

Fig 2. Types of mask material

- Cotton (non-woven cotton): which is widely used, affordable, comfortable, and highly absorbent, may not conform as well as more advanced substrates and may administer serum less reliably.[9]
- Bamboo fibre and yarns: derived from plants are marketed as more ecologically friendly alternatives; they are commonly used in "organic" mask lines and offer good breathability and softness.[9]
- Bio-cellulose: also called bacterial cellulose, is a fine-fibre network that resembles hydrogel and is produced by bacteria like Acetobacter. Because of its excellent skin adherence, high liquid-holding capacity, cooling sensation, and efficient active transfer, biocellulose is a preferred matrix for clinical and luxury masks.[10]
- Hydrogel and hydrogel-composite sheets: are used to create an occlusive, cooling coating on sensitive or post-procedure skin due to their gentle adherence and controlled release.[10]

D. Desirable characteristics of sheet mask substrates:
Softness and conformability to facial contours; controlled porosity to create semi-occlusion; biocompatibility and low potential for irritation; high serum absorbency and retention (so the sheet remains saturated until it is applied); and, ideally, biodegradability or compost ability to reduce environmental burden. For herbal formulations, the chemical inertness of the substrate is essential to avoid reactions with the botanical ingredients.[11]

E. Advantages of herbal sheet masks
- Concentrated distribution of botanical actives: enables the rapid, powerful application of antioxidants, calming agents, or anti-inflammatory botanicals with less systemic exposure than oral formulations.[12]
- Patch testing is recommended for people with sensitive skin or botanical allergies, but topical application of well-characterized herbal extracts in low-irritancy carriers frequently has fewer systemic adverse effects than oral herbal usage. [12]
- User comfort and reproducibility: Pre-measured dosages and regular application times improve user compliance and effect repeatability. [13]
- Creating greener alternatives: efforts are being made to reduce the environmental impact of single-use masks without compromising functionality through the development of bio-based and biodegradable sheet substrates (such as improved bio-based sheets and fibers derived from plants).[13]

III. KEY HERBAL INGREDIENTS AND THEIR PHARMACOLOGICAL ROLES

1. Turmeric (Curcuma longa)

Turmeric, and particularly its primary active ingredient, curcumin, has been extensively studied for dermatological applications. Curcumin has anti-inflammatory, antibacterial, antioxidant, and possibly anti-hyperpigmentation/photoprotective qualities. [14]

By inhibiting key inflammatory mediators and signaling pathways, including NF-κB, COX-2, and TNF-α, curcumin lowers cytokine production and cutaneous inflammation. [14]

In skin disease models, topical 1% curcumin gel reduced epidermal hyperplasia, improved histopathology, and prevented imiquimod-induced inflammation. [15] By scavenging reactive oxygen species (ROS) and strengthening antioxidant defenses (e.g., upregulating SOD, catalase, glutathione), it guards against oxidative stress. [15]

Curcumin also has antibacterial qualities (against bacteria and fungus) by breaking down microbial membranes and inhibiting microbial enzymes. [16] In terms of pigment modulation and photoaging, curcumin inhibits melanogenesis and lessens UVB-induced damage (such as UV-induced inflammation, DNA damage, and epidermal thickening). [16]

Clinical and review studies in dermatology show that curcumin is generally safe and well tolerated in topical or oral forms, despite its well-known drawback of poor bioavailability, especially when taken orally.[17]

Thus, curcumin is a multipotent phytochemical that is effective in skin care products that address inflammation, oxidative damage, photoaging, and blemishes.[17]

Fig 3 Curcuma Longa

2. Tea Tree Oil (Melaleuca alternifolia):

Tea tree oil (TTO), a volatile essential oil, possesses antibacterial, anti-inflammatory, and antioxidant properties. In dermatology, it is particularly used to treat acne and microbial skin conditions.[18]

TTO exhibits broad-spectrum antibacterial activity against Propionibacterium acnes (now Cutibacterium acnes) and other skin infections by rupturing cell membranes, increasing permeability and inhibiting cell respiration. [18]

In studies on human acne, TTO improved the appearance of the skin and reduced the quantity of inflammatory lesions (papules, pustules); in one famous experiment, 5% TTO gel was compared to benzoyl peroxide. [18]

Its anti-inflammatory and antioxidant qualities help to lessen the localized inflammation in acne lesions.[19]

TTO can be formulated as gels or sustained-release solutions to reduce irritation and improve tolerance in skin applications.[19]

However, caution is required due to its potential to cause sensitization or allergies, particularly when it oxidizes; concentrations higher than 1% are typically avoided in cosmetic applications. [20]

As long as formulation design ensures stability and safety, TTO's antibacterial and calming properties make it a beneficial addition to acne regimens overall.[21]

Fig 4 Melaleuca alternanulia

3. Centella asiatica Gotu Kola:

Centella asiatica, commonly referred to as gotu kola, is well known for its anti-inflammatory, antioxidant, and collagen-promoting qualities, which make it good for acne, scars, and skin repair.[22]

Its main bioactive triterpenoids asiatic acid, madecassoside, madecassic acid, and asiatic acid promote fibroblast proliferation, collagen (types I and III) deposition, and extracellular matrix remodeling.[23]

By accelerating wound closure and angiogenesis, it aids in the restoration of damaged skin.[23]

Numerous studies (including recent meta-analyses) have demonstrated that Centella asiatica has minimal negative effects while promoting skin recovery and reducing inflammatory and non-inflammatory acne lesions. [24]

Furthermore, it lowers inflammatory mediators (like TNF-α, IL-1, and IL-6) and oxidative stress in skin tissues.[24]

Its effectiveness is synergistic when combined with other antioxidants (e.g., in emulgels), as demonstrated by formulations that combine Centella and Moringa[24]

Fig 5 Centella asiatica

4. Pomegranate Peel Extract

Polyphenols like gall26ic acid, punicalagin, and ellagic acid, which have strong anti-inflammatory, anti-melanogenic, antibacterial, and UV-protective qualities, are abundant in pomegranate (Punica granatum) peels. [25]

The peel extract's phenols scavenge free radicals, reduce lipid peroxidation, and fortify the skin's antioxidant defenses. [25]

By demonstrating antibacterial activity, including against Staphylococcus aureus and other skin flora, it aids in the restoration of microbial equilibrium. News on Medicine Its components inhibit tyrosinase, which reduces hyperpigmentation and melanin synthesis. [26]

According to UV studies, pomegranate peel or extract reduces oxidative stress and DNA damage in skin cells, thereby preventing UVB-induced damage.[27]

As a result, pomegranate peel extract's brightening and protective qualities enhance acne and scar treatment.[27]

Fig 6 Pomegranate peel

5. Moringa (Moringa oleifera)

The leaves, seeds, and extracts of the nutrient-dense plant Moringa oleifera have anti-inflammatory, antibacterial, antioxidant, and wound-healing properties. These characteristics are crucial for managing skin that is irritated and prone to acne. [28]

glucosinolates, vitamins, and other substances that support its biological Phytochemical profiling is used to identify flavonoids, phenolic acids, activities. [29]

In wound-healing models, moringa extract (e.g., 10% formulations) reduced scarring while increasing fibroblast proliferation, angiogenesis, and re-epithelialization. [30]

Because of its antibacterial properties against Staphylococcus aureus, Escherichia coli, Pseudomonas, and other bacteria, it can be used to control skin pathogens. [31]

The integrity of the dermal matrix is supported by anti-aging activities such as the inhibition of collagenase, elastase, and hyaluronidase.[31]

The addition of Centella asiatica enhances the antioxidant capacity in a synergistic manner, promoting better skin protection and healing

Therefore, moringa can be used in a variety of formulations that address inflammatory/acneic skin, microbial control, and tissue regeneration.[32]

Fig 7 Moringa

6. Gotu Kola + Green Coffee Extract (Combination)

Centella asiatica (Gotu Kola) and green coffee extract combine to create a synergistic blend of antioxidant, photoprotective, and anti-inflammatory qualities that can help with acne, scarring, and skin tone improvement. [33]

By influencing overlapping pathways, the two may improve collagen and barrier repair in addition to modifying pigmentation (e.g., reducing ROS, inflammatory mediators).[33]

Green coffee extract contains chlorogenic acids and other polyphenols that inhibit melanogenesis and reduce oxidative stress.[34]

Some experimental formulations (like emulgels) show enhanced antioxidant and anti-inflammatory metrics when Gotu Kola is mixed with other plant extracts, like Moringa; on the other hand, mixing with green coffee can boost efficacy. [35]

Taken together, the combination exhibits promise for multi-target skin care by lowering inflammation, halting oxidative damage, and hastening the healing process.[35]

7. Base Ingredients: Rose Water, Glycerin, Tulsi Extract

They serve as both functional carriers and support agents:

Rose water is a gentle toner and calming agent with mild anti-inflammatory and moisturizing qualities.[36]

Glycerin is a conventional humectant that hydrates the skin by drawing water to the stratum corneum. [36]

Tulsi (Ocimum sanctum) extract's antibacterial, antifungal, and detoxifying qualities support relaxation, microbial balance, and skin cleansing. [36]

When used in the proper amounts, these fundamental components enhance the overall efficacy, hydration, and tolerance of the active herbal compounds.[36]

IV. RESULTS FROM RECENT STUDIES (2019–2025)

A. In brief

Between 2019 and 2025, there was a notable increase in the clinical and experimental literature on the ingredients in herbal sheet masks. Studies on three common active ingredients curcumin (turmeric), tea tree oil (Melaleuca alternifolia), and Centella asiatica when added to topical formulations or mask products demonstrated measurable improvements in

inflammatory outcomes, skin barrier repair, and post-procedural recovery. The literature is heterogeneous in terms of formulation type, active concentration, and results, which complicates head-to-head comparisons.[37]

B. Turmeric and curcumin-based formulations

Topical curcumin formulations have been researched for their anti-inflammatory, anti-photoaging, and antioxidant qualities. Systematic reviews and clinical summaries up until 2023–2024 show encouraging signs for a decrease in erythema, sebum production, and indicators of oxidative stress, despite the fact that most RCTs are modest and use a range of formulations (gels, creams, photodynamic delivery).[37] A 2024 study described curcumin-mediated photodynamic treatment (Curcumin-PDT) as having good safety and increasing lesion counts for mild-to-moderate acne. Curcumin seems to have promise as an adjuvant topical treatment for inflammation and photodamage, despite the lack of large, trustworthy RCTs with standardized dosages at this time.[38]

C. Crucial clinical points

- Topical curcumin reduced inflammatory markers and improved clinical indicators in a few short-term trials; however, there were several common problems, including small sample sizes and different delivery systems.[39]
- Innovative delivery systems (like photodynamic methods or nano formulations) improved skin penetration and clinical effect of curcumin in early studies[39]

V. TEA TREE OIL, OR MELALEUCA ALTERNIFOLIA

A 2019–2023 evidence synthesis found that tea tree oil has been consistently supported by RCTs in mild-to-moderate acne. Although sensitive individuals may experience local discomfort, topical formulations (typically 3–5% gels) reduced lesion counts and had fewer systemic side effects than some conventional treatments. Effectiveness is reaffirmed even though recent evaluations through 2023 emphasize the significance of standardizing concentration and vehicle for repeatable outcomes[40].

A. Crucial clinical points

- Tea tree oil formulations have demonstrated statistically significant reductions in both inflammatory and non-inflammatory acne lesions over an 8 12week period in multiple experiments.[41]
- Patch testing is recommended for sensitive skin; while contact dermatitis and local irritation are possible side effects, they are frequently less common than those of some topical drugs.[42]

B. Topical medications and masks containing Centella asiatica

Centella asiatica (madecassoside/asiaticoside) has drawn a lot of interest because of its anti-inflammatory, collagen-stimulating, and barrier-restoring capabilities. A randomized, two-center controlled trial of a commercially available Centella repairing face mask revealed improvements in investigator global scores for rosacea and barrier metrics when used in conjunction with traditional therapy. This suggests that Centella masks can speed up symptom relief and barrier restoration. In split-face and post-procedure studies, formulations containing centella were found to improve hydration, reduce post-inflammatory hyperpigmentation, and accelerate healing after resurfacing procedures. According to molecular/cellular studies published in 2024–2025, enriched Centella preparations are also associated with upregulated collagen production and antioxidant gene expression.[43]

C. Crucial Experimental and Clinical Information

- Centella mask use (typically two to three times per week for four to six weeks) improved subjective and objective indicators of barrier function and reduced erythema in rosacea and post-procedural settings.[43]
- Through cultivation and extract optimization (increased active content), collagen and barrier-related gene expression in vitro were further enhanced. These preclinical results support clinical findings of faster healing.[44]

D. A comparative study with practical applications

- Effectiveness: When it comes to reducing lesions in inflammatory acne, tea tree oil provides the best and most trustworthy RCT data. Curcumin shows promise despite the inconsistent data, especially

with better delivery methods. Centella is more effective at barrier restoration, erythema reduction, and post-procedure recovery than it is at treating primary acne.[44]

- Safety: Tea tree oil may cause local irritation; Centella is generally well tolerated with mild irritancy in most trials; topical curcumin preparations are generally well accepted but can discolor skin and clothing and rarely cause contact responses.[45]
- Limitations in the literature: Heterogeneous formulations (masks, creams, gels), uneven active concentrations, short follow-up periods, small sample sizes, and variable results make direct quantitative comparisons difficult. A number of recent and ongoing research trials aim to standardize dosage and regimen in order to provide insight into comparative efficacy.[45]

VI. ADVANTAGES

Fig 8. Advantages

1. Natural appearance, biocompatibility, and safety: Natural extracts (from plants, algae, microorganisms, etc.) are usually seen by consumers seeking "clean-label" or "green" products as safer, more biocompatible, and more palatable. Many natural antibacterial compounds, or GRAS (Generally Recognized As Acceptable) substances, are recognized as suitable alternatives to synthetic preservatives.[46]
2. It is multifunctional: due to its antimicrobial, antioxidant, and other bioactivities. Natural extracts often offer additional benefits beyond preservation, including flavor/aroma, UV protection, antioxidant, anti-inflammatory, and skin-soothing properties. This multifunctionality may eliminate the need for multiple additives.[47]
3. Eco-friendly and sustainable: These extracts usually help achieve sustainability goals, reduce reliance on artificial petrochemical preservatives, and have a smaller environmental impact because they come from renewable natural sources, biowaste, or by-products.[47]
4. Reduced Resistance Risk/Limited Toxicity (in certain situations): Some natural substances, especially those that contain complex combinations of bioactives (phenolics, terpenoids, etc.), may have antimicrobial activity across multiple targets, reducing the likelihood of microbial resistance developing. Furthermore, they might not be as damaging or irritating as potent synthetic antimicrobials (though this needs to be verified case by case).[48]
5. Attract Customers and Stand Out in the Market: Product positioning can be improved, consumer or regulatory demands for products with minimal or no additives can be met, and a marketing advantage can be gained by using the "natural" label.[49]

VII. LIMITATIONS AND CHALLENGES

1. Bioactive Compound Instability/Degradation: Many natural extracts are less chemically stable than synthetic molecules; they may break down when exposed to heat, light, oxygen, pH, or storage time, which could result in byproducts or a loss of effectiveness. For instance, phenolic compounds may undergo oxidation, essential oils may undergo isomerization or volatilization, or polymerization or enzymatic degradation may take place.[50]
2. batch to batch Standardization and Variability: Because of variations in cultivar, geographic origin, harvest time, extraction technique, and plant maturity, natural sources (plants, extracts) are unpredictable, making standard dosing and reproducibility difficult.[50]
3. Reduced Potency and Restricted Activity Spectrum: Certain natural antimicrobials may only be effective against particular germs (e.g., Gram-positive vs. Gram-negative) or may be less effective than synthetic preservatives. The high concentrations needed to achieve high microbial

kill or broad-spectrum protection may affect the product's safety or sensory aspects. [50]

4. Possible Synergistic or Antagonistic Relationships: Natural materials may cause incompatibility or reduced efficacy when combined with other formulation ingredients (pH buffers, emulsifiers, surfactants, and pigments). They may also become destabilized by the matrix environment, which consists of lipid and water phases.[50]
5. Risk of Microbial Growth and Contamination: Because they often contain leftover proteins, carbohydrates, or water, natural extracts themselves can promote microbial growth or contamination if handled or stored incorrectly. Without effective preservation, formulations could become contaminated, putting their safety and shelf life in jeopardy. [51]
6. Shorter Shelf-Life and Reduced Storage Stability: Careful packing, cooling, or other stabilizing methods may be required for products that solely use natural extracts because of the instability and potential for microbial spoiling.[51]
7. Scaling up and cost/economical constraints: Their economic viability may be limited by the high cost of extracting, purifying, standardizing, and stabilizing high-quality natural extracts on an industrial scale, as well as the possibility of limited output.[51]
8. Regulatory and Safety Concerns (Toxicity/Allergenicity): Even "natural" substances can have negative effects, be cytotoxic, or trigger allergic reactions. Regulatory approval requires extensive safety testing. Furthermore, at higher dosages required for antibacterial efficacy, safety margins must be ensured.[51]
9. Oxygen, Anaerobic Microbes, and Penetration Issues: The ability of natural antimicrobials to diffuse or penetrate into particular microenvironments (like emulsions or interfaces) may be limited, and while certain delivery methods (like pumps and airless packaging) may lessen contamination, they may not prevent the growth of anaerobic bacteria. [52]
10. Effects on the Organoleptic and Sensory Systems: Overuse of natural extracts (like essential oils or phenolic compounds) may change the product's acceptability by introducing undesirable changes in texture, color, taste, or odor. As a result, their useful concentration is constrained.[52]

VIII. FUTURE PROSPECTS

The use of sheet masks made possible by nanocarriers is a significant trend in next-generation topical cosmetics. The addition of nano emulsions, liposomes, ethosomes, and other nanoscale carriers to mask serums can improve solubility, protect labile botanicals, and increase the active ingredients' skin penetration and bioavailability in comparison to conventional formulations. Additionally, by enabling targeted or prolonged administration to different skin layers, these carriers enable the encapsulation of hydrophilic and lipophilic phytoconstituents, which can enhance the efficacy of anti-inflammatory, antioxidant, and wound-healing treatments.[54]

The development of hydrogel-based, biodegradable sheet substrates with controlled-release properties is another intriguing area. Hydrogel matrices, which are made of natural or environmentally friendly synthetic polymers, have a high-water content, excellent skin adherence [55], and a cooling or soothing sensation. For diffusion-controlled release of encapsulated nano-actives, they also provide mesh sizes that can be adjusted. Combining hydrogel sheets with nanocarriers (a "carrier-in-matrix" technique) enables dual control. While the carrier controls release and skin transport, the hydrogel controls residence duration and macromolecular diffusion, enabling longer contact and more gradual administration.[56]

Personalization and multimodal sensory integration will impact consumer adoption. Thanks to developments in rapid skin-type tests and custom formulation platforms, single-use masks can now be customized to a person's sebum level, moisture content, sensitivity profile, or cosmetic concern (e.g., hyperpigmentation vs. acne). [57]Meanwhile, adding low-dose aromatherapeutic volatile profiles (in microencapsulated or controlled-release reservoirs) may enhance user experience without compromising the stability of the primary active ingredients, opening up possibilities for "efficacy + wellness" mask concepts.[58]

Safety, scalability, and regulation are crucial for commercial translation. Even though many nanocarriers are biocompatible, extensive safety testing is required to ascertain how they affect photostability, long-term accumulation, skin irritation, and the environmental fate of biodegradable components.[59] Scale-up concerns (reproducible

particle size, sterilization, and stability during storage) and clear labeling/regulatory guidance must be addressed if nano-enabled cosmetics are to win over consumers and receive regulatory approval. Future studies should employ life-cycle analyses and standardized in vitro–in vivo correlation models to quantify both environmental impacts and performance enhancements.[60]

More sustainable, longer-acting, and more potent sheet masks are made possible by the combination of nanocarrier technologies, biodegradable hydrogel substrates, and a customized aromatherapeutic profile.[61] Among the short-term research priorities are standardizing safety testing and environmental evaluations for biodegradable mask materials, validating skin-diagnostic → formulation workflows for customization[62], and enhancing carrier-hydrogel compatibility for maximum active retention and release control. These steps will help herbal sheet masks utilizing nanotechnology move from niche novelties to evidence-based cosmeceuticals.[63]

IX. CONCLUSION

In the current review, the therapeutic potential and formulation opportunities of herbal sheet masks are examined using bioactive plant ingredients such as Curcuma longa (turmeric), Melaleuca alternifolia (tea tree oil), Centella asiatica, Punica granatum (pomegranate peel), Moringa oleifera, Coffea arabica (green coffee), rose water, tulsi, and glycerin. Since each of these herbal ingredients has distinct pharmacological effects, including anti-inflammatory, antioxidant, antibacterial, wound-healing, and skin-brightening properties, they are all excellent candidates for cosmeceutical applications.

Formulation design is crucial to the stability, safety, and efficacy of these herbal sheet masks. Biocompatible and biodegradable materials such as cotton, bamboo fiber, or bio-cellulose improve skin adherence, moisture retention, and user comfort. Combining hydrogel matrices with nanocarrier systems has several advantages, including enhanced skin penetration and controlled active release.

Safety and consumer acceptance remain critical factors for the success of herbal cosmetic formulations. Although herbal sheet masks are a more natural and eco-friendlier alternative to synthetic ones, issues like microbial contamination and a shorter shelf life must be resolved with the right standardization and preservation methods.

Future research should concentrate on long-term safety assessments and dermatological testing to confirm these formulations clinically. Furthermore, the growing consumer demand for environmentally friendly skincare products presents herbal sheet masks with significant economic potential, encouraging collaboration between academic research and the cosmetics industry to develop standardized, scientifically validated, and globally recognized herbal cosmeceuticals.

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