



NATURAL SOURCES IN SKIN CARE AND DERMATOLOGICAL THERAPY: A COMPREHENSIVE REVIEW

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ABSTRACT

Human skin functions as the primary protective barrier against physical, chemical, microbial, and ultraviolet-induced damage while also contributing to thermoregulation, sensory perception, and immunological defense. Increasing concerns regarding the adverse effects of synthetic cosmetic ingredients have accelerated global interest in natural and plant-derived skin care products. This review comprehensively summarizes the role of natural sources in modern skin care and dermatological applications, with emphasis on herbal extracts, vegetable oils, natural butters, bioactive phytochemicals, and traditional botanical remedies supported by contemporary scientific evidence. The review discusses fundamental aspects of skin biology, including skin types, patch testing, and essential nutrients involved in maintaining skin integrity and

function. Various topical dosage forms such as creams, lotions, gels, ointments, balms, oils, suspensions, and powders are critically evaluated with respect to formulation strategies and therapeutic relevance. In addition, major natural ingredients including aloe vera, green tea, turmeric, calendula, chamomile, shea butter, and essential oils are examined for their phytochemical composition, mechanisms of action, pharmacological properties, and dermatological benefits. Practical considerations in herbal skincare formulation, including sanitation, ingredient selection, preservation, and storage stability, are also highlighted. Furthermore, the review addresses current advances in natural cosmeceuticals, phytochemical delivery systems, and evidence-based dermatological applications. Despite promising therapeutic potential, challenges such as standardization, stability, safety evaluation, and regulatory compliance remain significant. Overall, this review provides a concise scientific

resource for researchers, dermatologists, cosmetic scientists, and pharmaceutical professionals involved in the development and evaluation of natural skin care formulations.

KEYWORDS: Natural skin care, herbal cosmetics, cosmeceuticals, phytochemicals, dermatology, botanical extracts, skin formulations, antioxidants.

INTRODUCTION AND SKIN FUNDAMENTALS METHODS OF LITERATURE SEARCH

Relevant literature was collected from PubMed, Scopus, Google Scholar, ScienceDirect, and Web of Science databases published between 2000 and 2026. Keywords including “natural skincare”, “herbal cosmetics”, “cosmeceuticals”, “botanical dermatology”, “phytochemicals”, and “skin formulations” were used for article retrieval. Peer-reviewed articles, clinical studies, systematic reviews, and dermatological research papers written in English were included in the review.

1.1 INTRODUCTION

Human skin is the largest organ of the body, accounting for approximately 15–20% of total body weight and covering a surface area of 1.5–2.0 m² in an average adult.^[1] It functions as a dynamic interface between the internal milieu and the external environment, performing thermoregulation, sensory perception, vitamin D synthesis, and immunological surveillance.^[2]

The concept of utilizing plants and natural materials for skin care predates written history. Ancient Egyptians employed castor oil, almond oil, and shea butter as emollients; Ayurvedic practitioners formulated turmeric and neem preparations for inflammatory skin conditions; and Traditional Chinese Medicine (TCM) leveraged numerous botanical extracts for cosmetic and therapeutic applications.^[3]

The global cosmetics and personal care market reached USD 430 billion in 2023 and is projected to surpass USD 580 billion by 2027, with the natural and organic segment growing at the fastest compound annual growth rate (CAGR) of 9.7%.^[4] Consumer concerns regarding synthetic preservatives (e.g., parabens), petrochemical emollients (e.g., mineral oil), and endocrine-disrupting chemicals (e.g., phthalates) have driven substantial interest in plant-derived alternatives.^[5]

Phytochemicals such as polyphenols, flavonoids, terpenoids, and alkaloids demonstrate

antioxidant, anti-inflammatory, antimicrobial, and photoprotective activities that are directly relevant to dermatological health.^[6] Cosmeceuticals, a term coined by Kligman in 1980, bridge the regulatory gap between cosmetics and pharmaceuticals, comprising products that exert biologically active effects on the skin beyond simple beautification.^[7]

This review provides a structured, comprehensive examination of natural sources for skin care and dermatological treatment, integrating contemporary scientific evidence with traditional knowledge to guide formulation science and clinical application. Despite increasing global interest in herbal and plant-derived skin care products, there remains fragmentation in scientific evidence regarding their formulation strategies, mechanisms of action, and dermatological efficacy. Therefore, this review aims to integrate traditional knowledge with recent pharmaceutical and dermatological research.

1.2 Skin Types

Understanding skin type is foundational to selecting appropriate natural skin care ingredients and formulations. Fitzpatrick's classification system, established in 1975 and refined subsequently, remains the standard clinical tool for categorizing skin based on its response to ultraviolet (UV) radiation.^[8]

Clinically, skin is broadly categorized into five types based on sebum production, hydration, and sensitivity

- i. Normal skin: Balanced sebum secretion, adequate hydration, minimal sensitivity, fine pores. Represents the ideal skin condition with an intact stratum corneum lipid barrier.
- ii. Dry skin (Xerosis): Reduced sebum production, trans-epidermal water loss (TEWL) > 10 g/m²/h, impaired barrier function. Associated with low ceramide content in the stratum corneum.
- iii. Oily skin: Sebaceous gland hyperactivity, enlarged pores, propensity for acne vulgaris. Sebum excretion rate exceeds 300 µg/cm²/3h.
- iv. Combination skin: Oily T-zone (forehead, nose, chin) with normal to dry cheek areas. Most common skin type in adult populations.
- v. Sensitive skin: Heightened reactivity to cosmetic ingredients, environmental triggers, and physical stimuli. Characterized by subjective symptoms (stinging, burning, pruritus) and objective signs (erythema, scaling).

Lueangarun et al. (2021) demonstrated that skin type classification significantly influences the

penetration rate and bioavailability of topically applied phytochemicals, Skin type significantly influences the penetration and bioavailability of topical phytochemicals due to differences in barrier integrity and sebum composition the penetration and bioavailability of topical phytochemicals due to differences in barrier integrity and sebum composition of hydrophilic actives compared to oily skin due to altered barrier function.^[9]

Natural ingredients such as aloe vera gel are particularly effective for sensitive and dry skin types, while astringent botanicals like witch hazel (*Hamamelis virginiana*) are more appropriate for oily and combination skin types.^[10]

Table 1: Classification of Skin Types and Suitable Natural Ingredients.

Skin Type	Characteristics	Common Problems	Suitable Natural Ingredients	Recommended Formulations
Normal Skin	Balanced sebum and hydration	Minimal issues	Aloe vera, jojoba oil	Light creams, lotions
Dry Skin	Low sebum, rough texture	Xerosis, flaking	Shea butter, avocado oil, honey	Creams, balms
Oily Skin	Excess sebum production	Acne, enlarged pores	Tea tree oil, witch hazel, neem	Gels, toners
Combination Skin	Oily T-zone with dry cheeks	Uneven hydration	Rose water, aloe vera	Emulsions
Sensitive Skin	Easily irritated	Redness, itching	Chamomile, calendula, oat extract	Hypoallergenic creams

1.3 Skin Patch Test

Before incorporating any new natural ingredient or formulation into a skin care regimen, patch testing is an indispensable safety measure. Contact dermatitis, both irritant and allergic, represents one of the most common adverse reactions to cosmetic ingredients, affecting approximately 10% of the general population annually.^[11] The standard patch test protocol (European Standard Series) involves application of test substances to the upper back using Finn chambers (8 mm diameter), occlusion for 48 hours, and reading at 48 and 96 hours according to the International Contact Dermatitis Research Group (ICDRG) grading scale.^[12]

For home-based self-testing of natural formulations, a simplified protocol is recommended

1. Apply a small amount (0.1 mL) of the formulation to the inner forearm or behind the ear.
2. Cover with a bandage and leave for 24–48 hours without washing.
3. Inspect for erythema, edema, vesiculation, or pruritus.

4. A positive reaction necessitates avoidance of the test formulation.

Common natural allergens identified in patch testing include Compositae/Asteraceae plant extracts (e.g., arnica, chamomile), fragrance mix compounds (linalool, limonene), essential oils (tea tree, lavender), and propolis.^[13] Gilissen et al. (2019) demonstrated that oxidized forms of terpene compounds-particularly linalool hydroperoxide and limonene hydroperoxide-are the principal sensitizers in natural cosmetic products, emphasizing the importance of antioxidant protection in formulations containing essential oils.^[14]

1.4 Skin Nutrients

Optimal skin health requires adequate supply of specific micro- and macronutrients, both topically applied and systemically derived through diet. Nutritional dermatology has emerged as a distinct subspecialty recognizing the bidirectional relationship between nutritional status and cutaneous integrity.^[15]

Table 2: Essential Nutrients and Their Role in Skin Health.

Nutrient	Physiological Role	Natural Sources	Dermatological Benefits
Vitamin C	Collagen synthesis	Citrus fruits, amla	Anti-aging, brightening
Vitamin E	Antioxidant protection	oil, sunflower oil	Moisturization
Vitamin A	Cell regeneration	Carrot seed oil	Anti-wrinkle
Zinc	Wound healing	Pumpkin seeds	Acne control
Omega-3 Fatty Acids	Barrier repair	Flaxseed oil	Anti-inflammatory
Selenium	Antioxidant enzyme support	Brazil nuts	UV protection

1.4.1 Vitamins

Vitamin C (L-ascorbic acid) is the most abundant antioxidant in human skin, with higher concentrations in the epidermis (70 µg/g) than dermis (40 µg/g). It is essential for collagen biosynthesis (cofactor for prolyl and lysyl hydroxylases), melanin suppression (inhibition of tyrosinase), and photoprotection through free radical quenching.^[16] Vitamin E (α-tocopherol) is the primary lipid-soluble antioxidant in the stratum corneum, protecting polyunsaturated fatty acids from lipid peroxidation. Natural vitamin E (d-α-tocopherol) demonstrates 36% greater bioavailability than the synthetic dl-form.^[17]

Vitamin A (retinol) and its active metabolite retinoic acid regulate keratinocyte differentiation, stimulate fibroblast activity, and accelerate epidermal turnover. Natural sources include sea buckthorn oil (*Hippophae rhamnoides*), carrot seed oil (*Daucus carota*), and rosehip oil (*Rosa canina*).^[18]

Vitamin B3 (niacinamide) reduces trans-epidermal water loss, inhibits melanosome transfer to keratinocytes, and demonstrates clinically significant anti-aging effects at 5% concentration in double-blind controlled studies.^[19]

1.4.2 Minerals and Fatty Acids

Zinc is essential for wound healing, sebum regulation, and immunological skin function. Deficiency manifests as acrodermatitis enteropathica, a condition characterized by periorificial and acral dermatitis. Natural zinc sources applicable topically include zinc oxide (inorganic) and zinc-rich plant extracts.^[20] Essential fatty acids (EFAs), specifically linoleic acid (omega-6) and α -linolenic acid (omega-3), are critical structural components of ceramides and phospholipid bilayers of the stratum corneum. EFA deficiency is associated with xerosis, scaling, and impaired barrier function. Rich natural sources include rosehip oil (77% linoleic acid), hemp seed oil (57% linoleic acid), and evening primrose oil (72% linoleic acid).^[21]

SKIN CARE FORMULATIONS AND DOSAGE FORMS

The efficacy of natural skin care actives is profoundly influenced by their delivery vehicle. Formulation science determines bioavailability, skin penetration, stability, and consumer acceptability of phytochemical actives. This chapter systematically reviews the major dosage forms employed in topical natural skin care.

2.1 Lotions and Creams

Lotions and creams are emulsion-based semi-liquid or semi-solid formulations constituting the dominant category in the topical skin care market, representing approximately 65% of all marketed products. They are classified as oil-in-water (O/W) or water-in-oil (W/O) emulsions based on the continuous phase.^[22] Lotions contain a higher water content (70–85%) and lower viscosity than creams, making them suitable for large body surface areas and oily or combination skin types. Natural emulsifiers used in botanical lotions include lecithin (derived from sunflower or soybean), beeswax, carnauba wax, and Cetearyl glucoside.^[23] Creams (water content 45–80%) are more occlusive and are preferred for dry skin formulations. Cold cream, historically one of the oldest emulsified skin preparations described by Galen (2nd century AD), consisted of beeswax, rose water, and olive oil-illustrating the deep historical roots of natural emulsion technology.^[24] Hwang et al. (2020) formulated an O/W nano-emulsion containing *Centella asiatica* extract with olive oil as the oil phase and demonstrated

superior penetration of asiaticoside (54% greater penetration depth) compared to conventional cream formulations, highlighting the role of formulation optimization in enhancing phytochemical delivery.^[25]

2.2 Solutions

Topical solutions are single-phase liquid preparations in which the active ingredients are dissolved in a suitable solvent or solvent system. Aqueous, alcoholic (hydroalcoholic), or polyol-based solvents are most commonly employed in natural skin care solutions.^[26] Natural astringent solutions (e.g., witch hazel water, rose water, green tea infusion) serve as toners, reducing surface oil and temporarily tightening pores. Hydrolats (floral waters-byproducts of steam distillation of aromatic plants) represent a distinctive category of natural solutions containing water-soluble aromatic compounds and trace essential oil components. Micellar water formulations utilizing natural surfactants derived from coconut (coco-glucoside) or sugar (decyl glucoside) have gained prominence as gentle cleansing solutions suitable for sensitive skin.^[27]

2.3 Suspensions

Suspensions contain finely dispersed insoluble solid particles (1–100 μm) distributed in a liquid continuous phase. In natural skin care, physical sunscreens (zinc oxide, titanium dioxide) are formulated as suspensions, as are exfoliating preparations containing ground botanical particles (walnut shell powder, bamboo microspheres, jojoba beads).^[28] Stability of natural suspensions requires careful attention to particle size distribution, zeta potential (optimally $\geq \pm 30$ mV for electrostatic stabilization), viscosity modifiers (natural thickeners: xanthan gum, guar gum, carrageenan), and pH control. Sedimentation rate is governed by Stokes' law and is inversely proportional to the viscosity of the continuous phase.

2.4 Gels

Gels are semi-solid systems comprising a liquid phase (aqueous or hydroalcoholic) gelled by a network of polymeric chains or colloidal particles. Natural gelling agents used in botanical skin care include aloe vera gel (containing acemannan as the primary active polysaccharide), Carbopol (though synthetic, often used with natural actives), xanthan gum, locust bean gum, and carrageenan.^[29] Gels are preferred for oily and acne-prone skin owing to their low occlusive nature, rapid absorption, and cooling sensation. A clinical study by Mitkari et al. (2021) demonstrated that a 3% neem (*Azadirachta indica*) leaf extract gel significantly reduced acne lesion count (57.3% reduction vs. 41.2% with placebo, $p < 0.05$) after 8 weeks

of twice-daily application.^[30]

2.5 Oils

Single-phase lipid preparations-both fixed oils (expressed from plant seeds/fruits) and essential oils (volatile aromatic compounds obtained by steam distillation or cold pressing)-constitute a rapidly growing segment of natural skin care. Facial oils have gained particular traction as cleansing, moisturizing, and anti-aging vehicles.^[31]

Key natural oils and their principal skin care applications include

- Rosehip oil (*Rosa canina*): Anti-aging, hyperpigmentation, scar reduction (high trans-retinoic acid and linoleic acid content)
- Jojoba oil (*Simmondsia chinensis*): Technically a liquid wax ester; closely mimics human sebum composition; excellent emollient and carrier oil
- Argan oil (*Argania spinosa*): Rich in oleic acid (43%), linoleic acid (36%), squalene, and tocopherols; demonstrated efficacy in atopic dermatitis
- Sea buckthorn oil (*Hippophae rhamnoides*): Highest natural source of carotenoids (β -carotene, lycopene); documented wound-healing and anti-inflammatory activity
- Marula oil (*Sclerocarya birrea*): 72% oleic acid content; superior oxidative stability; demonstrated efficacy in skin moisture retention^[32]

2.6 Ointments

Ointments are anhydrous or water-in-oil semi-solid preparations providing the highest degree of occlusion among topical dosage forms, reducing TEWL by up to 90%. Natural ointment bases include beeswax-petrolatum combinations, lanolin (wool wax alcohol), and pure vegetable shortening formulations.^[33]

In natural skin care, beeswax serves as the primary structuring agent in anhydrous ointments, providing emollient and mild antibacterial activity through its principal components: myricyl palmitate (70–80%), cerotic acid, and hentriacontane. The optimal beeswax-to-oil ratio for natural ointment preparation ranges from 1:5 to 1:8 depending on the desired consistency and ambient temperature.

2.7 Balms

Balms are concentrated, anhydrous preparations combining waxes (beeswax, candelilla wax, carnauba wax), butters (shea, mango, kokum), and oils in higher proportions than ointments.

Historically, balms contained aromatic resins (balsams) from trees such as Commiphora (myrrh), Boswellia (frankincense), and Myroxylon (Peru balsam).^[34] Lip balms, heel balms, and muscle balms represent the principal commercial categories. Anti-inflammatory balms commonly incorporate menthol (from *Mentha arvensis* or *M. piperita*), camphor (*Cinnamomum camphora*), and arnica (*Arnica montana*) extracts, validated in clinical studies for topical analgesic activity.

2.8 Powders

Topical powders reduce skin friction, absorb sebum and sweat, and deliver active ingredients with minimal occlusion. Natural powders used in skin care include colloidal oat flour (*Avena sativa*), arrowroot powder (*Maranta arundinacea*), kaolin clay, bentonite clay, rice flour, and zinc oxide.^[35] Kaolin and bentonite clays possess negatively charged lattice structures capable of adsorbing cationic organic molecules, sebum, and particulate matter. A study by Wardhana et al. (2022) demonstrated that bentonite face masks (applied twice weekly for 4 weeks) produced a 43.7% reduction in casual sebum level compared to baseline, with significant improvement in pore appearance ($p < 0.01$).^[36]

Table 3. Topical Dosage Forms Used in Natural Skin Care

Dosage Form	Characteristics	Advantages	Common Natural Ingredients
Creams	Semi-solid emulsions	Moisturizing	Shea butter, aloe vera
Lotions	Fluid emulsions	Easy spreadability	Rose water, glycerin
Gels	Water-based systems	Non-greasy	Aloe vera, neem
Oils	Lipid formulations	Occlusive effect	Argan oil, jojoba oil
Ointments	Highly occlusive	Barrier protection	Beeswax, lanolin
Balms	Concentrated lipid systems	Deep nourishment	Cocoa butter
Powders	Dry formulations	Sebum absorption	Kaolin clay

2.9 Other Methods of Skin Care

Beyond conventional dosage forms, several innovative delivery systems and treatment modalities utilizing natural actives have emerged in contemporary skin care practice.^[37]

Phytosomes (phospholipid complexes of plant extracts) significantly enhance bioavailability of polyphenolic actives-particularly quercetin and silybin-by improving lipophilicity and membrane permeation. Nanoparticulate systems (solid lipid nanoparticles, nanostructured lipid carriers) using natural waxes and oils as matrices have demonstrated superior penetration of botanical actives into viable epidermis and dermis. Sheet masks utilizing plant-based fiber

substrates (bamboo, cotton, cellulose) impregnated with active serums represent a high-growth innovation segment, delivering concentrated actives under semi-occlusive conditions for 15–20 minutes. Herbal steam facials, clay mask treatments, and botanical poultices represent traditional methodologies with enduring relevance supported by contemporary mechanistic studies.

SKIN CARE INGREDIENTS

3.1 Water and Vegetable Oils

3.1.1 Water

Water constitutes 60–85% of most emulsion-based skin care formulations and serves multiple functions: solvent for water-soluble actives, vehicle for humectants, and medium for emulsification. Purified water (Ph. Eur. grade), deionized water, or specialized waters (thermal spring water, glacier water) are employed.^[38] Thermal spring waters contain trace minerals (selenium, manganese, silicon) with documented free-radical scavenging and anti-inflammatory properties. La Roche-Posay thermal spring water contains 13 mg/L selenium—a concentration with measurable antioxidant efficacy in clinical studies.

3.1.2 Vegetable Oils

Vegetable oils are obtained by mechanical pressing (cold-pressed, expeller-pressed) or solvent extraction from seeds, nuts, and fruits of plants. Cold-pressed oils retain higher concentrations of tocopherols, carotenoids, and phenolic compounds compared to refined oils.^[39] The fatty acid composition determines the functional properties of each oil. Oils high in oleic acid (monounsaturated, C18:1)—such as olive, avocado, and sweet almond—provide intensive moisturization and enhanced penetration of fat-soluble vitamins. Oils rich in linoleic acid (polyunsaturated, C18:2)—including rosehip, hemp seed, and evening primrose—support barrier repair and are indicated for inflammatory skin conditions (eczema, psoriasis, acne). Oils with high lauric acid content—coconut oil—exhibit significant antimicrobial activity against *Cutibacterium acnes* and *Staphylococcus aureus*. A systematic review by Lin *et al.* (2018) encompassing 26 randomized controlled trials evaluated multiple plant oils in atopic dermatitis and concluded that sunflower seed oil (*Helianthus annuus*) significantly improved skin barrier function (TEWL reduction: weighted mean difference -3.22 g/m²/h, 95% CI: -5.38 to -1.06) while virgin coconut oil exhibited superior antimicrobial and anti-inflammatory effects.^[40]

Table 4: Vegetable Oils and Their Dermatological Applications.

Vegetable Oil	Major Fatty Acids	Key Activities	Skin Indications
Coconut Oil	Lauric acid	Antimicrobial	Dry skin, eczema
Jobba Oil	Wax esters	Sebum balancing	Oily skin
Rosehip Oil	Linoleic acid	Scar reduction	Hyperpigmentation
Argan Oil	Oleic acid	Moisturizing	Aging skin
Hemp Seed Oil	Omega-6 fatty acids	Barrier repair	Sensitive skin

3.2 Natural Butters

Natural butters are semi-solid lipid preparations derived from the fat-rich components of plant seeds and kernels, characterized by their high content of saturated fatty acids and unsaponifiable fractions rich in bioactive compounds.^[41]

3.2.1 Shea Butter (*Vitellaria paradoxa*)

Shea butter remains the most widely used natural butter in skin care formulation. Its unsaponifiable fraction (6–17%) contains triterpene alcohols (lupeol, butyrospermol, α -amyrin), tocopherols, and phenolic compounds. A randomized clinical trial by Dweck AC. 2002 demonstrated that 10% shea butter cream applied twice daily for 6 weeks significantly reduced transepidermal water loss by 29.4% and skin roughness score by 22.7% in patients with mild to moderate xerosis ($p < 0.001$).^[42]

3.2.2 Cocoa Butter (*Theobroma cacao*)

Cocoa butter contains stearic acid (34%), oleic acid (35%), and palmitic acid (26%) with a high melting point (32–35°C), making it a superior skin lubricant and barrier occlusive. Its polyphenol fraction (procyanidins, epicatechin) confers antioxidant and mild anti-inflammatory properties

3.2.3 Mango Butter (*Mangifera indica*)

Mango kernel butter is a non-comedogenic emollient rich in oleic acid (46%) and stearic acid (38%). It contains mangiferin, a C-glycosylxanthone with potent antioxidant, anti-inflammatory, and UV-absorbing properties, documented at IC₅₀ values comparable to commercial antioxidants in in vitro assays.^[43]

3.2.4 Other Notable Butters

Kokum butter (*Garcinia indica*): contains 75–80% symmetrical triacylglycerols; fast-absorbing, non-greasy; regenerative properties. Illipe butter (*Shorea stenoptera*): closest in composition to cocoa butter; provides extreme moisturization; used in lip and body care. Murumuru butter (*Astrocaryum murumuru*): 45% lauric acid content; excellent emollient and hair conditioning agent.

3.3 Herbs and Flowers

The diversity of bioactive phytochemicals in medicinal herbs and flowers provides an extensive pharmacopeia for natural skin care formulation. The primary mechanisms through which botanical extracts benefit skin include antioxidant activity (radical scavenging, metal chelation), anti-inflammatory effects (COX-2 and 5-LOX inhibition, NF- κ B pathway modulation), antimicrobial action, and stimulation of collagen and elastin synthesis.^[44]

3.3.1 Aloe vera (*Aloe barbadensis* Miller)

Aloe vera gel contains over 200 biologically active compounds including acemannan (β -1,4-acetylated mannan), anthraquinones, sterols, saponins, vitamins C and E, and mineral salts. Clinical evidence supports its efficacy in mild-to-moderate sunburn treatment, psoriasis management, seborrheic dermatitis reduction, and wound healing acceleration.^[45]

3.3.2 Chamomile (*Matricaria chamomilla*)

German chamomile contains α -bisabolol, chamazulene (formed during steam distillation from matricine), and apigenin-7-glucoside. These compounds collectively produce anti-inflammatory, antispasmodic, and wound-healing effects. α -Bisabolol at 0.5% concentration demonstrated equivalence to 0.25% hydrocortisone in reducing experimentally induced skin inflammation.

3.3.3 Green Tea (*Camellia sinensis*)

Epigallocatechin-3-gallate (EGCG), the principal catechin of green tea, inhibits UV-induced NF- κ B activation and AP-1 expression, reducing inflammatory cytokine production. A placebo-controlled randomized trial demonstrated that 10% EGCG cream applied for 8 weeks significantly improved skin elasticity (31.3% increase by cutometer measurement) and reduced erythema index in photoaged skin.^[46]

3.3.4 *Turmeric (Curcuma longa)*

Curcumin (1,7-bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione), the primary bioactive of turmeric, exerts anti-inflammatory effects by inhibiting COX-2, 5-LOX, iNOS, and NF- κ B signaling pathways. Its poor topical bioavailability (due to hydrophobicity and photo-instability) necessitates advanced delivery systems; curcumin-loaded solid lipid nanoparticles demonstrated 4.8-fold enhancement in skin permeation compared to conventional cream in ex vivo pig skin models.^[47]

3.3.5 *Calendula (Calendula officinalis)*

Calendula flowers contain flavonoids (quercetin, isorhamnetin, narcissin), triterpene saponins (oleanolic acid glycosides), polysaccharides, and carotenoids (lutein, zeaxanthin, β -carotene). Clinical studies document its efficacy in acute radiation dermatitis (superior to trolamine in reducing acute dermatitis in breast cancer patients undergoing radiotherapy), wound healing, and diaper rash management.

3.3.6 *Lavender (Lavandula angustifolia)*

Lavender essential oil (principal components: linalool 25–38%, linalyl acetate 25–45%) demonstrates anxiolytic, analgesic, and antimicrobial properties. Topically, it has been studied in alopecia areata—a randomized double-blind trial by Hay et al. reported 44% improvement in hair growth with lavender essential oil scalp massage compared to 15% with carrier oil alone.^[48]

3.4 Other Ingredients

Numerous additional natural ingredients play critical functional roles in botanical skin care formulations.^[49] Hyaluronic acid (HA): Although now produced by bacterial fermentation (*Streptococcus equi* subsp. *zooepidemicus*), HA is a naturally occurring glycosaminoglycan originally isolated from bovine vitreous humor. Its exceptional water-binding capacity (1 g HA binds approximately 6 L water) makes it the premier natural humectant in skin care. Honey (*Apis mellifera*): Contains methylglyoxal (antibacterial), hydrogen peroxide (antimicrobial), bee defensin-1 (peptide antimicrobial), flavonoids (pinocembrin, chrysin), and high osmolarity—collectively providing superior wound-healing, antibacterial, and moisturizing properties. Manuka honey with UMF ≥ 15 is the most clinically validated grade for therapeutic skin applications. Propolis: A resinous mixture collected by bees from plant exudates, rich in caffeic acid phenethyl ester (CAPE), chrysin, galangin, and pinocembrin. Demonstrates potent antimicrobial activity against *Staphylococcus aureus* (MIC 0.06–0.25

mg/mL), antifungal activity against *Candida* species, and wound-healing promotion through stimulation of fibroblast proliferation.

Clay minerals (kaolin, bentonite, montmorillonite, rhassoul): Natural aluminosilicates with high surface area and cation-exchange capacity. Function as sebum absorbers, mechanical exfoliants, mineral nutrient sources, and anti-inflammatory agents when applied as face masks.

MAKING HERBAL SKINCARE PRODUCTS

The preparation of herbal skincare products requires an integration of phytochemical knowledge, formulation science, and quality management principles. Whether for small-scale artisan production or commercial manufacture, adherence to Good Manufacturing Practice (GMP) principles-as outlined in ICH Q10 and ISO 22716 (Cosmetics GMP)-is essential for safety, efficacy, and shelf-life assurance.

4.1 Working Space

A dedicated, organized workspace is the foundation of quality herbal skincare production. ISO 22716 recommends that cosmetic manufacturing premises be designed to minimize contamination risk, facilitate cleaning, and support orderly workflow.^[50] Key workspace requirements include: smooth, non-porous, easily cleanable surfaces (stainless steel, high-density polyethylene); dedicated zones for raw material storage, weighing, processing, and finished product storage; adequate ventilation and temperature control (15–25°C); exclusion of domestic activities, pets, and food from the production area; and clearly demarcated clean and dirty flow paths. Lighting (minimum 540 lux at work surfaces), drainage, and pest control are additional considerations specified in GMP guidelines. Hot and cold running water, with appropriate drainage, is mandatory for equipment washing stations.

4.2 Requirements

Essential equipment for herbal skincare formulation includes:

- Precision balance (0.01 g accuracy for small-batch work; 0.001 g for essential oil addition)
- Stainless steel or borosilicate glass double boiler (water bath, 60–80°C for wax/butter melting)
- Calibrated thermometer (digital infrared preferred for non-contact measurement)
- Immersion blender / high-speed homogenizer for emulsion formation

- pH meter (calibrated with standard buffer solutions at pH 4.0 and 7.0)
- Graduated cylinders and pipettes (Class A borosilicate glass)
- Amber glass storage jars and dispensing containers (UV-protective for photo-sensitive formulations)

Measuring instruments must be regularly calibrated and records maintained as per ISO 22716 documentation requirements.

4.3 Sanitation

Microbial contamination represents the primary quality and safety risk in natural cosmetic formulation, as botanical ingredients introduce a diverse microbial flora and natural formulations typically employ milder preservative systems than synthetic counterparts.

Mandatory sanitation practices include: personal hygiene (hand washing with soap for minimum 20 seconds, clean attire, hair nets, avoidance of work when unwell); equipment sanitization (70% isopropanol spray or UV-C irradiation for contact surfaces; autoclaving or boiling for heat-stable equipment; validated chemical sanitizers-quaternary ammonium compounds or food-grade hydrogen peroxide-for bulk containers); and environmental monitoring (regular surface swab testing targeting total aerobic count < 100 CFU/cm² and absence of *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Candida albicans* per ISO 17516 microbiological limits for cosmetics).

The preservative challenge test (PCT) per ISO 11930 (formerly Ph. Eur. 5.1.3) is the definitive method for validating the efficacy of the preservative system in finished natural formulations, requiring inoculation with standard challenge organisms (*S. aureus*, *P. aeruginosa*, *C. albicans*, *Aspergillus brasiliensis*, *E. coli*) and demonstrating adequate log reduction over 28 days.

4.4 Basic Ingredients

A well-curated ingredient inventory enables the formulation of a diverse range of natural skincare products. Essential categories include

Base oils: Sweet almond, jojoba, avocado, rosehip, coconut, argan (store in amber glass under nitrogen headspace to prevent oxidative rancidity) Waxes and butters: Beeswax, carnauba wax, candelilla wax, shea butter, cocoa butter, mango butter Humectants: Vegetable glycerin (USP grade, 99.7% purity), aloe vera gel, hyaluronic acid sodium salt, sorbitol Natural

emulsifiers: BTMS-50, Olivem 1000, beeswax + borax system, lecithin, cetearyl alcohol+ cetearyl glucoside Natural preservatives: Rosemary extract (tocopherols, rosemarinic acid), vitamin E oil (antioxidant, not preservative per se), Leucidal (ferment of *Lactobacillus*), Microguard (cultured corn-sugar ferment), Naticide (fragrance-compatible preservative blend) Active botanicals: Standardized extracts (verified by HPLC fingerprinting), hydrolats, infused oils, tinctures pH adjusters: Citric acid (for lowering pH), sodium hydroxide solution (10% w/v, for raising pH to 5.5–6.5 range optimal for skin)

4.5 Storing Your Finished Products

Proper storage is critical to maintaining the microbiological safety, chemical stability, and sensory properties of natural skincare products throughout their shelf life. Key storage parameters include.

Temperature: Natural formulations should be stored below 25°C (77°F); heat accelerates oxidation of unsaturated fatty acids, degrades unstable actives (vitamin C, retinol), and can cause phase separation in emulsions. Refrigeration (2–8°C) extends shelf life of preservative-free and water-rich formulations.

Light protection: UV radiation catalyzes photo-oxidation of oils and degradation of colorants. Amber, cobalt blue, or UV-opaque packaging is mandated for products containing rosehip oil, vitamin C serums, retinol formulations, and essential oil-based products.

Air exclusion: Airless pump dispensers minimize oxygen exposure and microbial contamination risk while improving dose accuracy. Bulk products should be stored under nitrogen headspace where oxidation-sensitive ingredients are present. Labeling: All finished products must be labeled with: product name, full INCI ingredient list (descending order of concentration), manufacturer information, batch number, date of manufacture, use-by date, and usage instructions (ISO 22716 and EU Cosmetics Regulation No. 1223/2009 requirements).

FACE CARE

The facial skin presents unique challenges for natural product formulation owing to its higher density of sebaceous glands, greater sebum secretion rate, larger pore size (particularly in the T-zone), and heightened cosmetic sensitivity. Natural face care encompasses cleansing, toning, moisturizing, masking, targeted treatment, and photoprotection.

5.1 Natural Facial Cleansers

Gentle cleansing is foundational to any face care routine. Natural cleansing agents include saponin-rich plant extracts (soapwort-*Saponaria officinalis*, soapbark-*Quillaja saponaria*, horse chestnut-*Aesculus hippocastanum*), oil cleansing (utilizing the 'like dissolves like' principle with jojoba, castor, and sweet almond oils in combination), and micellar water systems. Optimal facial cleanser pH is 4.5–6.0-matching the skin's acid mantle. Alkaline cleansers (soap, pH 9–10) disrupt tight junction proteins, transiently raising stratum corneum pH for 2–3 hours, impairing serine protease function, and increasing TEWL.

5.2 Natural Toners and Hydrolats

Following cleansing, toners restore skin pH, remove residual cleanser/impurities, and deliver humectants and soothing actives. Rose water (*Rosa damascena* hydrolat) is the most widely used natural toner, containing phenethyl alcohol, geraniol, and citronellol with demonstrated anti-inflammatory and antimicrobial properties. Witch hazel water (*Hamamelis virginiana* distillate) provides astringent, anti-inflammatory, and antioxidant effects through its hamamelitannin and galloylated procyanidin content.

5.3 Natural Facial Moisturizers and Serums

Natural moisturizers function through three mechanisms: occlusion (forming a lipid film to retard TEWL-beeswax, plant oils, butters), humectancy (attracting water from dermis and environment-glycerin, aloe vera, hyaluronic acid, honey), and emolliency (filling intercellular spaces in stratum corneum to smooth and soften-plant ceramides, phytosterols, squalane).

Facial serums-concentrated, low-viscosity active delivery systems-have become the most scientifically advanced segment of natural face care. Natural actives commonly incorporated include vitamin C (as ascorbic acid 10–20%, ascorbyl glucoside, or ascorbyl phosphate), bakuchiol (a meroterpene from *Psoralea corylifolia* seeds demonstrating retinol-like anti-aging efficacy without irritation), resveratrol (trans-resveratrol from *Polygonum cuspidatum* root), and ferulic acid (naturally abundant in rice bran).

5.4 Natural Face Masks

Face masks deliver concentrated actives under semi-occlusive conditions, enhancing penetration through transient hydration of the stratum corneum. Clay masks (kaolin, bentonite, rhassoul) for sebum control and pore purification; peel-off masks (natural film-formers: gelatin, fruit pectin, agar-agar) for mechanical cleansing; cream masks (rich butter-

based compositions) for intense moisturization; and sheet masks represent the principal commercial categories in natural face masking.

5.5 Natural Photoprotection

Sun protection is the single most evidence-based anti-aging intervention in dermatology. Natural UV filters include zinc oxide (inorganic, broad-spectrum UVA/UVB, non-irritating, photostable), titanium dioxide (excellent UVB filter, less effective UVA coverage), red raspberry seed oil (reported SPF 28–50 in early studies, though subsequent peer-reviewed research has not confirmed reliable UV protection), and pomegranate seed oil. Antioxidant supplementation (green tea, resveratrol, vitamin C) provides photoprotection through free radical quenching rather than UV absorption and should be viewed as adjunctive rather than primary sun protection.

BODY CARE

Natural body care formulations address the diverse needs of skin areas beyond the face, including the hands, feet, décolleté, scalp, and general body surface. While body skin is generally less sensitive than facial skin, it is subject to distinct challenges including greater sebum production on the back, thick stratum corneum on the heels and palms, and scalp-specific microbiome dynamics.

6.1 Natural Body Moisturizers

Body moisturizers prioritize cost-effectiveness, spreadability over large surface areas, and robust formulation stability. Natural body lotions utilizing shea butter, coconut oil, sweet almond oil, and glycerin as principal moisturizing ingredients have demonstrated efficacy in improving skin hydration and barrier function in clinical studies. Colloidal oatmeal (*Avena sativa*)-FDA-approved as an over-the-counter (OTC) skin protectant-represents the most evidence-based natural moisturizing ingredient for eczematous and xerotic body skin.

6.2 Natural Body Scrubs and Exfoliants

Physical exfoliation of the body using natural abrasive particles removes dead corneocytes, stimulates microcirculation, and enhances penetration of subsequently applied moisturizers. Natural exfoliants include: sugar (brown and white, rapidly dissolving-gentlest option), sea salt (mineral-rich, coarser), ground coffee (caffeine absorption may provide temporary anticellulite vasoactive effects), oat flour (soothing), bamboo powder, rice bran, and pumice (volcanic rock, used for keratotic areas-heels, elbows).

Chemical exfoliation with natural alpha-hydroxy acids (AHAs)-glycolic acid (sugarcane), lactic acid (fermented dairy or sugar beet), malic acid (apple), tartaric acid (grapes)-and beta-hydroxy acid (salicylic acid, from *Salix* bark or synthesized from natural salicylates) dissolves intercorneocyte desmosomes, providing more uniform and less mechanically traumatic exfoliation than physical methods.

6.3 Natural Hand and Foot Care

The hands and feet are subject to frequent mechanical stress, water exposure (leading to barrier disruption), and chemical exposure (detergents, solvents). Intensive natural hand creams typically incorporate higher concentrations of occlusive butters (shea, cocoa) and waxes (beeswax) combined with skin-repairing actives (allantoin from comfrey root-promotes cell proliferation and tissue regeneration; panthenol from royal jelly-provitamin B5, deeply penetrating humectant and anti-inflammatory).

Foot care formulations address callus reduction (urea 10–40% in natural cream bases; salicylic acid 5–12% in natural ointments or plasters), fungal prevention (tea tree oil 5–10%, demonstrated equivalent efficacy to 1% clotrimazole in tinea pedis in a randomized double-blind trial), and cracked heel treatment (intensive occlusive overnight foot masks with lanolin, shea butter, or coconut oil).

6.4 Natural Body Oils and Massage Preparations

Botanical body oils serve the dual purpose of delivering active phytochemicals and providing the lubrication required for massage therapy. Dry body oils (low-viscosity, rapidly absorbing formulations utilizing squalane, fractionated coconut oil, and camellia oil) have gained popularity as non-greasy alternatives to conventional body lotions.

Aromatherapeutic body massage oils incorporating essential oils-lavender, eucalyptus (*Eucalyptus globulus*), rosemary, geranium-at 1–3% concentration in carrier oil bases have documented evidence for relaxation, pain modulation, and lymphatic drainage enhancement when combined with appropriate massage techniques.

6.5 Natural Scalp and Hair Care

The scalp is a specialized skin region with the highest hair follicle density and a unique microbiome dominated by *Malassezia* species. Natural scalp care formulations address dandruff (seborrheic dermatitis), hair loss, scalp dryness, and folliculitis.

Ketoconazole-equivalent antifungal activity has been demonstrated for tea tree oil (*T. alternifolia*) at 5% in shampoo formulations for *Malassezia*-associated dandruff. Rosemary oil (*Rosmarinus officinalis*), applied topically at 400 mg/day for 6 months, produced statistically equivalent hair count increase to 2% minoxidil lotion in androgenetic alopecia, without the scalp itching associated with minoxidil. Saw palmetto extract (*Serenoa repens*) provides natural 5 α -reductase inhibition, addressing the hormonal component of androgenetic alopecia through reduction of DHT production in the scalp.

6.6 Natural Deodorants and Body Sprays

Natural deodorant formulations address body odor through antimicrobial activity against odor-producing bacteria (primarily *Corynebacterium* and *Staphylococcus* species of the axillary microbiome) and absorption of perspiration, without the antiperspirant mechanism of aluminum salts (which block eccrine sweat pores-an increasingly controversial practice from a toxicological perspective).

Natural deodorant actives include: baking soda (sodium bicarbonate, pH-raising, bacteriostatic-effective but potentially irritating at higher concentrations), magnesium hydroxide (gentler alkaline antimicrobial), zinc ricinoleate (from castor oil-odor encapsulator), mineral alum (potassium alum-the original crystal deodorant), and essential oils (tea tree, lavender, lemon-antimicrobial aromatics).

Table 5: Clinical Evidence Supporting Natural Skin Care Ingredients.

Ingredient	Study Type	Major Findings	Reference
Aloe vera	Clinical study	Improved wound healing	Surjushe et al.
Green tea	RCT	Reduced photoaging	Chiu et al.
Tea tree oil	Double-blind trial	Reduced acne lesions	Clinical trial
Shea butter	Clinical study	Improved hydration	Akihisa et al.
Rosemary oil	Comparative trial	Hair growth promotion	Hay et al.

LIMITATIONS OF NATURAL SKIN CARE PRODUCTS

Despite their therapeutic potential, natural skin care products face challenges including instability of phytochemicals, oxidation of oils, microbial contamination, variability in plant extract composition, and limited large-scale clinical validation. Certain botanical ingredients may also produce allergic or irritant reactions in sensitive individuals.

CONCLUSION

Natural sources remain highly valuable in modern dermatological and cosmetic science

because of their diverse bioactive compounds and multifunctional therapeutic properties. Botanical ingredients such as aloe vera, green tea, curcumin, shea butter, and essential oils demonstrate significant antioxidant, anti-inflammatory, antimicrobial, and wound-healing activities. Advances in nanotechnology, phytosome delivery systems, microbiome-based skincare, and sustainable formulation approaches are expected to further improve the efficacy and safety of natural skin care products. However, standardization, stability, regulatory compliance, and large-scale clinical validation remain important challenges requiring continued research.

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