Exploring Herbal Creams in the Treatment of Hyperpigmentation: Current Approaches and Future Perspectives

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Abstract: Hyperpigmentation characterized by the darkening of skin due to excess melanin production, is a common cosmetic concern. Chemical-based medicines are used in conventional therapies; however, because of their negative effects, herbal formulations have gained popularity. Herbal creams provide a less harmful and safer substitute. The formulation techniques for herbal creams intended to cure hyperpigmentation, the herbal substances included, their modes of action, and the evaluation techniques used to gauge the formulations' safety and effectiveness are all covered in this review. The difficulties and potential paths in the creation of herbal creams for hyperpigmentation are also examined.

INTRODUCTION

Hyperpigmentation refers to the darkening of skin areas due to an increase in melanin production. This occurs when specific skin regions create excessive amounts of melanin. Melanin is an essential pigment produced by the melanogenesis process in cases of skin hyperpigmentation(Rathee et al., 2021). The epidermis and dermis of the skin are both impacted by UV radiation. There are three categories for UV radiation: UV-A, UV-B, and UV-C. UV-A is the least energetic. UV-C photons are the most energetic, with the shortest wavelengths falling between 100 and 280 nm, UV-B photons fall between 280 and 315 nm, and the longest wavelength photons UV-A fall between 315 and 400 nm. UV has an impact on skin physiology based on exposure, leading to either immediate or delayed pigmentation(Kaur et al., 2019).

Hyperpigmentation may be caused by changes in hormones, pregnancy, UV exposure, abnormal skin growths, skin injuries or irritation, and other medical conditions. Certain drugs including several anticancer drugs, can also cause hyperpigmentation(Nautiyal & Wairkar, 2021).

TYPES OF HYPERPIGMENTATION

Melasma/Chloasma appears on the faces of some women who are using birth control tablets, who are pregnant. Additional etiological factors include phototoxicity,UVradiationexposure, and genetic effect.medications, anti-convulsants, and cosmetics(Nieuweboer-Krobotova, 2013).

Postinflammatory hyperpigmentation (PIH) Postinflammatory hyperpigmentation (PIH) is a prevalent skin condition that has a big psychological effect . Limited knowledge exists on its pathophysiology as well as the treatment approaches employed to treat it. Although many studies on hyperpigmentation have been conducted, few have concentrated on PIH specificallym.(Chaowattanapanit et al., 2017)

Sunspots Skin pigmentation is frequently caused by exposure to the sun. The body increases melanin production to protect itself from the sun's UV radiation. In order to protect the skin from the sun's rays, this may result in increased pigmentation.(Thawabteh et al., 2023)

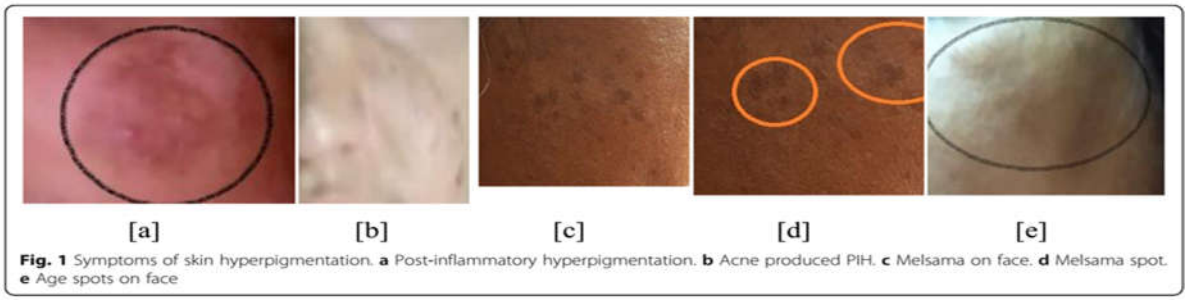

Fig. 1 Symptoms of skin hyperpigmentation. **a** Post-inflammatory hyperpigmentation. **b** Acne produced PIH. **c** Melsama on face. **d** Melsama spot. **e** Age spots on face

EPIDEMIOLOGY OF HYPERPIGMENTATION

According to a study that was published in the Indian Journal of Dermatology, 16.7% of people in urban areas had melasma. High UV exposure and urban living conditions are two factors that may have an impact on its prevalence.(Jangra et al., n.d.) One hundred patients with fifteen distinct face melanoses were enrolled in the study. In 53 (53%) of the cases, the most prevalent age group impacted was 21–40 years old. The ratio of females to males was 1.63:1. According to reports, melasma accounts for 49 (49%) of all cases of face melanosis, making it the most

common cause. From the Out of the total number of melasma instances, 22 (45%) were epidermal, four (4%) were dermal, and 23 (47%) were mixed.(Solanki et al., 2024) People with SOC made up 30% of the US population in 2000, and the US Census Bureau predicts that by 2050, at least 50% of Americans will have SOC . Thus, it is crucial and It is vital to gain a deeper comprehension of cutaneous conditions associated with SOC. According to El-Essawi et al. (2008), 50% of survey respondents said that skin discolouration and uneven skin tone were two of the most worrisome skin issues among Arab Americans.(Solanki et al., 2024) A research by Halber et al. comparing the most prevalent dermatoses in African Americans and white patients. In contrast to vitiligo, pigmentary diseases were the seventh most prevalent dermatosis among Caucasian patients (1.7%), but the third most common among African-American patients (9%).(Features, 2010) Melasma is more prevalent in females. It has been reported that 10% of instances include men. 1. Melasma is most noticeable during and after sun exposure. The two main elements linked to the etiopathogenesis of melasma are genetic predisposition and sunshine, albeit the precise reason is yet unknown.(Nicolaidou & Katsambas, 2014) Melasma is the most prevalent diagnosis (52%) based on the clinicodemographic profile, followed by Reihl's TSDF (6.6%), ashy dermatosis (3.3%), PDL (2%), melanosis (21.3%), ochronosis (10%), arrhythmia, amyloidosis, and DLE (1.3% each), and poikiloderma of civatte (0.6%).(Rao et al., 2020)

PATHOPHYSIOLOGY OF HYPERPIGMENTATION

Melanocytes undergo melanogenesis to create melanin. The melanosomes are tiny, membrane-bound structures where this happens .(Section, 2014) The basal layer of the epidermis contains melanocytes, which are responsible for the synthesis of melanin. It is the enzyme that oxidizes tyrosine to L-DOPA initially as tyrosinase and then as dopaquinone. Both pheomelanin and eumelanin are the products of dopaquinone, depending on the oxidative and enzymatic circumstances. Tyrosinase is essential for controlling the final pigment result, but two other enzymes, tyrosinase-related protein 1 (TRP1) and tyrosinase-related protein 2 (TRP2), are also important.(Europe, 2025) UV light is a special kind of skin pigmentation modulator that affects tanning pathways. The pro-opiomelanocortin (POMC) gene is expressed by p53 as a result of UVB-induced keratinocyte DNA damage, which initiates the delayed tanning pathway and releases α-melanocyte-stimulating hormone (α-MSH). Melanocortin 1 receptor (MC1R) stimulation by α-MSH results in melanogenesis and m-MITF expression in melanocytes.(Yardman-Frank & Fisher, 2021) There are numerous causes of hyperpigmentation. Diabetes, Acanthosis nigricans, and hyperthyroidism. The following

nutritional factors are deficiencies: Kwashiorkor, vitamin B12, folate, niacin, tryptophan, and vitamin A.(Rathee et al., 2021)

Diagnostic Considerations

The patient's demographics and clinical examination can offer hints for making a diagnosis.Since some conditions are congenital (such as CALM, naevus of Ota, naevus of Ito, etc.), the history should include the period of onset. Certain features of particular hyperpigmentary disorders can be found by examination. A Wood's lamp examination can confirm that the pigmentation is in the dermis if it is blue or grey in color instead of brown.(Yoo, 2022)

Conventional light microscopy

Histopathology of lesional melasma shows increased melanin, and conventional light microscopy reveals an increase in melanocytes and melanogenic enzyme activity. throughout all levels of the epidermis, but especially in the basal layer. With their distinctive expanded appearance and prominent dendrites, the epidermal melanocytes appear normal to slightly enhanced.(Pagan et al., 2023)

Dermoscopy

Depending on the underlying condition, post-inflammatory hyperpigmentation might have different dermoscopic characteristics. The probability of persistent post-inflammatory pigmentation can be predicted by dermoscopy.(Oskay & Kutluay, 2003) Both dermoscopy and Wood's lamp examination are equally useful for identifying the different kinds of periorbital hyperpigmentation.(Samsul et al., 2021)

APPROACHES

Cream: Creams are flexible semi-solid emulsions that can integrate with either the water-dispersed oil (w/o) phase or the oil-dispersed water (o/w) phase.(Dudhe et al., 2023) People can use herbal, ayurvedic, or allopathic creams based on their individual needs. Additionally, creams are utilized for a variety of purposes, including medicinal, cleansing, beautifying, and protection.(Miss. Adhalrao Supriya B. et al., 2022) For both local and systemic treatment, topical administration is a desirable method of medication administration. In order to maximize the local effects and reduce the systemic effects, efforts are made to formulate topical dosage forms using drug carriers that guarantee sufficient localization or penetration of the medication within or through the skin.(Pathak et al., 2016) These topical formulations aid in the delivery of the active medication to the skin's inner layer or mucous membrane.(Anchal et al., 2021)

Creams have several cosmetic uses, such as cleansing, beautifying, improving appearance, protecting, and healing. Creams are divided into two categories based on their phases: w/o and o/w emulsion types. Historically, semisolid products that are made as water-in-oil (cold cream) or oil-in-water (vanishing cream) have been called creams.(Tekade et al., 2024) Due to their natural ingredients, Ayurvedic remedies are generally thought to be safer.(Sharma & Rao, 2025)

TYPES OF CREAM

Oil-in-Water (O/W) - Creams consist of tiny oil droplets distributed in a continuous phase, and an emulsion where the oil is distributed as droplets all over .The term oil-in-water (O/W) emulsion refers to the aqueous phase.(Chauhan & Gupta, 2020)

Water-in-oil (W/O) creams: W/O formulation, and the oil concentration will be higher than the water content in this formulation. Mostly, these lotions are applied to dry, chapped skin.(Chauhan & Gupta, 2020)

CLASSIFICATION OF CREAMS

Skin creams can be categorized based on their kind of emulsion, function, and distinguishing characteristics.(Gaidhani, K. A., Harwalkar, M., Bhambere, D., & Nirgude, 2021)

1. Make-up cream (o/w emulsion): a) Vanishing creams. b) Foundation creams.
2. Cleansing cream, Cleansing milk, Cleansing lotion (w/o emulsion)
3. Winter cream (w/o emulsion): a) Cold cream or moisturizing creams.
4. All-purpose cream and general creams.
5. Night cream and massage creams.
6. Skin protective cream.
7. Hand and body creams.

METHODS OF CREAMS

Liquid or semisolid preparations like ointments, lotions, gels, and creams are known as topical products.(Shah et al., 2015) Creams are often thermodynamically unstable emulsions made up of two-phase systems (oil in water or water in oil), where one phase is distributed as tiny droplets throughout the other.(Buhse et al., 2005) Stabilizers such thickening agents, gelling agents, weighing agents, ripening inhibitors, and emulsifiers must be used in the production of

commercial products.(McClements & Gumus, 2016) The emulsifying agent lowers interfacial tension by having hydrophilic and hydrophobic groups that are absorbed at the water-oil interface. (Cañizares et al., 2007) Emulsifiers are very crucial components for creating stable emulsions with suitable shelf life and useful properties. Nowadays, synthetic surfactants like Tweens and Spans make up the majority of industrial emulsifiers used to stabilize oil-in-water emulsions.(Kralova & Sjöblom, 2009)

Preparation of o/w emulsion cream

O/W emulsions are typically made by mixing the water and oil phases together at a high temperature (80–85 °C) while vigorously stirring the mixture with an emulsifier until the oil droplets are fully distributed throughout the water. Typically, the emulsifying ingredient is present in the oil phase at a weight percentage of anywhere from 10% to 30%. The resulting emulsion must then be constantly stirred while cooling to avoid the emulsion separating into its two original phases. Up until the emulsion cools to 40 °C or lower, agitation is usually necessary.(*Preparation of Ow Emulsion Cream.Pdf*, n.d.)

Preparation of w/o emulsion creams

The emulsifier and the oil-soluble ingredients are combined in a single beaker and melted at 75°C. At 75°C, water and water-soluble ingredients are melted in a different beaker. Once melted, the water phase is placed in a mortar and pestle, and the oil phase is gradually added and stirred until a clicking sound is produced. This is followed by the addition of the fragrance agent once the cream has cooled. This preparation will have a higher oil phase and a lower water phase.(Aulton & Taylor, 2018)

CURRENT TREATMENTS FOR HYPERPIGMENTATION

Topical medications, which have been developed into topical dose forms including creams and gels, are frequently used to treat or manage site-specific skin hyperpigmentation.

Topical agent	**Study group**	**Study type**	**References**
Hydroquinone (4%)	30 melasma patients with skin types III-V	A double-blind, randomized, prospective study	(Haddad et al., 2003)
Arbutin (3%)	50 Caucasian and dark-skinned patients with solar lentigines	A paired comparison, vehicle-controlled, double-blind study	(Boissy et al., 2005)

Tretinoin (0.1%)	40 Caucasian patients	A randomized, double-blind, vehicle-controlled study	(&NA;, 1992)
Azelaic Acid (20%)	329 female patients	A randomized double-blind study	(Baliña & Graupe, 1991)
Niacinamide (5%)	18 Japanese women with multiple types of brown pigmentation	A randomized split-face double-blind paired design study	(Hakozaki et al., 2002)

FUTURE PERSPECTIVES

The rising demand for natural, safe, and effective alternatives to conventional therapies has positioned herbal creams as a promising solution for hyperpigmentation. However, several areas require further exploration to enhance their therapeutic potential and market acceptance. One of the foremost challenges is the standardization of herbal extracts. Variability in plant sources, extraction methods, and active compound concentrations can significantly impact the efficacy and reproducibility of herbal creams. Future research must focus on developing standardized protocols to ensure consistency in formulations.Advancements in nanotechnology and delivery systems offer another promising direction. Encapsulation techniques such as nanoemulsions, liposomes, and solid lipid nanoparticles can improve the skin penetration and stability of herbal actives, increasing their effectiveness while minimizing degradation and irritation. These technologies may allow for targeted delivery to deeper skin layers, offering superior treatment outcomes.Moreover, clinical trials with diverse populations are essential to validate safety and efficacy across different skin types, especially in people with skin of color, who are disproportionately affected by hyperpigmentation. Integrating modern analytical tools such as high-performance liquid chromatography (HPLC) and in vivo imaging can further support the pharmacological validation of herbal compounds.Regulatory frameworks also need to evolve to accommodate herbal cosmetics and medicines, ensuring consumer safety without stifling innovation. Finally, a multidisciplinary approach combining dermatology, pharmacognosy, and cosmetic science will be key in driving future development. With these advances, herbal creams have the potential to become first-line, scientifically supported treatments for hyperpigmentation.

Conclusion:

Hyperpigmentation is a common dermatological concern that affects individuals across all skin types and ages, often resulting in psychological distress. While conventional treatments like hydroquinone and retinoids are effective, they are often associated with adverse effects, leading to increased interest in herbal alternatives. Herbal creams, formulated with plant-based ingredients, offer a safer and more holistic approach due to their antioxidant, anti-inflammatory, and melanin-inhibiting properties. Their biocompatibility and reduced risk of side effects make them appealing for long-term use. However, challenges such as formulation stability, standardization of herbal extracts, and limited clinical data need to be addressed to fully harness their potential. Continued research, including modern delivery systems and rigorous clinical trials, is essential for optimizing efficacy. Overall, herbal creams represent a promising and natural solution for managing hyperpigmentation and could play a significant role in future dermatological and cosmetic therapies.

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