Extraction, Phytochemical Investigation, And Formulation Development of Turmeric-Based Herbal and Cosmeceutical Creams

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Abstract—**This study focuses on the extraction, phytochemical investigation, and formulation development of turmeric-based herbal and cosmeceutical creams using rhizomes of *Curcuma longa* as a natural bioactive source. Ethanolic extraction was employed to obtain a concentrated extract rich in secondary metabolites, followed by preliminary phytochemical screening which confirmed the presence of flavonoids, phenolic compounds, tannins, terpenoids, saponins, and glycosides. These constituents are known for their significant antioxidant, antimicrobial, and anti-inflammatory properties, with curcumin identified as the principal active compound contributing to therapeutic efficacy. The extracted material was incorporated into cream formulations using the oil-in-water (O/W) emulsion technique, and the prepared formulations were evaluated for key physicochemical parameters such as pH, spread ability, consistency, homogeneity, and stability. The results indicated that the developed creams exhibited desirable characteristics suitable for topical application, with enhanced texture and stability observed in the cosmeceutical formulation. The study demonstrates that turmeric extract can be effectively utilized in stable and skin-compatible formulations, highlighting its potential in managing various skin conditions including acne, inflammation, hyperpigmentation, and premature aging. Overall, the findings support the development of safe, economical, and plant-based alternatives to synthetic dermatological products, while providing a foundation for further research involving clinical validation and large-scale formulation development.**

Index Terms—**Turmeric, Curcumin, Phytochemical screening, Herbal cream, Cosmeceutical formulation, Antioxidant activity.**

I. INTRODUCTION

Herbal medicines and plant-based formulations have been used for centuries as safe and effective remedies for a wide range of ailments [1]. These traditional systems of healing, deeply rooted in cultural practices across the world, have relied on the therapeutic potential of natural resources to treat diseases and maintain overall health [2]. In modern times, this ancient knowledge has gained renewed importance as researchers and consumers increasingly recognize the limitations associated with synthetic drugs and chemical-based formulations [3].

In recent years, there has been a renewed global interest in natural products due to their biocompatibility, lower incidence of adverse effects, and growing consumer preference for herbal and sustainable alternatives to synthetic drugs and cosmetics [4]. This shift is further supported by increased awareness regarding environmental sustainability and the need for eco-friendly products [5]. As a result, herbal formulations are gaining widespread acceptance in both developed and developing countries [6].

This trend has led to the rapid expansion of herbal and cosmeceutical products, which combine traditional medicinal knowledge with modern pharmaceutical and cosmetic science [7]. Cosmeceuticals represent a unique category of products that bridge the gap between cosmetics and pharmaceuticals, offering both aesthetic and therapeutic benefits [8]. The integration of plant-based bioactive compounds into such formulations has opened new avenues for innovation in skincare and personal care industries [9].

Turmeric (Curcuma longa Linn.), a perennial herb belonging to the family Zingiberaceae, is one of the most extensively studied medicinal plants [10]. It has been widely used in traditional systems of medicine such as Ayurveda, Unani, and Traditional Chinese Medicine for centuries [11]. The therapeutic significance of turmeric has been documented in ancient texts, highlighting its diverse medicinal properties [12].

The rhizomes of turmeric are rich in bioactive phytochemicals, particularly curcuminoids such as curcumin, demethoxycurcumin, and bisdemethoxycurcumin [13]. In addition to these, turmeric contains volatile oils, phenolic compounds, and flavonoids that contribute to its pharmacological activities [14]. These constituents exhibit a wide range of biological effects, making turmeric a valuable natural resource for therapeutic and cosmetic applications [15].

Curcumin, the principal active compound of turmeric, has been extensively studied for its anti-inflammatory, antioxidant, antimicrobial, and wound-healing properties [16]. It plays a crucial role in neutralizing free radicals, reducing oxidative stress, and modulating inflammatory pathways [17]. These properties make curcumin particularly suitable for use in dermatological formulations aimed at treating various skin disorders [18].

Phytochemical investigation plays a crucial role in identifying and characterizing the bioactive compounds responsible for the therapeutic and cosmetic benefits of plant materials [19]. Such investigations provide scientific validation for the traditional use of medicinal plants and help in standardizing herbal formulations [20]. Furthermore, phytochemical screening assists in determining the presence of key constituents such as alkaloids, flavonoids, tannins, terpenoids, and glycosides [21].

Efficient extraction techniques are essential to obtain these active constituents in a stable and concentrated form suitable for formulation development [22]. The choice of solvent and extraction method significantly influences the yield, purity, and biological activity of the extract [23]. Therefore, optimization of extraction parameters is a critical step in ensuring the effectiveness of herbal products [24].

Cosmeceutical creams are topical formulations designed not only to enhance skin appearance but also to provide therapeutic benefits such as protection against oxidative stress, microbial infections, premature aging, and inflammation [25]. These formulations are increasingly preferred due to their ability to deliver active ingredients directly to the site of action [26]. Incorporating plant-based extracts into creams enhances their functional properties while maintaining safety and compatibility with the skin [27].

Incorporating turmeric extracts into cream formulations offers the potential to develop effective, safe, and natural skincare products [28]. However, successful formulation requires careful consideration of various factors such as stability, consistency, pH, spread ability, and skin compatibility [29]. These parameters play a crucial role in determining the quality and acceptability of the final product [30].

The increasing demand for herbal products in both pharmaceutical and cosmetic industries reflect a growing awareness of the limitations associated with synthetic chemicals, including skin irritation, toxicity, and long-term adverse effects [31]. Consumers now prefer formulations derived from natural sources that are perceived to be safer, eco-friendly, and multifunctional [32]. This shift has significantly influenced research and development activities in the field of herbal cosmeceuticals [33].

Cosmeceuticals are formulated to deliver biologically active ingredients capable of improving skin health at a cellular level [34]. Unlike conventional cosmetics, these products aim to prevent or treat dermatological conditions such as acne, hyperpigmentation, inflammation, microbial infections, photoaging, and oxidative damage [35]. Plant-based compounds with antioxidant and anti-inflammatory properties are particularly valuable in this regard [36].

Turmeric has gained considerable attention as a natural cosmeceutical ingredient due to its diverse phytochemical composition and well-documented biological activities [37]. In addition to its therapeutic properties, turmeric has been traditionally used in skincare practices for improving complexion, reducing pigmentation, and enhancing skin radiance [38]. These traditional applications further support its inclusion in modern cosmetic formulations [39].

Despite its extensive potential, the incorporation of turmeric into topical formulations presents certain

challenges, primarily due to the poor solubility and stability of curcumin [40]. Curcumin is sensitive to light, heat, and oxidative conditions, which may affect the shelf life and efficacy of formulations [41]. Therefore, appropriate formulation strategies are necessary to overcome these limitations [42].
Phytochemical screening and formulation optimization serve as essential steps in the development of effective herbal creams [43]. These processes ensure the presence of active constituents in adequate concentrations and help in maintaining product stability and performance [44]. In this context, the present study focuses on the extraction, phytochemical evaluation, and formulation development of turmeric-based herbal and cosmeceutical creams, aiming to develop safe, effective, and consumer-friendly natural skincare products.

II. LITERATURE REVIEW

Ammon and Wahl (1991) performed detailed pharmacological studies on Curcuma longa, establishing its anti-inflammatory, antioxidant, and antimicrobial properties—particularly attributed to curcuminoids. These activities laid the groundwork for later studies focusing on cosmeceutical applications. In Preprints.org (2024), Imrana Siddiqua et al. (2022) prepared and evaluated a herbal cold cream with incorporated Curcuma longa extract and reported favourable physicochemical characteristics—such as stability, appropriate pH, and lack of irritation—indicating suitability for skin application.

Al-Busaid et al. (2020) isolated curcumin from Curcuma longa and successfully formulated a moisturizing herbal cream, with physicochemical evaluations confirming smooth texture, good spread ability, and consistent pH, thereby validating standardization techniques for curcumin extraction and topical delivery. A 2019 study by Dhyani et al. formulated a multipurpose herbal cream containing turmeric along with other botanicals like Aloe vera and neem, showing acceptable evaluation results relevant to moisturizing and therapeutic skin benefits. Bait et al. (2025) prepared and evaluated an herbal turmeric cream for the face, emphasizing its antibacterial, anti-inflammatory, and antioxidant effects, with observations of stability and lack of phase separation—key criteria for cosmeceutical applicability.

Nikhil Kumar et al. (2024) developed a novel polyherbal topical cream combining Curcuma longa with other botanicals such as Aloe vera and Carica papaya, demonstrating non-irritating formulations with adequate spread ability and pH within the safe range for human skin. Imrana Siddiqua et al. (2022) prepared a turmeric-incorporated cold cream that showed stable pH, viscosity, and acceptable skin compatibility.

Ismadi (2025) demonstrated that turmeric cream formulations exhibited good spread ability and stability in oil-in-water systems. Bait et al. (2025) evaluated a turmeric herbal cream with positive 8 results and antibacterial activity. Polyherbal formulations combining turmeric with other botanicals have also been explored. Dhyani et al. (2024) and Kumar et al. (2024) reported stable, well-evaluated creams containing turmeric along with herbs like Aloe vera, highlighting synergistic effects and enhanced topical benefits.

Siddiqua et al. (2022) demonstrated good appearance, pH and viscosity values, and showed no irritation in patch tests, indicating that turmeric can be formulated in various topical bases with acceptable cosmetic properties. Nur Laili Syazwani Ismadi (2025) reported on a turmeric cream that had a normal skin pH, good spread ability, and stability in an oil-in-water emulsion system, emphasizing the practical considerations in developing consumer-friendly products. J. Arct and co-workers (2014) conducted studies on emulsions containing turmeric extract, reporting statistically significant effects on skin colour and hydration parameters. Though the change in skin tone was not always perceived as desirable by volunteers, this study confirmed the impact of turmeric on skin appearance and highlighted the scope for further optimization in cosmetic formulations.

Nikhil Kumar et al. (2024) developed a polyherbal topical cream with Aloe vera, Carica papaya, and turmeric extract. Their evaluation showed good pH values, homogeneity, and stability, demonstrating that turmeric can be effectively integrated with other herbal extracts to produce stable topical products with desirable characteristics. Archana Dhyani et al. (2024) formulated a multipurpose herbal cream using turmeric alongside Aloe vera, Neem, and Amla. Their study focused on evaluating the cream's efficacy for moisturizing and nourishing the skin, indicating the synergistic effects of combining turmeric with other botanicals for enhanced topical benefits.

Samiksha Laxman Bait et al. (2025) developed an herbal cream containing turmeric extract and evaluated its physicochemical characteristics. The cream exhibited good pH, spreadability, homogeneity, and stability, with demonstrated antibacterial activity, supporting turmeric's efficacy as a natural skincare agent. Ammon & Wahl (1991) provided early evidence of turmeric's anti-inflammatory and antioxidant activities, largely due to curcuminoids such as curcumin, demethoxycurcumin, and bisdemethoxycurcumin. These findings laid the groundwork for later topical and therapeutic applications. Khanna (1999) documented the traditional medicinal use of turmeric and identified major bioactive constituents, reinforcing its therapeutic relevance in skin care.
In 2014, Arct et al. evaluated turmeric extract in topical emulsion systems and observed measurable effects on skin colour and hydration parameters, suggesting its potential role in cosmetic formulations. A 2013 study developed a validated analytical method for estimating curcumin in cream formulations, which is crucial for quality control and standardization of turmeric-based products.

Imrana Siddiqua et al. (2022) successfully formulated an herbal cold cream with turmeric extract. Their work reported desirable physicochemical properties including stable pH and viscosity, along with no observed irritation in preliminary tests.

Nur Laili Syazwani Ismadi (2025) prepared a turmeric cream that demonstrated good spreadability and physical stability, reinforcing turmeric's suitability in oil-in-water cosmetic systems. Bait et al. (2025) developed a turmeric herbal cream with antibacterial activity and favorable physicochemical evaluations, highlighting turmeric's functional benefits beyond basic skin moisturization.

III. DRUG PROFILE

Turmeric (Curcuma longa) is a perennial herb (family Zingiberaceae) growing up to 1 meter high, characterized by an underground, branched, yellow-orange, and aromatic rhizome. It has large, oblong, dark green leaves, a short stem, and a terminal, spike-shaped inflorescence with yellow- white flowers.

Morphological Features of Turmeric (*Curcuma longa*)
The morphological characteristics of *Curcuma longa* play an important role in its identification and evaluation as a medicinal plant. The plant exhibits distinct structural features, particularly in its rhizomes, leaves, flowers, and root system.

Rhizomes (Underground Stem):
The rhizome is the primary economic and medicinally valuable part of turmeric. It is thick, branched, and segmented in structure. Externally, it appears yellowish-brown, while internally it shows a deep orange color due to the presence of curcuminoids. The rhizome possesses a characteristic pungent odor and a slightly bitter taste.

Leaves:
Turmeric leaves are large, simple, and oblong-lanceolate in shape. They arise directly from the rhizome and are supported by long petioles (leaf stalks). The leaves are bright green in color and contribute to photosynthetic activity.

Inflorescence (Flower Spike):
The inflorescence is a terminal spike measuring approximately 12–20 cm in length. It consists of a series of bracts that are usually light green, sometimes

with a purple tinge, giving the plant an attractive appearance.

Flowers:
The flowers are yellow in color and possess a typical structure with three fused petals forming the corolla. A prominent pale-yellow labellum is present, which is a modified petal contributing to pollination.

Root System:
Turmeric has a fibrous root system that originates from the rhizome. These roots help in anchorage and absorption of nutrients and water from the soil.

Microscopy of Turmeric Rhizome
Microscopic examination of *Curcuma longa* rhizome powder reveals several characteristic diagnostic features that are useful for identification and quality control. The powder typically shows abundant yellow-colored, gelatinized starch granules, parenchymatous cells containing oil and oleoresin, and scattered vascular bundles with spiral vessels.

Microscopic Features of Turmeric Powder
Starch Grains:
Numerous yellow-stained, gelatinized starch granules are present, generally ranging from 4–15 µm, and sometimes extending up to 15–25 µm in size.

Oleoresin Cells:
These cells contain yellow to orange-red droplets of essential oils or amorphous resinous substances, contributing to the therapeutic properties of turmeric.
Vessels: Spiral or reticulate vessels are commonly observed, often appearing in fragmented form within the powder.

Parenchyma Cells:
These are thin-walled cells, sometimes containing folded yellow-colored material, indicating stored metabolites.

Cork Cells and Fibers:
Multilayered cork cells, brown or yellow in color, are present along with fragments of vascular fibers, contributing to structural support.

Diagnostic Tissue Structure (Transverse Section)
Epidermis/Cork:
The outermost layer consists of 4–6 layers of thin-walled, brick-shaped cork cells that provide protection.

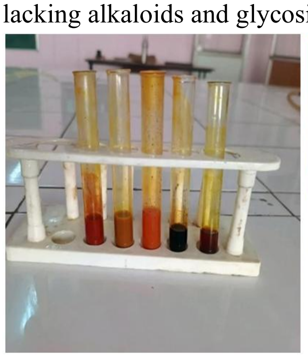
Cortex:
A wide parenchymatous region containing scattered vascular bundles and oleoresin cells is observed, playing a role in storage and transport.
Stele: The central region shows a structure similar to the cortex, with a distinct endodermis and scattered, closed collateral vascular bundles.

IV. PROCESS

EXTRACTION
The extraction of bioactive compounds from turmeric is carried out using a Soxhlet apparatus with dried turmeric powder as the primary material. Initially, turmeric rhizomes are dried (if fresh) and ground into a fine powder. A measured quantity (about 10–20 g) is placed in a cellulose thimble, which is then inserted into the Soxhlet extractor. An appropriate solvent, commonly ethanol (150–250 mL), methanol, or hexane, is added to a round bottom flask connected to the extractor, and a condenser is fixed on top with proper water circulation. The setup is heated using a heating mantle, allowing the solvent to reflux; the vapor rises, condenses, and continuously washes the turmeric powder, extracting its constituents. Once the chamber fills, the solvent siphons back into the flask carrying dissolved compounds, and this cycle is repeated for about 6–8 hours (10–15 cycles) to ensure efficient extraction. After completion, the system is cooled, and the solvent is removed using a rotary evaporator or water bath, yielding a concentrated extract. The final extract is then dried to constant weight and stored in an airtight container, resulting in a yellow-orange extract rich in curcumin and other phytochemicals.

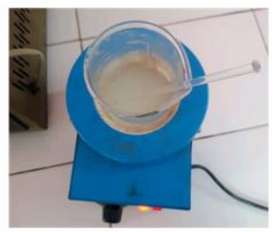
PHYTOCHEMICAL SCREENING

Phytochemical screening of turmeric rhizome using aqueous or alcoholic extract reveals the presence of several important bioactive compounds through standard qualitative tests. The alkali test confirms curcuminoids by producing a reddish-brown color upon addition of sodium hydroxide, indicating the presence of curcumin. Phenolic compounds are detected using the ferric chloride test, which gives a blue-green or dark coloration. Dragendorff's test for alkaloids shows no formation of an orange or reddish-brown precipitate, confirming their absence. Similarly, the Borntrager's test for glycosides yields no pink or red coloration after hydrolysis and chloroform extraction, indicating glycosides are absent. Flavonoids are present as confirmed by the Shinoda test, which produces a pink or reddish color upon reaction with magnesium turnings and concentrated hydrochloric acid. The gelatin test indicates tannins through the formation of a white precipitate, while the foam test confirms saponins by producing persistent froth lasting 10–15 minutes. Finally, the Sudan III test shows red coloration, indicating the presence of volatile oils. Overall, turmeric extract is rich in curcuminoids, phenolics, flavonoids, tannins, saponins, and volatile oils, while lacking alkaloids and glycosides.



FORMULATIONS

The formulation of herbal turmeric cream (oil-in-water type) is prepared using a 100 g batch comprising an oil phase, aqueous phase, active ingredients, and additives. The oil phase includes beeswax (5 g), stearic acid (3 g), coconut or almond oil (7 g), and cetyl alcohol (2 g), while the aqueous phase consists of distilled water (approximately 68 g) and glycerin (5 g). The active herbal component is turmeric extract (2 g) or finely sieved turmeric powder (0.5–1 g), along with additives such as preservative (0.2 g), optional perfume (0.1–0.2 g), and triethanolamine (q.s.) to maintain pH between 5.5 and 6.5. The preparation begins by melting the oil phase ingredients together at 70–75°C, while the aqueous phase is heated separately to the same temperature. The aqueous phase is then slowly added to the oil phase with continuous stirring to form an emulsion. The mixture is stirred continuously during cooling until it thickens into a cream. Once the temperature drops below 40°C, turmeric extract, preservative, and perfume are added, followed by pH adjustment using TEA if necessary. The prepared cream is then transferred into clean, airtight containers. This turmeric cream exhibits anti-inflammatory, antiseptic, and skin-soothing properties, making it beneficial for minor cuts, acne, and skin irritation. Evaluation of the formulation may include tests for appearance and color, pH, spreadability, skin irritation, and stability under room and accelerated conditions.



THERAPEUTIC ACTIVITIES

Turmeric cream exhibits a wide range of therapeutic uses due to its rich bioactive compounds, particularly curcumin, which provides strong medicinal properties for skin care. It acts as a powerful anti-inflammatory agent by reducing redness, swelling, and irritation, while its antimicrobial nature helps prevent bacterial and fungal infections. The cream promotes faster wound healing in minor cuts, burns, and cracked skin, and its antibacterial action makes it effective in reducing acne and pimples. Additionally, turmeric cream enhances skin complexion by reducing pigmentation and dark spots, offering a natural skin-brightening effect. Its antioxidant properties protect the skin from free radical damage, thereby slowing signs of aging such as fine lines and wrinkles. It also works as a soothing agent, relieving itching, rashes, insect bites, and mild allergic reactions including dermatitis. For chronic conditions like mild eczema and psoriasis, it helps reduce dryness, scaling, and redness. Furthermore, turmeric cream supports scar reduction and post-inflammatory hyperpigmentation, improves overall skin texture, and provides relief from mild sun damage such as tanning and sunburn. When combined with emollients, it also contributes to moisturizing the skin, keeping it soft, healthy, and nourished.

V. RESULT AND DISCUSSION

RESULT:
The extraction of *Curcuma longa* rhizomes using an ethanolic or hydroalcoholic solvent system yielded a dark yellow to orange extract with a characteristic aromatic odor, indicating the successful isolation of active constituents. Preliminary phytochemical screening confirmed the presence of flavonoids, saponins, terpenoids, phenolic compounds, tannins, and glycosides, while alkaloids and proteins were absent or present only in trace amounts, highlighting the strong antioxidant potential due to phenolics and flavonoids. Two formulations—herbal turmeric cream and cosmeceutical turmeric cream—were successfully developed using the oil-in-water (O/W) emulsion method, ensuring non-greasy, easily washable, and cosmetically acceptable products. Evaluation studies showed that both creams possessed desirable organoleptic properties, including light yellow color, pleasant odor, smooth texture, uniform homogeneity, and no phase separation. Stability studies conducted under room, refrigerated, and elevated temperature (40°C ± 2°C) conditions indicated that the formulations remained stable without significant changes, confirming their suitability for topical application.

DISCUSSION:
Turmeric has long been valued for its dermatological benefits due to the presence of curcuminoids and volatile oils exhibiting antimicrobial, antioxidant, and anti-inflammatory activities. The extraction process effectively isolated curcumin-rich compounds, and the phytochemical findings were consistent with previously reported studies, validating the therapeutic potential of the extract. The formulated creams demonstrated appropriate physicochemical characteristics such as skin-compatible pH, good spreadability, homogeneity, and stability under accelerated conditions. Notably, the cosmeceutical cream exhibited enhanced texture and stability, likely due to the synergistic effects of additional ingredients like vitamin E and aloe vera. Incorporating turmeric into a cream formulation improves user convenience, reduces staining issues associated with raw turmeric, and enhances patient compliance. Overall, the study confirms that turmeric extract can be effectively utilized in stable topical formulations with promising applications in acne treatment, skin brightening, anti-aging, and anti-inflammatory therapies, supporting the increasing demand for safe and effective plant-based cosmeceuticals.

VI. CONCLUSION

The present study successfully demonstrated the extraction, phytochemical evaluation, and formulation development of turmeric-based herbal and cosmeceutical creams using rhizomes of *Curcuma longa*, where ethanolic extraction proved to be an efficient method for isolating bioactive constituents, yielding a significant amount of extract rich in secondary metabolites, and preliminary phytochemical screening confirmed the presence of flavonoids, phenolic compounds, tannins, terpenoids, saponins, and glycosides, which are known to contribute to antioxidant, antimicrobial, and anti-inflammatory activities; moreover, the presence of curcumin, the principal active compound of turmeric, supports the therapeutic relevance of the developed formulations due to its ability to neutralize free radicals, reduce inflammatory mediators, and inhibit microbial growth, making it particularly valuable in dermatological and cosmetic applications, while the formulated herbal and cosmeceutical creams prepared using the oil-in-water (O/W) emulsion technique exhibited desirable physicochemical characteristics such as acceptable pH compatible with skin physiology, good spreadability and consistency, homogeneity without grittiness, absence of phase separation, and physical stability under different storage conditions; additionally, the cosmeceutical formulation demonstrated comparatively enhanced texture and stability, suggesting possible synergistic effects when turmeric extract is combined with supportive cosmetic excipients such as emollients and antioxidants, and overall, the findings confirm that turmeric extract can be effectively incorporated into stable topical cream formulations without compromising quality attributes, with promising potential in managing skin conditions such as acne, inflammation, hyperpigmentation, minor wounds, and premature aging, thereby establishing turmeric-based herbal and cosmeceutical creams as a safe, economical, and scientifically supported alternative to synthetic dermatological products, while also providing a strong foundation for further advanced investigations including clinical evaluation, bioavailability enhancement, and large-scale commercial formulation development.

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