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Research Article

FORMULATION AND EVALUATION OF POLYHERBAL D-TAN FACE PACK FOR SKIN BRIGHTENING AND ANTI-PIGMENTATION ACTIVITY

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Abstract

The skin is the largest and most important protective organ of the human body, continuously exposed to environmental pollutants, ultraviolet radiation, dust, and harmful microorganisms. In recent years, there has been increasing demand for herbal cosmetic products due to growing awareness regarding the side effects associated with synthetic chemical-based cosmetics. The present study was aimed at formulation and evaluation of a polyherbal D-Tan face pack using natural herbal ingredients possessing antioxidant, anti-inflammatory, antimicrobial, cleansing, and skin-brightening properties. The polyherbal face pack was prepared using cinnamon powder, orange peel powder, neem powder, ritha powder, rose powder, turmeric powder, and sandalwood powder in suitable proportions. The herbal ingredients were dried, powdered, sieved, and blended uniformly to obtain a smooth powder formulation. The prepared face pack was evaluated for various physicochemical and organoleptic parameters including color, odor, texture, pH, particle size, flow properties, moisture content, washability, irritancy, and stability. The results obtained showed that the formulation possessed good appearance, smooth texture, pleasant odor, acceptable pH, satisfactory flow properties, low moisture content, easy washability, and good stability during storage. The irritation study confirmed that the formulation was non-irritant and safe for topical application. The selected herbal ingredients collectively provided cleansing, soothing, antioxidant, anti-pigmentation, and skin rejuvenating effects. From the present investigation, it can be concluded that the formulated polyherbal D-Tan face pack is a safe, stable, effective, and economical herbal cosmetic preparation suitable for skincare applications.

Keywords: Herbal Face Pack, Formulation, Polyherbal Cosmetics, Skin Brightening, Anti-Pigmentation Activity

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Introduction

The skin is the largest organ of the human body and serves as the primary protective barrier against environmental pollutants, ultraviolet (UV) radiation, microorganisms, chemicals, and physical injuries. In addition to its protective role, the skin performs several important physiological functions including thermoregulation, sensory perception, vitamin D synthesis, immune defense, and prevention of excessive water loss [1]. Continuous exposure of the skin to sunlight, dust, pollution, and harmful chemicals often results in various dermatological and cosmetic problems such as tanning, hyperpigmentation, premature aging, acne, dryness, and dullness [2]. Among these conditions, skin tanning and pigmentation are among the most common cosmetic concerns affecting individuals worldwide, particularly in tropical countries with high sunlight exposure.

Skin tanning occurs mainly due to excessive exposure to ultraviolet radiation, especially UVA and UVB rays, which stimulate melanocytes to produce increased amounts of melanin pigment as a protective response against UV-induced damage [3]. Although melanin helps protect cellular DNA from radiation damage, excessive melanin accumulation leads to darkening of the skin, uneven complexion, and hyperpigmentation [4]. Prolonged UV exposure also generates reactive oxygen species and oxidative stress, which contribute to premature aging, collagen degradation, inflammation, and loss of skin elasticity [5]. Conventional cosmetic treatments used for detanning and pigmentation management include chemical peels, laser therapy, hydroquinone creams, corticosteroids, and bleaching agents. However, long-term use of these synthetic products may cause adverse effects such as irritation, redness, hypersensitivity, dermatitis, and skin barrier damage [6].

In recent years, there has been increasing demand for herbal cosmetic formulations due to growing awareness regarding the safety concerns associated with synthetic cosmetics. Herbal cosmetics are products formulated using natural ingredients derived from medicinal plants and botanical sources that provide cosmetic as well as therapeutic benefits [7]. These formulations contain phytoconstituents such as flavonoids, alkaloids, polyphenols, tannins, vitamins, and essential oils possessing antioxidant, anti-inflammatory, antimicrobial, soothing, and skin-brightening activities [8]. Herbal products are generally considered safer, eco-friendly, biodegradable, economical, and more compatible with skin physiology compared to synthetic chemical-based products [9].

Herbal face packs are among the most widely used cosmetic preparations for cleansing, nourishing, rejuvenating, and improving skin appearance naturally. They help remove dead skin cells, absorb excess oil, unclog pores, improve blood circulation, and reduce tanning and pigmentation [10]. Ingredients such as turmeric, sandalwood, neem, orange peel, rose, cinnamon, and ritha have been traditionally used in Ayurvedic and herbal skincare preparations because of their antioxidant, anti-inflammatory, antimicrobial, exfoliating, and skin-soothing properties [11]. Turmeric contains curcumin, which exhibits strong antioxidant and anti-inflammatory activity, while orange peel is rich in vitamin C and flavonoids that help improve complexion and reduce pigmentation [12]. Neem provides antimicrobial protection, sandalwood offers cooling and soothing effects, and ritha acts as a natural cleansing agent due to the presence of saponins [13].

Therefore, the present study was undertaken to formulate and evaluate a polyherbal D-Tan face pack using selected medicinal plant powders possessing complementary cosmetic and therapeutic properties.

The prepared formulation was evaluated for various physicochemical and organoleptic parameters including color, odor, texture, pH, flow properties, moisture content, washability, irritancy, and stability in order to determine its suitability as a safe and effective herbal cosmetic preparation for skin brightening and anti-pigmentation applications.

Materials and Methods

Materials

The materials used for the formulation of the polyherbal D-Tan face pack mainly consisted of herbal powders possessing antioxidant, anti-inflammatory, antimicrobial, cleansing, soothing, and skin-brightening properties. The selected herbal ingredients included cinnamon powder, orange peel powder, neem powder, ritha powder, rose powder, turmeric powder, and sandalwood powder. All herbal materials were procured from local Ayurvedic and herbal raw material suppliers and were authenticated prior to use according to standard pharmacognostic procedures [14,15].

Distilled water was used throughout the experimental work for preparation and evaluation studies. All chemicals and reagents used were of analytical grade. The equipment utilized during formulation and evaluation included analytical balance, mortar and pestle, mixer grinder, sieve no. 80, pH meter, hot air oven, desiccator, measuring cylinders, porcelain dish, spatula, and airtight glass containers [16].

Collection and Authentication of Plant Materials

The medicinal plant materials used in the present study were collected in dried form from authenticated herbal stores to minimize moisture content and microbial contamination. The plant materials included dried bark of *Cinnamomum verum* (cinnamon), dried peels of *Citrus sinensis* (orange peel), dried leaves of *Azadirachta indica* (neem), dried fruits of *Sapindus mukorossi* (ritha), dried petals of *Rosa* species (rose), dried rhizomes of *Curcuma longa* (turmeric), and dried wood of *Santalum album* (sandalwood).

Authentication of herbal ingredients was carried out based on organoleptic and morphological characteristics such as color, odor, texture, appearance, and botanical identity using standard herbal monographs and pharmacognostic references [17]. Foreign particles including dust, dirt, fibers, and impurities were removed manually. The authenticated plant materials were stored separately in clean airtight containers protected from moisture and direct sunlight until further processing.

Preparation of Herbal Powders

The collected herbal materials were cleaned thoroughly and dried under shade at room temperature for several days to remove residual moisture. Shade drying was preferred because direct sunlight may degrade thermolabile phytoconstituents and volatile constituents present in medicinal plants [18].

After drying, the crude drugs were pulverized separately using a mixer grinder and mortar-pestle to obtain coarse powder. The powders were then passed through sieve no. 80 to obtain fine particles with uniform size suitable for cosmetic application. Sieving also helped remove coarse particles that could produce irritation during facial application. The prepared powders were weighed accurately and stored in airtight containers until formulation [19].

Formulation of Polyherbal D-Tan Face Pack

The polyherbal D-Tan face pack was formulated by mixing accurately weighed quantities of selected herbal powders possessing complementary cosmetic and therapeutic activities. The formulation composition is presented in Table 1.

Table 1. Composition of Polyherbal D-Tan Face Pack

S. No.	Ingredient	Quantity (%)	Role in Formulation
1	Cinnamon powder	10%	Exfoliating agent
2	Orange peel powder	20%	Skin brightening agent
3	Neem powder	15%	Antimicrobial agent
4	Ritha powder	10%	Cleansing agent
5	Rose powder	15%	Soothing agent
6	Turmeric powder	10%	Anti-inflammatory agent
7	Sandalwood powder	20%	Cooling and anti-pigmentation agent

All ingredients were blended uniformly using geometric mixing technique to obtain a homogenous powder mixture. The final formulation was transferred into airtight containers and stored under dry conditions until further evaluation [20].

Preparation Procedure

Each herbal powder was separately passed through sieve no. 80 to ensure uniform particle size and smooth texture. The required quantities of powders were weighed accurately using an analytical balance. The powders were then transferred into a clean and dry mortar and mixed thoroughly by geometric dilution method to ensure homogeneity of the formulation.

The prepared formulation was visually inspected for color uniformity, texture, smoothness, and absence of lumps or foreign particles. The final face pack powder was packed in airtight glass containers and labeled properly. For topical application, the required quantity of powder was mixed with rose water or distilled water to prepare a smooth paste and applied evenly over the facial skin for approximately 15–20 min before washing with water [21].

Evaluation of Polyherbal D-Tan Face Pack

Organoleptic Evaluation

The prepared formulation was evaluated for color, odor, appearance, texture, smoothness, and homogeneity by visual inspection and touch sensation. Organoleptic evaluation helps determine the aesthetic acceptability of cosmetic formulations [22].

Determination of pH

The pH of the formulation was determined using a calibrated digital pH meter. One gram of face pack powder was dispersed in distilled water and allowed to stand for a few minutes before measurement. The pH was recorded to assess compatibility with skin physiology [23].

Evaluation of Flow Properties

Flow properties of the powder formulation were evaluated by determining bulk density, tapped density, angle of repose, Carr's index, and Hausner ratio using standard methods. These parameters help determine handling properties and powder flow behavior [24].

Particle Size Evaluation

Particle size was evaluated visually and by sieving method to ensure smooth texture and absence of coarse particles. Fine particle size improves spreadability and minimizes skin irritation during topical application [25].

Moisture Content Determination

Moisture content of the formulation was determined using hot air oven drying method. A weighed quantity of formulation was dried at controlled temperature until constant weight was obtained. Low moisture content is important to minimize microbial growth and improve stability [26].

Washability Study

Washability was evaluated by applying the prepared paste on the skin and observing ease of removal with normal water after drying. Residue formation and skin feel after washing were also observed [27].

Irritation Study

The irritancy test was carried out by applying a small quantity of formulation over a small area of skin and observing for redness, itching, swelling, or irritation after a specific time interval. The study was performed to assess safety of the formulation for topical application [28].

Stability Study

The stability study was conducted by storing the prepared formulation at room temperature and observing changes in color, odor, appearance, texture, and homogeneity over a specified period. Stability testing helps determine physical stability and storage suitability of the formulation [29].

Results and Discussion

The present study was carried out to formulate and evaluate a polyherbal D-Tan face pack containing medicinal plant powders possessing antioxidant, anti-inflammatory, antimicrobial, cleansing, soothing, and skin-brightening properties. The prepared formulation was evaluated for various physicochemical and organoleptic parameters including color, odor, texture, pH, flow properties, particle size, moisture content, washability, irritation potential, and stability. The results obtained indicated that the prepared formulation possessed satisfactory cosmetic characteristics and was suitable for topical application.

Organoleptic Evaluation

Organoleptic evaluation is one of the most important parameters in cosmetic formulation development because it determines the aesthetic appeal and acceptability of the product by users. The prepared polyherbal D-Tan face pack was evaluated for color, odor, appearance, texture, homogeneity, and consistency. The formulation exhibited a light brown to yellowish-brown color due to the presence of turmeric, sandalwood, cinnamon, and orange peel powders. The odor was found to be pleasant, aromatic, and characteristic of herbal ingredients, mainly because of sandalwood and rose powder.

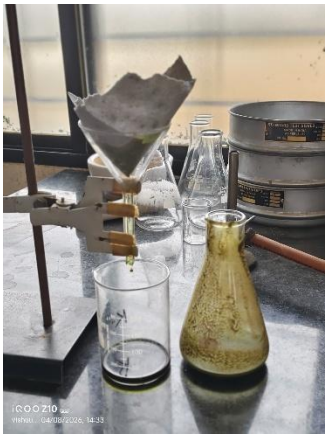
The texture of the formulation was smooth and soft without the presence of coarse particles or lumps. Proper sieving and geometric mixing contributed to uniformity and homogeneity of the formulation. These findings indicate that the formulation possessed acceptable cosmetic properties suitable for facial application.

Table 2. Organoleptic Properties of Polyherbal D-Tan Face Pack

Parameter	Observation
Color	Light brown to yellowish brown
Odor	Pleasant and aromatic
Appearance	Fine powder
Texture	Smooth and soft
Homogeneity	Uniform
Consistency	Good

The satisfactory organoleptic properties observed in the present study are comparable with previously reported herbal face pack formulations [30]. Smooth texture and pleasant odor are highly desirable

characteristics because they improve consumer compliance and cosmetic acceptability.



pH Evaluation

The pH of topical formulations plays a significant role in maintaining skin compatibility and preventing irritation. Human skin normally possesses slightly acidic pH ranging from 4.5 to 6.5, which helps maintain barrier integrity and microbial balance [23]. Therefore, cosmetic products intended for topical use should possess pH near physiological skin pH.

The pH of the prepared polyherbal D-Tan face pack was determined using a digital pH meter after dispersing the powder in distilled water. The formulation showed a pH value of 6.4 ± 0.2, which falls within the acceptable range suitable for skin application.

Table 3. pH of Polyherbal D-Tan Face Pack

Formulation	Observed pH
Polyherbal D-Tan Face Pack	6.4 ± 0.2

The obtained pH indicates that the formulation is unlikely to cause irritation, dryness, or damage to the skin barrier. Herbal ingredients such as sandalwood, rose, and turmeric may contribute toward maintaining balanced pH and soothing effects on the skin. Similar findings were reported in herbal cosmetic formulations developed by Grace et al. and Patel et al. [20,27].

Evaluation of Flow Properties

Flow properties are important parameters for powder formulations because they influence handling, packaging, mixing, and ease of application. Good flow behavior indicates proper particle size distribution and improved processability.

The flow properties of the prepared face pack powder were evaluated by determining bulk density, tapped density, angle of repose, Carr's index, and Hausner ratio. The results are presented in Table 4.

Table 4. Flow Properties of Polyherbal D-Tan Face Pack

Parameter	Observation
Bulk Density	0.48 g/cm³
Tapped Density	0.57 g/cm³
Angle of Repose	27.4°
Carr's Index	15.7%
Hausner Ratio	1.18

The angle of repose value below 30° indicated good flow behavior of the powder formulation. Carr's index and Hausner ratio values also confirmed satisfactory compressibility and flow characteristics. Proper pulverization and sieving through sieve no. 80 significantly contributed to improved powder flow properties.

Good flowability is advantageous because it ensures uniformity during packaging and smooth application over the skin surface [24].

Particle Size Evaluation

Particle size is an important parameter in herbal cosmetic formulations because it affects texture, spreadability, skin feel, and overall cosmetic acceptability. Fine particles improve smoothness and minimize irritation during topical application.

The prepared formulation showed fine and uniform particles without the presence of coarse or gritty material.

Table 5. Particle Size Evaluation of Polyherbal D-Tan Face Pack

Parameter	Observation
Particle Nature	Fine powder
Uniformity	Uniform
Presence of coarse particles	Absent
Skin feel	Smooth

The fine particle size observed in the present formulation may be attributed to proper grinding and sieving methods employed during preparation. Fine particles improve spreadability and help achieve uniform application on facial skin [25].

Moisture Content Determination

Moisture content is an important quality control parameter for herbal powder formulations because excessive moisture may promote microbial growth, reduce stability, and shorten shelf life.

The moisture content of the prepared formulation was determined using hot air oven drying method and was found to be 4.2% w/w.

Table 6. Moisture Content of Polyherbal D-Tan Face Pack

Parameter	Observation
Moisture Content	4.2% w/w

The low moisture content indicates good stability and reduced risk of microbial contamination. Proper shade drying and storage conditions maintained during preparation contributed significantly toward reduced moisture level. Low moisture content also improves flow properties and prolongs shelf life of herbal formulations [26].

Washability Study

Washability is an important characteristic of face pack formulations because it determines ease of removal after application. An ideal face pack should spread easily and should be washable without excessive rubbing or residue formation.

The prepared formulation exhibited good spreadability and was easily washable with normal water.

Table 7. Washability Study of Polyherbal D-Tan Face Pack

Parameter	Observation
Ease of Application	Good
Ease of Removal	Easily washable
Residue Formation	Minimal
Skin Feel After Washing	Smooth and refreshed

The presence of ritha powder containing natural saponins contributed significantly toward cleansing and easy washability of the formulation. After washing, the skin appeared refreshed, smooth, and free from oily residue. Similar observations were reported in herbal face pack studies by Sahu et al. and Khanna et al. [12,28].

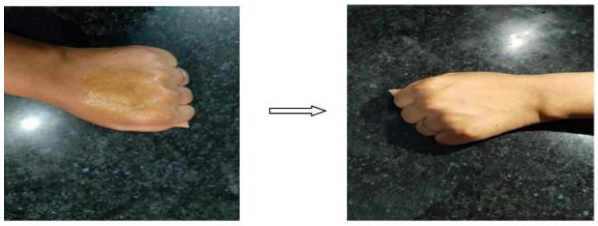
Irritation Study

Safety is one of the most important requirements for cosmetic formulations intended for topical application. Therefore, the prepared polyherbal D-Tan face pack was evaluated for irritation potential by applying the formulation over a small area of skin and observing for redness, itching, inflammation, or allergic reactions.

The formulation was found to be non-irritant and safe for topical use.

Table 8. Irritation Study of Polyherbal D-Tan Face Pack

Parameter	Observation
Redness	Absent
Itching	Absent
Swelling	Absent
Irritation	Not observed
Skin Sensitivity Reaction	Negative



No adverse reactions such as erythema, itching, or inflammation were observed after application of the formulation. The absence of irritation may be due to the natural and skin-friendly nature of herbal ingredients used in the formulation. Ingredients such as sandalwood, turmeric, rose, and neem possess anti-inflammatory and soothing activities which help improve skin compatibility [29].

Stability Study

Stability studies are essential to determine the ability of a formulation to maintain its physical characteristics and performance during storage. The prepared polyherbal D-Tan face pack was stored at room temperature and evaluated periodically for changes in color, odor, appearance, and texture.

Table 9. Stability Study of Polyherbal D-Tan Face Pack

Storage Condition	Duration	Observation
Room temperature	Initial	Stable
Room temperature	15 days	No significant change
Room temperature	30 days	Stable
Room temperature	45 days	No change in color or odor

The formulation remained physically stable throughout the storage period without significant changes in color, odor, texture, or homogeneity. The dry powder nature of the formulation and low moisture content contributed significantly toward improved stability and reduced chances of microbial spoilage.

The results obtained from the present investigation demonstrate that the formulated polyherbal D-Tan face pack possesses satisfactory physicochemical characteristics, good stability, acceptable safety profile, and favorable cosmetic properties suitable for skincare application.

Discussion

The present investigation successfully demonstrated the formulation and evaluation of a polyherbal D-Tan face pack using medicinal plant powders possessing antioxidant, anti-inflammatory, antimicrobial, cleansing, soothing, and skin-brightening activities. Herbal cosmetic formulations have gained considerable attention in recent years because of increasing awareness regarding the adverse effects associated with prolonged use of synthetic cosmetic products. The current study focused on the development of a safe, economical, stable, and effective herbal cosmetic preparation intended for detanning and improvement of skin appearance.

The organoleptic evaluation revealed that the prepared formulation possessed acceptable cosmetic characteristics including pleasant odor, smooth texture, fine appearance, and good homogeneity. These findings are important because organoleptic properties directly influence consumer acceptability and product compliance [30]. The light brown to yellowish-brown appearance observed in the formulation was mainly due to the presence of turmeric, sandalwood, cinnamon, and orange peel powders. Similar observations were reported in previously developed herbal face pack formulations containing polyherbal ingredients [31]. The pleasant aromatic odor contributed by rose and sandalwood powders further enhanced the aesthetic appeal of the formulation.

The pH of the prepared face pack was found to be 6.4 ± 0.2, which falls within the normal physiological range of skin pH. Maintenance of suitable pH is essential because highly acidic or alkaline formulations may disrupt the skin barrier and produce irritation, dryness, or microbial imbalance [23]. The observed pH suggests that the prepared formulation is compatible with skin physiology and safe for topical application. Similar pH values have been reported in herbal cosmetic formulations developed using turmeric, sandalwood, and neem extracts [27]. The balanced pH may also help maintain the natural acid mantle of the skin and improve skin barrier protection.

The flow property studies demonstrated satisfactory flow characteristics of the prepared powder formulation as evidenced by angle of repose, Carr's index, and Hausner ratio values. Proper flow behavior is important for powder-based cosmetic products because it facilitates handling, packaging, storage, and uniform application [24]. The good flow properties observed in the present study may be attributed to fine particle size, uniform sieving, and proper blending of herbal ingredients. Similar results were reported in herbal powder formulations prepared using sieve no. 80 for uniform particle distribution [25].

Particle size evaluation indicated that the prepared formulation possessed fine and uniform particles without coarse or gritty material. Fine particle size is highly desirable in facial cosmetic preparations because it improves spreadability, smoothness, and skin feel while minimizing mechanical irritation during application [32]. Proper pulverization and sieving procedures followed during formulation preparation contributed significantly toward achieving smooth texture and improved homogeneity.

Moisture content determination showed low moisture level (4.2% w/w), indicating reduced risk of microbial contamination and improved stability of the formulation. Moisture control is particularly important in herbal powder formulations because excessive moisture may promote microbial growth, degradation of phytoconstituents, caking, and reduced shelf life [26]. The low moisture content obtained in the present study may be attributed to proper shade drying and storage conditions maintained throughout the preparation process. Similar observations have been reported in stable herbal cosmetic powders intended for topical application [33].

The washability study demonstrated that the prepared face pack possessed good spreadability and could be removed easily with water without excessive residue formation. Easy washability is an important characteristic because cosmetic products should provide cleansing effects without causing discomfort or excessive dryness after application [34]. The presence of ritha powder containing natural saponins may have contributed significantly toward cleansing activity and easy removal of the formulation from the skin surface. After washing, the skin appeared refreshed, smooth, and free from oily residue,

indicating effective cleansing and soothing action of the herbal ingredients.

Safety evaluation through irritancy testing confirmed that the prepared formulation was non-irritant and safe for topical use. No signs of redness, itching, swelling, erythema, or inflammation were observed following application. The absence of irritation may be attributed to the use of natural herbal ingredients possessing anti-inflammatory and soothing activities. Turmeric contains curcumin, which exhibits potent antioxidant and anti-inflammatory effects, while sandalwood and rose provide cooling and soothing actions beneficial for sensitive skin [12,13]. Neem also contributes antimicrobial protection and helps reduce inflammatory reactions associated with acne and skin infections [35]. These findings support the suitability of the prepared formulation for regular cosmetic application.

The stability study revealed that the formulation remained physically stable during storage without significant changes in color, odor, texture, or homogeneity. Stability is an important parameter because cosmetic products must retain their quality, appearance, and efficacy throughout the storage period [29]. The dry powder nature of the formulation and low moisture content may have contributed significantly toward improved physical stability and reduced microbial spoilage. The findings indicate that the prepared polyherbal face pack possesses acceptable shelf stability under normal storage conditions.

The effectiveness of the present formulation can also be explained based on the synergistic activity of its herbal constituents. Orange peel powder is rich in vitamin C, flavonoids, and citric acid which help reduce pigmentation and improve skin brightness through antioxidant and exfoliating mechanisms [5]. Turmeric exhibits antioxidant and anti-inflammatory activity due to curcumin, which may help reduce oxidative stress and tanning caused by ultraviolet exposure [12]. Neem provides antimicrobial protection, sandalwood offers cooling and anti-pigmentation effects, rose contributes soothing and rejuvenating activity, while cinnamon enhances exfoliation and blood circulation [11,13]. The combined action of these ingredients may therefore contribute toward cleansing, detanning, skin rejuvenation, and improvement of complexion naturally.

Overall, the results obtained from the present study indicate that the formulated polyherbal D-Tan face pack possesses satisfactory physicochemical properties, good stability, acceptable safety profile, and promising cosmetic potential for skincare applications. The formulation may serve as a safe and effective herbal alternative to synthetic cosmetic products used for detanning and skin brightening purposes.

Conclusion and Future Scope

The present study successfully demonstrated the formulation and evaluation of a polyherbal D-Tan face pack using natural herbal ingredients such as turmeric, neem, sandalwood, orange peel, rose, cinnamon, and ritha powders. The prepared formulation showed satisfactory physicochemical properties including acceptable pH, good flow behavior, smooth texture, low moisture content, easy washability, and good stability. The formulation was also found to be non-irritant and safe for topical application. The synergistic action of the herbal ingredients may help reduce tanning, improve skin complexion, provide antioxidant protection, and maintain skin hygiene naturally. Therefore, the formulated polyherbal face pack can be considered a safe, stable, economical, and effective herbal cosmetic preparation for skincare applications.

Further studies may focus on incorporation of additional herbal extracts and advanced drug delivery systems to improve cosmetic efficacy and stability.

Clinical evaluation, antioxidant studies, antimicrobial studies, and melanin inhibition assays may provide scientific validation of the formulation. Future development of herbal gels, peel-off masks, creams, and nanoformulations may enhance commercial applicability and therapeutic effectiveness of herbal cosmetic products.

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