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DEVELOPMENT AND EVALUATION OF A POLYHERBAL FACIAL SERUM WITH ANTIOXIDANT, ANTIMICROBIAL, AND MOISTURIZING PROPERTIES

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ABSTRACT

Skin disorders such as dryness, acne, hyperpigmentation, and inflammation are increasingly prevalent among young adults, necessitating the development of safe and effective topical formulations. In recent years, herbal and Ayurvedic cosmetic products have gained significant attention due to their perceived safety, multifunctional benefits, and cultural acceptance. Among topical dosage forms, facial serums offer advantages such as low viscosity, rapid absorption, and efficient delivery of active constituents to the skin. The present study aimed to develop and evaluate a polyherbal face serum formulated using natural plant extracts, namely *Ocimum sanctum* (Tulsi), *Curcuma longa* (Turmeric), *Nyctanthes arbor-tristis* (Parijat flower stalks), and *Punica granatum* (Pomegranate). Oil infusion and aqueous extraction techniques were employed to obtain the herbal extracts, which were incorporated into a serum base comprising almond oil and rose water. The formulation was evaluated for physicochemical properties, phytochemical composition, antimicrobial activity, skin hydration potential, stability, and user acceptability. The developed serum exhibited a skin-compatible pH of 5.3, suitable viscosity (~320 cP), good spreadability, and satisfactory physical stability under accelerated storage conditions. Qualitative and quantitative phytochemical analyses confirmed the presence of phenolics and flavonoids, with total phenolic content of 78 mg GAE/g and flavonoid content of 56 mg QE/g extract. The formulation demonstrated notable antimicrobial activity against *Staphylococcus aureus* and *Cutibacterium acnes*. In vivo skin

hydration assessment showed a 38% increase in moisture content after 2 hours of application, while user acceptability studies indicated good tolerability with no signs of skin irritation.

KEYWORDS: Polyherbal face serum, Herbal cosmetic formulation, Antioxidant and antimicrobial activity, Skin hydration, Ayurvedic skin care.

1. INTRODUCTION

The skin is the largest organ of the human body and serves as a critical protective barrier against environmental, chemical, and microbial insults while maintaining internal homeostasis. It plays a vital role in regulating hydration, thermoregulation, immune defence, and sensory perception.[1] However, continuous exposure to environmental stressors such as ultraviolet radiation, air pollution, microbial colonization, and lifestyle-related factors including stress and hormonal imbalance can compromise skin integrity and function.[2] As a result, various skin-related concerns such as dryness, acne, inflammation, uneven skin tone, and hyperpigmentation have become increasingly prevalent, particularly among young adults. Acne vulgaris is often associated with excessive sebum production and bacterial proliferation, whereas dryness and inflammation are linked to impaired barrier function and oxidative stress.[3] These multifactorial skin conditions highlight the need for topical formulations that not only provide cosmetic enhancement but also support skin health through hydration, protection, and biological activity.

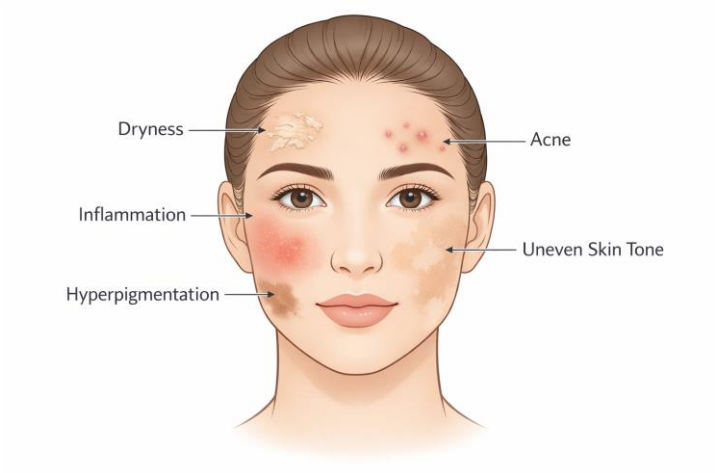

Fig. 1: Common facial skin concerns associated with dryness, acne, inflammation, uneven skin tone, and hyperpigmentation.

Note: The image is for illustrative purposes only.

Limitations Of Conventional Synthetic Cosmetics

Conventional cosmetic formulations commonly rely on synthetic active ingredients, preservatives, fragrances, and emulsifying agents to achieve desired aesthetic and functional effects. While such products may offer rapid and visible outcomes, their prolonged or inappropriate use has been associated with adverse skin reactions, including irritation, contact dermatitis, hypersensitivity, and disruption of the skin's natural barrier. Ingredients such as synthetic antioxidants, alcohol-based solvents, and certain preservatives may compromise skin hydration and exacerbate inflammation, particularly in individuals with sensitive or acne-prone skin. Moreover, the long-term safety of repeated exposure to complex synthetic formulations remains a concern, especially when used on facial skin.[4,5] These limitations, coupled with increasing consumer awareness regarding ingredient safety and sustainability, have prompted a growing demand for alternative skincare solutions that are effective yet gentle, biocompatible, and suitable for regular use.

Shift Toward Herbal and Ayurvedic Skincare

In response to the limitations associated with synthetic cosmetic products, there has been a substantial shift toward the use of herbal and Ayurvedic formulations in skincare. Herbal cosmetics are derived from natural plant sources and are valued for their holistic approach, combining therapeutic efficacy with improved skin compatibility. Ayurvedic principles emphasize the use of botanicals possessing antioxidant, anti-inflammatory, antimicrobial, and rejuvenating properties, which help maintain skin balance and promote long-term skin health. Plant-based formulations often contain a diverse range of bioactive phytochemicals such as phenolics, flavonoids, tannins, and terpenoids that act synergistically to protect the skin against oxidative stress, microbial invasion, and environmental damage.[6] Additionally, herbal cosmetics enjoy strong cultural acceptance in India and are increasingly gaining global recognition due to rising consumer preference for natural, sustainable, and eco-friendly personal care products.[7] This growing inclination toward herbal skincare has encouraged scientific validation of traditional formulations using modern pharmaceutical and cosmetic evaluation techniques.

Role and Advantages of Face Serums

Among the various topical cosmetic dosage forms, face serums have gained considerable popularity due to their unique formulation characteristics and enhanced performance. Face serums are typically low-viscosity, lightweight preparations designed to deliver a high

concentration of active ingredients directly to the skin. Their smaller molecular size and reduced lipid content enable better penetration into the superficial layers of the skin, resulting in faster onset of action and improved bioavailability of active constituents. Compared to conventional creams and lotions, serums provide superior spreadability, non-greasy feel, and minimal occlusiveness, making them particularly suitable for daily facial application and for individuals with oily or acne-prone skin. Furthermore, serums allow effective incorporation of herbal extracts and antioxidants without excessive use of heavy emulsifiers, thereby maintaining formulation stability while enhancing skin hydration, radiance, and overall skin texture.[8,9] These advantages make face serums an ideal dosage form for delivering multifunctional herbal actives aimed at improving skin health.

Rationale for Selected Herbal Ingredients

The selection of herbal ingredients for the present formulation was based on their well-documented traditional use and scientifically reported benefits for skin health. *Ocimum sanctum* (Tulsi) is widely recognized for its antioxidant, anti-inflammatory, and antimicrobial properties, which contribute to protection against oxidative stress and microbial-induced skin conditions.[10] *Curcuma longa* (Turmeric) contains curcuminoids known for their strong antioxidant and anti-inflammatory activities, along with skin-brightening and soothing effects.[11] *Nyctanthes arbor-tristis* (Parijat) has been traditionally used in Ayurvedic medicine for its anti-inflammatory and skin-conditioning properties, supporting skin rejuvenation and clarity.[12] *Punica granatum* (Pomegranate) is rich in polyphenols and flavonoids that enhance skin hydration, improve barrier function, and protect against environmental damage.[13] The synergistic combination of these botanicals was therefore considered suitable for developing a multifunctional face serum capable of addressing multiple skin concerns such as dryness, inflammation, acne, and uneven skin tone.

Research Gap and Aim of the Study

Although numerous studies have reported the individual cosmetic and therapeutic benefits of herbal ingredients such as *Ocimum sanctum*, *Curcuma longa*, *Nyctanthes arbor-tristis*, and *Punica granatum*, limited scientific literature is available on their combined incorporation into a stable and consumer-acceptable face serum formulation. Most existing reports focus on single-herb preparations or conventional dosage forms, with inadequate emphasis on formulation optimization, physicochemical characterization, and user-oriented performance evaluation. Furthermore, systematic studies assessing skin hydration potential, antimicrobial

efficacy against acne-associated microorganisms, and overall user acceptability of polyherbal serums remain scarce. In view of these gaps, the present study was undertaken to develop and evaluate a polyherbal face serum using selected medicinal plant extracts, with the objective of assessing its physicochemical properties, phytochemical composition, antimicrobial activity, skin hydration effect, stability, and user acceptability. The study aims to scientifically validate a natural cosmetic formulation that integrates traditional herbal knowledge with modern cosmetic evaluation parameters.

2. MATERIALS AND METHODS

2.1 Materials

Fresh rhizomes of *Curcuma longa* (Turmeric), leaves of *Ocimum sanctum* (Tulsi), and flower stalks of *Nyctanthes arbor-tristis* (Parijat) were procured from local markets in Panvel, Maharashtra, India. Fresh arils of *Punica granatum* (Pomegranate) were obtained from local vendors and used for the preparation of the aqueous extract. All plant materials were cleaned thoroughly and authenticated based on their morphological characteristics prior to use.

Fig. 2: Dried flower stalks of *Nyctanthes arbor-tristis* (Parijat) used for preparation of oil infusion.

Fig. 3: Dried leaves of *Ocimum sanctum* (Tulsi) used for extraction.

Table 1: List of Herbal Ingredients Used in the Polyherbal Face Serum.

Sr. No.	Common Name	Botanical Name	Part Used	Role in Formulation	Ref. no.
1	Tulsi	*Ocimum sanctum*	Leaves	Antioxidant, anti-inflammatory, antimicrobial; helps in reducing acne and skin inflammation	[14]
2	Turmeric	*Curcuma longa*	Rhizomes	Anti-inflammatory, antioxidant, skin brightening and soothing agent	[11,15]
3	Parijat	*Nyctanthes arbor-tristis*	Flower stalks	Anti-inflammatory, skin-conditioning and rejuvenating agent	[12]
4	Pomegranate	*Punica granatum*	Arils	Antioxidant, humectant; improves skin hydration and barrier function	[13,16]

Sweet almond oil was used as the carrier oil for the preparation of herbal oil infusions, while rose water was employed as the aqueous base of the formulation. Orange essential oil was used as a fragrance and volatile bioactive component. Ascorbic acid was incorporated as an antioxidant stabilizer, sodium benzoate was used as a preservative, and sodium alginate served as a viscosity-modifying agent. All chemicals and excipients used in the study were of analytical grade and procured from standard suppliers.

Distilled water was used throughout the experimental work. All glassware employed was of borosilicate quality. Analytical instruments, including a digital pH meter, Brookfield viscometer, refractometer, pycnometer, and corneometer, were calibrated prior to use to ensure accuracy and reliability of measurements.

2.2 Preparation of Herbal Extracts

2.2.1 Preparation of Turmeric Extract (*Curcuma longa*) – Oil Infusion Method

Fresh rhizomes of *Curcuma longa* were washed thoroughly with water to remove adhering soil and impurities, followed by shade drying at room temperature until constant weight was achieved. The dried rhizomes were coarsely powdered using a mechanical grinder. Approximately 50 g of the powdered material was transferred to a clean glass container and immersed in sweet almond oil in sufficient quantity to completely cover the plant material. The mixture was kept at room temperature for 7 days with occasional stirring to facilitate extraction of oil-soluble phytoconstituents. After completion of the infusion period, the mixture was filtered initially through muslin cloth and subsequently through Whatman filter paper to obtain a clear turmeric-infused oil. The yield of the extract obtained was approximately 85% w/w with respect to the initial plant material.

2.2.2 Preparation of Tulsi Extract (*Ocimum sanctum*) – Oil Infusion Method

Fresh leaves of *Ocimum sanctum* were cleaned, shade dried, and pulverized to obtain a coarse powder. The powdered leaves were subjected to cold maceration using sweet almond oil as the carrier oil. The plant material was immersed in the oil and kept undisturbed for 7 days at room temperature with intermittent stirring to enhance diffusion of phytoconstituents into the oil phase. After maceration, the mixture was filtered through muslin cloth followed by Whatman filter paper. The filtered tulsi-infused oil was collected and stored in an airtight container, yielding approximately 45% w/w extract.

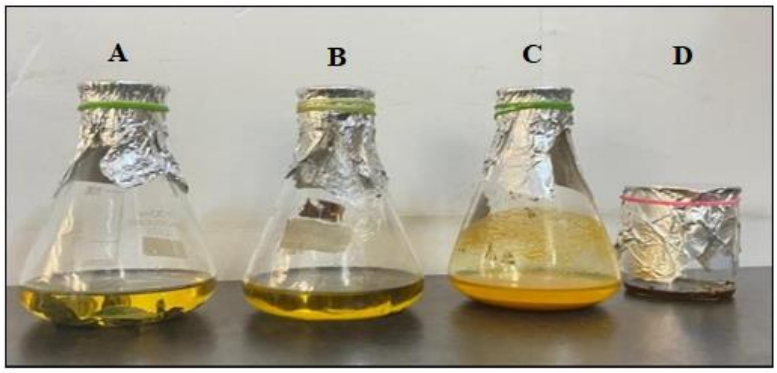

Fig. 4: Herbal materials immersed in carrier oil for preparation of oil infusions.

A) Dried leaves of *Ocimum sanctum* immersed in carrier oil.
B) Dried stalks of *Nyctanthes arbor-tristis* flowers immersed in carrier oil.
C) Dried rhizomes of *Curcuma longa* immersed in carrier oil.
D) Extract obtained from arils of *Punica granatum*

2.2.3 Preparation of Parijat Flower Stalk Extract (*Nyctanthes arbor-tristis*) – Oil Infusion Method

Dried flower stalks of *Nyctanthes arbor-tristis* were coarsely powdered and infused in sweet almond oil using a procedure similar to that described for turmeric and tulsi extracts. The mixture was maintained at room temperature for 7 days with occasional agitation. Following the infusion period, the oil was filtered to remove plant residues, resulting in a pale-yellow aromatic extract. The yield of the parijat flower stalk extract was found to be approximately 30% w/w.

2.2.4 Preparation of Pomegranate Extract (*Punica granatum*)

Fresh arils of *Punica granatum* were separated manually and pressed to obtain the juice. The juice was filtered to remove solid residues and concentrated under reduced pressure at a

temperature below 45°C to preserve thermolabile phytoconstituents. The concentrated aqueous extract obtained showed a yield of approximately 80% w/w and was stored under refrigerated conditions until further use in formulation.

2.3 Phytochemical Evaluation

2.3.1 Qualitative Phytochemical Screening

Qualitative phytochemical screening of the prepared herbal extracts was carried out to identify the presence of major classes of secondary metabolites responsible for biological activity. Standard phytochemical tests were performed using established procedures to detect phenolics, flavonoids, tannins, saponins, terpenoids/steroids, and alkaloids. The tests included the ferric chloride test for phenolics, alkaline reagent and Shinoda tests for flavonoids, gelatine or lead acetate test for tannins, foam test for saponins, and Salkowski and Liebermann–Burchard tests for terpenoids and sterols. Alkaloids were screened using Mayer's and Wagner's reagents. The appearance of characteristic colour changes or precipitates was considered indicative of the presence of the respective phytochemical constituents.

2.3.2 Quantitative Phytochemical Analysis

Determination of Total Phenolic Content

The total phenolic content of the herbal extracts was determined using the Folin–Ciocalteu colorimetric method. Briefly, a measured quantity of the extract was mixed with Folin–Ciocalteu reagent, followed by the addition of sodium carbonate solution. The reaction mixture was incubated for a specified duration at room temperature, and the absorbance was measured using a UV–Visible spectrophotometer. Gallic acid was used as the reference standard, and the total phenolic content was expressed as milligrams of gallic acid equivalents (mg GAE) per gram of extract.

Determination of Total Flavonoid Content

The total flavonoid content was estimated by the aluminium chloride colorimetric method. An appropriate volume of the extract was mixed with aluminium chloride solution and allowed to react under controlled conditions. The absorbance of the resulting complex was measured spectrophotometrically. Quercetin was used as the standard reference compound, and the flavonoid content was expressed as milligrams of quercetin equivalents (mg QE) per gram of extract.

2.4 Formulation of Polyherbal Face Serum

2.4.1 Composition of the Polyherbal Face Serum

The composition of the polyherbal face serum was finalized based on preliminary trials and literature evidence to achieve optimum stability, skin compatibility, and functional performance. The formulation comprised herbal extracts of *Ocimum sanctum*, *Curcuma longa*, *Nyctanthes arbor-tristis*, and *Punica granatum*, along with almond oil as the carrier oil, rose water as the aqueous base, orange essential oil as a fragrance component, ascorbic acid as a stabilizer, sodium benzoate as a preservative, and sodium alginate as a viscosity-modifying agent. The detailed formulation composition is presented in the formulation table.

Table 2: Formulation Table.

Sr. No.	Ingredient	Role	% w/w
1.	Tulsi extract	Antioxidant, anti-inflammatory[14]	5.0%
2.	Turmeric extract	Anti-inflammatory, brightening agent[15,17]	3.0%
3.	Parijat flower extract	Skin brightening	2.0%
4.	Pomegranate extract/juice	Antioxidant, humectant[13,16]	10%
5.	Almond oil	Carrier emulsifier[18]	10%
6.	Orange essential oil	Aroma	0.5%
7.	Rose water	Aqueous base	68%
8.	Ascorbic acid	Stabilizer	0.5%
9.	Sodium benzoate	Preservative	0.5%
10.	Sodium alginate	Viscosity agent	0.5–1.0%

2.4.2 Method of Preparation

Oil Phase Preparation

The oil phase was prepared by combining sweet almond oil with the oil-infused herbal extracts of turmeric (3% w/w), tulsi (5% w/w), and parijat flower stalks (2% w/w). The mixture was stirred gently at ambient temperature until a uniform and homogeneous oil phase was obtained. Orange essential oil (0.5% w/w) was then added to the oil phase and mixed thoroughly to ensure even distribution.

Aqueous Phase Preparation

The aqueous phase was prepared by mixing rose water (68% w/w) with concentrated pomegranate extract (10% w/w). Ascorbic acid (0.5% w/w) was dissolved completely in the aqueous phase to act as an antioxidant stabilizer, followed by the addition of sodium benzoate (0.5% w/w) as a preservative. Sodium alginate (0.5–1.0% w/w) was dispersed in warm rose water with continuous stirring to improve viscosity and formulation stability. The aqueous phase was maintained at a temperature of approximately 35–40 °C prior to emulsification.

Emulsification Process

The oil phase was slowly added to the aqueous phase under continuous mechanical stirring at approximately 700 rpm for 20–25 minutes. The mixture was then allowed to cool gradually to room temperature while the stirring speed was reduced to around 300 rpm, resulting in the formation of a homogeneous, emulsion-like serum.

Fig. 5: Emulsification process during preparation of the polyherbal face serum using a magnetic stirrer with hot plate.

pH Adjustment

The pH of the formulated serum was measured using a calibrated digital pH meter and adjusted to the skin-compatible range of 5.0–5.5 by the addition of dilute citric acid or sodium bicarbonate solution. The final pH of the formulation was observed to be 5.3.

Filling and Storage

The finished serum was transferred into sterilized amber-colored glass dropper bottles to protect the formulation from light-induced degradation. The containers were labeled appropriately and stored under refrigerated conditions (4 °C), room temperature, and accelerated stability conditions (40 °C) for further evaluation.

2.5 Evaluation of the Polyherbal Face Serum

The formulated polyherbal face serum was evaluated using the following parameters to assess its physicochemical characteristics, stability, safety, and functional performance:

Physicochemical Evaluation

- Organoleptic characteristics (color, odor, texture)

- pH determination
- Viscosity measurement
- Spreadability
- Refractive index
- Specific gravity

Stability Studies

- Accelerated stability testing at refrigerated (4 °C), room temperature, and elevated temperature (40 °C) conditions.

Phytochemical Content

- Determination of total phenolic content
- Determination of total flavonoid content

Antimicrobial Activity

- Evaluation of antibacterial activity against acne-associated microorganisms.

Skin Irritation Study

- Patch test for assessment of dermal irritation and safety.

Skin Hydration Study

- Measurement of skin hydration using a corneometer.

User Acceptability Study

- Assessment of user satisfaction and tolerability through a structured questionnaire.

3. RESULTS AND DISCUSSION

The polyherbal face serum formulated using extracts of *Ocimum sanctum*, *Curcuma longa*, *Nyctanthes arbor-tristis*, and *Punica granatum* was evaluated for its physicochemical properties, phytochemical composition, stability, antimicrobial activity, skin hydration potential, and user acceptability. The results obtained from these evaluations are discussed below in relation to formulation performance and skin applicability.

3.1 Physicochemical Properties

The formulated serum exhibited acceptable organoleptic characteristics, appearing pale pinkish-brown in color with a pleasant floral aroma and smooth texture, indicating good

aesthetic appeal for cosmetic use. The pH of the formulation was found to be 5.3, which lies within the normal physiological pH range of human skin, suggesting suitability for topical facial application without causing irritation. Viscosity measurement showed a value of approximately 320 cP at 25°C, indicating a low-viscosity formulation that allows easy spreadability and rapid absorption. The spreadability value (7.1 cm^2) further supported the ease of application and uniform distribution of the serum over the skin surface. Refractive index (1.338) and specific gravity (1.03 g/cm^3) values were within acceptable limits, reflecting formulation uniformity and stability.

3.2 Phytochemical Composition

Qualitative phytochemical screening confirmed the presence of major secondary metabolites, including phenolics, flavonoids, tannins, saponins, and terpenoids, which are known to contribute to antioxidant, antimicrobial, and skin-protective activities. Quantitative analysis revealed a total phenolic content of 78 mg GAE/g extract and total flavonoid content of 56 mg QE/g extract, indicating a rich phytochemical profile. The presence of these bioactive compounds supports the multifunctional nature of the serum and its potential role in protecting the skin against oxidative stress and environmental damage.

Table 3: Qualitative phytochemical screening of herbal extracts.

Sr. No.	Phytochemical class	Test(s) used	Result (qualitative)
1.	Phenolics	Ferric chloride test	Positive (phenolics detected).
2.	Flavonoids	Alkaline reagent / Shinoda test	Positive (flavonoids detected)
3.	Tannins	Gelatin or Lead acetate test	Positive (Tannins detected)
4.	Saponins	Foam test	Positive (Saponins detected)
5.	Terpenoids / Sterols	Salkowski / Liebermann–Burchard	Positive (terpenoids detected).
6.	Alkaloids	Mayer/Wagner test	Positive (alkaloids detected)

3.3 Stability Studies

The formulated serum remained physically stable under refrigerated (4 °C), room temperature, and accelerated conditions (40 °C) for a period of one month. No phase separation, precipitation, or significant change in texture was observed during the study period. A slight change in colour was noted at elevated temperature, which may be attributed to the presence of natural pigments and phenolic compounds; however, this did not affect the overall stability or performance of the formulation.

3.4 Antimicrobial Activity

The antimicrobial evaluation demonstrated notable antibacterial activity of the polyherbal serum against acne-associated microorganisms. The formulation exhibited zones of inhibition of 17 mm against *Staphylococcus aureus* and 20 mm against *Cutibacterium acnes*. This activity can be attributed to the synergistic antimicrobial effects of herbal constituents such as curcuminoids, polyphenols, and essential oils present in the formulation, indicating its potential usefulness in managing acne-prone skin.

3.5 Skin Irritation and Hydration Studies

The skin irritation study conducted using a patch test revealed no signs of redness, itching, inflammation, or discomfort in any of the volunteers, indicating that the formulation is non-irritant and safe for topical application. The skin hydration study showed a significant increase of approximately 38% in skin moisture content after 2 hours of application, demonstrating the moisturizing and humectant properties of the serum. This effect may be attributed to the presence of pomegranate extract, rose water, and the serum's lightweight formulation, which enhances skin hydration without greasiness.

3.6 User Acceptability Study

The user acceptability survey conducted among volunteers reported high satisfaction with respect to texture, spreadability, absorption, and overall feel of the serum. No adverse reactions were observed during the study period, further supporting the formulation's suitability for regular facial use.

The results obtained from the present study indicate that the polyherbal face serum possesses desirable physicochemical properties, a rich phytochemical profile, satisfactory stability, antimicrobial activity, and effective skin hydration potential. The combined action of selected herbal extracts provides a synergistic effect, making the formulation suitable for addressing multiple skin concerns such as dryness, acne, and inflammation. These findings support the potential application of the developed serum as a natural cosmetic formulation, although further long-term stability studies and controlled clinical evaluations are recommended to substantiate its commercial applicability.

Table 4: Physicochemical, stability, and biological evaluation of polyherbal serum.

Sr. no.	Test	Purpose	Method	Sample Result
1	**Organoleptic Properties**	Assess visual/sensory appeal	Visual & sensory inspection	Pale pinkish-brown, floral odour, smooth texture
2	**pH**	Suitability for facial skin	Digital pH meter	5.3 (within skin compatible range)
3	**Viscosity**	Serum flow/spread property	Brookfield viscometer	320 cP at 25°C
4	**Spreadability**	Ease of application	Glass slide method	7.1 cm^2
5	**Refractive Index**	Formulation clarity	Abbe Refractometer	1.338
6	**Specific Gravity**	Physical property for packaging	Pycnometer method	1.03 g/cm^3
7	**Stability Test (Accelerated**	Shelf-life prediction	Stored at 4°C, RT, 40°C for 1 month	No separation; slight color change at 40°C
8	**Flavonoid Content**	Secondary metabolites	Aluminium chloride colorimetric method	56 mg QE/g extract
9	**Antibacterial Activity**	Against acnecausing bacteria	Agar well diffusion (S. aureus, P. acnes)	Zone of inhibition: 17 mm (S. aureus), 20 mm (P. acnes)
10	**Skin Irritation Study (Patch Test)**	Check for skin sensitivity	Human patch test	No redness, itching, or irritation observed
11	**Skin Hydration Effect**	Moisturizing property	Corneometer (before & after application)	38% increase in skin hydration (after 2 hrs)
12	**User Acceptability Survey**	Consumer satisfaction	Questionnaire (n=15 volunteers)	No redness, itching or irritation observed in 15 volunteers

Fig. No. 6: Final formulated polyherbal face serum.

CONCLUSION

The present study successfully developed and evaluated a polyherbal face serum incorporating extracts of *Ocimum sanctum*, *Curcuma longa*, *Nyctanthes arbor-tristis*, and *Punica granatum* using almond oil and rose water as the formulation base. The formulated

serum exhibited desirable physicochemical properties, including skin-compatible pH, appropriate viscosity, good spreadability, and satisfactory physical stability under varied storage conditions. Phytochemical evaluation confirmed the presence of bioactive constituents such as phenolics and flavonoids, which contribute to the antioxidant and protective potential of the formulation.

The polyherbal serum demonstrated notable antimicrobial activity against acne-associated microorganisms and showed a significant improvement in skin hydration without causing irritation or adverse reactions in volunteers. The favorable user acceptability further supports the suitability of the formulation for regular facial application. The synergistic action of the selected herbal ingredients played a key role in addressing multiple skin concerns, including dryness, inflammation, and acne-prone conditions.

Overall, the findings of this study indicate that the developed polyherbal face serum has promising potential as a natural cosmetic formulation. However, further analytical standardization, extended stability studies, and controlled clinical evaluations are required to establish its long-term safety, efficacy, and commercial viability.

FUTURE SCOPE

The findings of the present study provide a foundation for further research and development of the formulated polyherbal face serum. Future work may focus on advanced analytical standardization of the formulation using instrumental techniques such as HPTLC, GC–MS, or LC–MS to ensure batch-to-batch consistency and identification of key bioactive constituents. Extended stability studies in accordance with regulatory guidelines are required to establish the shelf life and long-term physical, chemical, and microbiological stability of the product.

Controlled clinical studies involving a larger and more diverse population may be conducted to substantiate the skin hydration, anti-acne, and skin-conditioning effects observed in the preliminary evaluation. In addition, assessment of other functional parameters such as antioxidant activity on skin, transdermal penetration, and efficacy under different skin types and environmental conditions may further validate the formulation’s performance. Optimization of formulation composition and packaging, along with evaluation of consumer safety and regulatory compliance, will be essential steps toward successful commercialization of the polyherbal face serum as a natural cosmetic product.

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