Formulation and Evaluation of a Poly-Herbal Face Serum

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***Abstract*—The present work focuses on the formulation and evaluation of a poly-herbal face serum using natural and safe ingredients such as Aloe vera gel, rose water, cucumber extract, green tea extract, liquorice root extract, almond oil, and sodium benzoate. The serum was developed to achieve improved skin nourishment, antioxidant protection, and overall cosmetic stability. Various physicochemical and biological tests including patch test, pH determination, spreadability, centrifugation, microbial safety, specific gravity, and stain test were conducted. The results confirmed that the serum was stable, skin-friendly, and safe for topical application.**

***Index Terms*—Herbal serum, Aloe vera, Green tea, Antioxidant, Cosmetic evaluation, Stability**

I. INTRODUCTION

In recent years, consumer preference has shifted towards herbal and natural cosmetic formulations due to their biocompatibility, reduced side effects, and sustainable nature. Herbal face serums are lightweight formulations rich in plant-based actives that penetrate deeper into the skin, providing targeted nourishment and therapeutic effects. Aloe vera (Aloe barbadensis), rose water, cucumber extract, green tea extract, liquorice root extract, and almond oil are among the most widely used natural ingredients known for their synergistic effects in improving skin tone, hydration, and texture.[1]

Aloe vera is well known for its moisturizing and soothing properties; it contains polysaccharides and glycoproteins that help in skin hydration and healing. Rose water acts as a natural toner with a mild fragrance and possesses antioxidant activity. Cucumber extract provides cooling, anti-inflammatory, and moisturizing effects. Green tea extract is rich in catechins that prevent oxidative damage. Liquorice root extract helps in reducing pigmentation and inflammation, while almond oil provides emollient and nourishing benefits. Sodium benzoate serves as a preservative ensuring microbial safety of the formulation.[2]

With the growing awareness of skin health and environmental sustainability, consumers increasingly seek products that are free from synthetic chemicals, parabens, and artificial fragrances. Herbal formulations not only provide safer alternatives but also offer multifunctional benefits derived from bioactive plant compounds. These natural ingredients are often rich in vitamins, antioxidants, and phytochemicals that enhance the skin's natural repair mechanisms and protect against environmental stressors. [1,2]

Face serums, as compared to traditional creams and lotions, are designed to deliver concentrated doses of active ingredients with improved skin penetration. Their lightweight and non-greasy texture make them suitable for all skin types, including sensitive and acne-prone skin. The formulation of herbal serums, therefore, combines the advantages of advanced cosmetic technology.

The present study aims to formulate and evaluate a herbal face serum using Aloe vera gel as the base, incorporating rose water, cucumber extract, green tea extract, liquorice root extract, and almond oil as key ingredients. The formulation is intended to provide hydration, nourishment, and protection to the skin while ensuring stability, safety, and consumer acceptability.[2]

II. EXPERIMENTAL WORK

2.1 Materials and Methods

2.1.1 Ingredients

The serum formulation (Batch A) consisted of the following ingredients:

- Aloeveragel
- Rosewater
- Cucumberextract
- Greenteaextract
- Liquoricerootextract
- Almondoil(sweet)
- Sodium benzoate

1. Aloe Vera Gel

Botanical name: Aloe barbadensis Miller

Family: Asphodelaceae

Category: Natural moisturizer and soothing agent

Aloe vera gel is widely used in cosmetic formulations due to its excellent moisturizing and healing properties. It contains vitamins A, C, and E along with polysaccharides that help in retaining skin moisture and improving elasticity. It soothes skin irritation, reduces redness, and supports wound healing. In face serums, aloe vera gel acts as a hydrating base, providing a smooth and cooling effect while preventing dryness and acne.

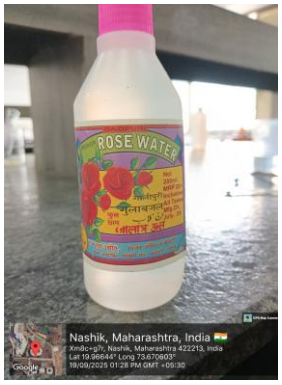
2. Rose Water

Botanical source: Rosa damascena / Rosa centifolia

Family: Rosaceae

Category: Toner and natural astringent

Rose water is a traditional skincare ingredient valued for its soothing and refreshing qualities. It helps in balancing the skin's pH, tightening pores, and reducing redness or inflammation. Its natural aroma provides a pleasant sensory experience. In face serums, rose water acts as a hydrating and toning agent that enhances skin texture and radiance.



3. Cucumber Extract

Botanical name: Cucumis sativus

Family: Cucurbitaceae

Category: Cooling and antioxidant agent

Cucumber extract is known for its cooling, calming, and revitalizing properties. It is rich in vitamins C and K, minerals, and antioxidants that nourish and rejuvenate the skin. In face serums, cucumber extract helps reduce puffiness and dark circles, soothes irritated skin, and provides a fresh and hydrated appearance.

4. Green Tea Extract

Botanical name: Camellia sinensis

Family: Theaceae

Category: Antioxidant and anti-aging agent

Green tea extract is a powerful natural antioxidant that protects the skin from free radical damage and environmental stress. It contains polyphenols, particularly epigallocatechin gallate (EGCG), which help in reducing signs of aging, controlling sebum

production, and calming inflammation. In face serums, it helps prevent premature aging and enhances skin clarity.

5. Liquorice Root Extract
Botanical name: Glycyrrhiza glabra
Family: Fabaceae (Leguminosae)
Category: Skin-brightening and anti-inflammatory agent
Liquorice root extract is a popular natural ingredient known for its ability to reduce hyperpigmentation and dark spots. It contains glabridin, which inhibits melanin production, resulting in a more even skin tone. It also soothes irritation and offers antioxidant benefits. When added to face serums, liquorice extract promotes brightness and a healthy, radiant complexion.

6. Almond Oil (Sweet)
Botanical name: Prunus amygdalus var. dulcis
Family: Rosaceae
Category: Emollient and carrier oil
Sweet almond oil is rich in vitamin E, fatty acids, and proteins that nourish and soften the skin. It helps in improving skin tone, reducing fine lines, and maintaining moisture balance. As a carrier oil, it enhances the absorption of other active ingredients in face serum formulations

7. Sodium Benzoate
Chemical formula: C_6H_5COONa
Category: Preservative and antimicrobial agent
Sodium benzoate is a commonly used preservative in cosmetic and pharmaceutical products. It helps prevent the growth of bacteria, yeast, and fungi, thereby extending the shelf life of formulations. In face serums, it ensures product stability and safety without affecting the efficacy of natural ingredients.

2.2 Method of Preparation

1. Base Preparation:Aloe vera gel was used as the base medium for the serum.
2. Blending of Extracts:Rose water and cucumber extract were added to the base and blended uniformly to form a smooth mixture.
3. Incorporation of Active Ingredients:Green tea extract and liquorice root extract were gently stirred into the blend to ensure even distribution.

4. Addition of Oils:Sweet almond oil and the essential oil mixture were carefully dispersed into the aqueous phase to obtain a uniform emulsion.
5. Preservation Step:Sodium benzoate was added at the final stage to act as a preservative and maintain product stability.
6. Storage: The prepared face serum was transferred into sterile, airtight glass containers and stored at room temperature for further evaluation.

III. EVALUATION PARAMETER

3.1 Patch Test

A patch test was conducted to evaluate the safety and skin compatibility of the prepared herbal face serum. A small amount of the formulation was applied to a cleaned area on the inner forearm of selected volunteers and left undisturbed for 24 hours. The test site was then observed for any signs of redness, itching, swelling, or irritation. Absence of such reactions indicated that the formulation was safe and non-irritating to the skin. This simple yet effective procedure helped ensure that the serum is suitable for topical application and can be safely used on facial skin without causing adverse effects.[3]

The patch test was carried out on six volunteers by applying a small quantity of serum on the forearm and observing for 24 hours. No redness or irritation was noticed, confirming dermatological safety.

3.2 Organoleptic Evaluation

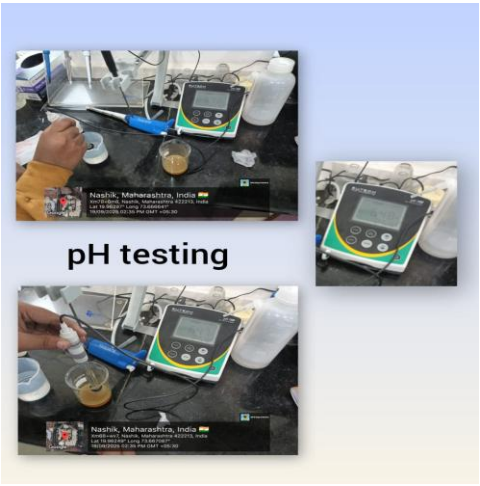
The prepared herbal face serum was evaluated for its organoleptic characteristics, which include color, odor, texture, and appearance. The formulation was visually inspected under normal light conditions to assess its clarity and consistency. The color and fragrance were noted to ensure they were pleasant and acceptable for cosmetic use. The texture was examined by applying a small quantity to the skin to observe smoothness, spreadability, and absorption. These observations helped determine the overall aesthetic appeal and user acceptability of the serum, which are important parameters for cosmetic formulations.[4, 17]

The color, odor, and consistency were visually evaluated. The serum showed a light-yellow color, pleasant aroma, and smooth texture.

3.3 pH Determination

The pH of the prepared herbal face serum was measured to ensure it is suitable for skin application and maintains product stability. A calibrated digital pH meter was used for the measurement. A small amount of the serum was dispersed in distilled water (in a 1:10 ratio) and the pH was recorded at room temperature. The test was performed in triplicate to ensure accuracy and consistency. The obtained pH value was found to be within the skin-friendly range of 5.0–6.5, indicating that the formulation is mild, non-irritating, and compatible with the natural acid mantle of the skin.[5]

The pH was determined using a digital pH meter and found to be 7, which lies within the acceptable range for skin application.



3.4 Spreadability

The spreadability of the prepared herbal face serum was evaluated to determine how easily it can be applied to the skin. A small quantity of the serum was placed between two glass slides, and a known weight was gently applied to the upper slide. The time taken for the upper slide to move a fixed distance was recorded. Good spreadability indicates that the formulation can be applied smoothly and evenly without excessive effort. The serum showed excellent spreadability, suggesting that it can form a thin, uniform layer on the skin, enhancing user comfort and product performance[5,6]

Spreadability was evaluated by the glass plate method. The serum exhibited good spreadability, indicating ease of application and uniform coverage.

3.5 Centrifugation Test

The centrifugation test was performed to assess the physical stability of the prepared herbal face serum. A known quantity of the formulation was placed in a centrifuge tube and subjected to centrifugation at 3000 revolutions per minute (rpm) for 15 minutes. The sample was then observed for any signs of phase separation, creaming, or sedimentation. Absence of such changes indicated good stability of the emulsion and proper dispersion of the ingredients. This test helped confirm that the serum maintains its uniformity and consistency under stress conditions, ensuring long-term product stability.[7,18]

A centrifugation test at 3000 rpm for 15 minutes was performed to check for phase separation. No separation was observed, indicating good stability.

3.6 Specific Gravity

The specific gravity of the prepared herbal face serum was determined to evaluate its density and consistency compared to water. A clean, dry specific gravity bottle was first weighed empty and then filled with distilled water to record its weight. The procedure was repeated using the serum formulation. The specific gravity was calculated using the ratio of the weight of the serum to that of water. This test provides useful information about the uniformity and physical characteristics of the formulation. The obtained value indicated that the serum possessed an appropriate consistency, neither too thick nor too fluid, making it suitable for smooth topical application.[8,9]

The specific gravity was found to be 0.97, indicating suitable viscosity and texture.

3.7 Microbial Testing

The antimicrobial activity of the prepared herbal face serum was evaluated to assess its effectiveness against bacterial and fungal contaminants. The test was performed using the agar well diffusion method. Nutrient agar plates were inoculated with bacterial strains such as Staphylococcus aureus and Escherichia coli, while Sabouraud dextrose agar plates were used for fungal strains like Candida albicans and Aspergillus niger. Wells were bored into the agar, and a measured amount of the serum was introduced into each well. The plates were incubated at 37°C for 24–48 hours, and the zones of inhibition around each well were measured in millimeters.[10]

The presence of clear zones indicated positive antimicrobial activity, demonstrating that the

formulation possesses both antibacterial and antifungal properties. This activity can be attributed to the presence of bioactive compounds in the herbal ingredients such as polyphenols, flavonoids, and essential oils, which are known to inhibit microbial growth. The results confirmed that the herbal serum not only nourishes the skin but also helps protect it from microbial contamination and infections.[10,11]
The serum was tested for microbial contamination. The antibacterial test revealed no harmful bacterial growth, and antifungal tests showed mild inhibition against Candida albicans.

3.8 Stain Test
The staining test was performed to evaluate whether the prepared herbal face serum leaves any stains or discoloration on the skin or fabric after application. A small amount of the serum was applied to a clean area of the skin and lightly rubbed in, while another portion was applied to a piece of white cotton cloth. Both samples were observed after drying to check for any visible stains or color residues. The absence of staining indicated that the formulation is safe for use and will not cause unwanted marks on clothing or skin during regular application. This test is important in ensuring the product's aesthetic quality and consumer acceptability.[12,15]

No staining was observed when the serum was applied to fabric, confirming cosmetic acceptability

3.9 HPLC and UV Analysis
High-Performance Liquid Chromatography (HPLC) analysis was carried out to identify and quantify the major bioactive compounds present in the herbal face serum. The prepared sample was filtered through a 0.45 µm membrane filter before injection into the HPLC system. A C18 column was used as the stationary phase, and a suitable mobile phase (such as methanol and water in a specific ratio) was employed under isocratic conditions. The flow rate and detection wavelength were optimized based on the nature of the phytoconstituents. The chromatograms obtained were compared with standard reference compounds to confirm the presence of key actives such as flavonoids, phenolic acids, and other antioxidant molecules derived from plant extracts. This analysis helped in validating the chemical composition and consistency of the serum formulation.[13,15]
UV-Visible spectrophotometric analysis was performed to further confirm the presence of bioactive components and to evaluate the absorbance profile of the herbal face serum. The serum sample was diluted appropriately with distilled water or methanol, and its absorbance was measured in the wavelength range of 200–800 nm using a UV-Visible spectrophotometer. The characteristic peaks obtained in the UV spectrum indicated the presence of phenolic and flavonoid compounds, which are responsible for antioxidant and skin-protective activities. This technique provided a simple and reliable method for qualitative and quantitative analysis of the phytoconstituents present in the formulation.[14,19]

Future analysis includes quantification of bioactive compounds using HPLC and UV spectroscopy for stability profiling.

IV. RESULTS AND DISCUSSION

The formulated herbal face serum exhibited desirable cosmetic properties and remained stable during the evaluation period. Its pH was skin-friendly, ensuring compatibility. The absence of phase separation and microbial growth confirmed formulation stability. The herbal extracts provided synergistic benefits such as moisturization, antioxidant protection, and anti-inflammatory activity. The serum was easy to apply, absorbed quickly, and left no sticky or oily residue. These findings indicate that the herbal formulation is a suitable alternative to synthetic face serums.

V. CONCLUSIONS

The present study successfully formulated and evaluated a poly-herbal face serum that showed excellent physicochemical and biological properties. The serum was stable, skin-compatible, and effective for cosmetic use. Further work should involve advanced stability testing, phytochemical profiling, and long-term microbial studies to validate its shelf life and therapeutic potential.

REFERENCES

[1] Sharma, V., et al. (2020) . Herbal cosmetics: A review. International Journal of Pharmaceutical Sciences and Research, 11 (4) , 1458 – 1468.

[2] Singh, D., et al. (2021) . Formulation and evaluation of herbal cosmetic products. Journal of Pharmaceutical Sciences and Research, 13 (3) , 120 – 127.

[3] Kumar, S., et al. (2023). A review on herbal face serum for multipurpose uses. International Journal of Pharmaceutical Sciences Review and Research, 80 (2) , 52 – 60 .

[4] Joshi, S., et al. (2024) . Herbal serum formulation for skin rejuvenation. International Journal of Pharmacy and Pharmaceutical Sciences, 16 (1) , 33 – 40 .

[5] Kaur, M., et al. (2022) . Natural antioxidants in cosmetic formulations. Journal of Cosmetic Dermatology, 21 (5) , 1984 – 1992 .

[6] Gupta, R., et al. (2020) . Stability studies of herbal formulations. Indian Journal of Pharmaceutical Sciences, 82 (4) , 789 – 795 .

[7] Sahu, A. N., et al. (2021) . Formulation and evaluation of herbal gel containing Aloe vera and neem extract. Asian Journal of Pharmaceutical and Clinical Research, 14 (5) , 95 – 101 .

[8] Patel, P., et al. (2022) . Green tea polyphenols in skincare. Journal of Cosmetic Science, 73 (2) , 110 – 120 .

[9] Mehta, N., et al. (2019) . Liquorice extract as a depigmenting agent. International Journal of Research in Ayurveda and Pharmacy, 10 (6) , 45 – 50 .

[10] Jain, P., et al. (2020) . Herbal emulsions in cosmetology. Journal of Pharmaceutical and Biological Sciences, 15 (2) , 56 – 63 .

[11] Mankar, S., & Vaidya, S. (2023) . Review on face serum. Asian Journal of Pharmaceutics, 17 (3) , 740 .

[12] Costa, E. F., Magalhães, W. V., & Di Stasi, L. C. (2022) . Recent advances in herbal-derived products with skin anti-aging properties and cosmetic applications. Journal of Cosmetic Dermatology, 21 , 1 – 12.

[13] Deshmukh, G., Katkar, V., Garje, S., & Sayyad, G. (2024) . A comprehensive review of herbal face serum. EPRA International Journal of Multidisciplinary Research, 10 (3) , 1 – 8.

[14] Mishra, N., & Tiwari, A. (2023) . Development and stability evaluation of polyherbal cosmetic face serum for dermatological use. Journal of Ayurveda and Integrative Medicine, 14 (2), 100 – 107.

[15] Sari, R., et al. (2024). Formulation and evaluation of facial serum containing Sacha Inchi oil (Plukenetia volubilis L.) as an anti-aging agent. Cosmetics, 11 (6) , 226.

[16] Pandey, A., & Tripathi, S. (2021) . Formulation and evaluation of herbal cosmetic serum for skin rejuvenation. International Journal of Research in Pharmaceutical Sciences, 12 (3) , 2105 – 2112 .

[17] Rathod, R. R., & Chaudhari, S. R. (2020) . Development and evaluation of polyherbal cosmetic serum for anti-aging activity. Journal of Drug Delivery and Therapeutics, 10 (5) , 185 – 191 .

[18] Kulkarni, P. K., & Joshi, A. S. (2022) . Herbal cosmeceuticals: Formulation approaches and evaluation parameters for skin care products.

Asian Journal of Pharmaceutical Research, 12 (2) , 98 – 105 .

[19] Verma, S., & Gupta, A. (2023) . Recent trends in herbal face serums for dermatological applications. International Journal of Herbal Medicine, 11 (4) , 45 – 52 .

[20] Chavan, R. B., & Patil, S. S. (2022) . Formulation and evaluation of herbal face serum containing plant extracts for skin nourishment. International Journal of Pharmaceutical Research and Applications, 7 (4) , 145 – 152 .