



Development And Characterization Of Herbal-Based Sunscreen And Peel-Off Face Mask For Cosmeceutical Applications

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ABSTRACT:

This study focuses on the development and characterisation of herbal-based cosmeceutical formulations, including a sunscreen and a peel-off face mask. Continuous exposure to ultraviolet (UV) radiation leads to skin damage, premature ageing, and increased risk of skin cancer. Conventional synthetic products often contain harmful chemicals such as parabens and oxybenzone, which may cause adverse effects. Therefore, the present study aims to develop eco-friendly and skin-compatible alternatives using plant-based ingredients.

Selaginella bryopteris was utilised for the preparation of a herbal sunscreen incorporating zinc oxide nanoparticles (ZnO-NPs) via green synthesis, while *Bougainvillea glabra* and orange-peel extracts were used to formulate a peel-off mask. The formulations were evaluated for physicochemical properties, phytochemical constituents, antioxidant activity, and sun protection factor (SPF). The sunscreen exhibited a high SPF value of 48–50, indicating effective UV protection. Both formulations demonstrated good stability, spreadability, and non-irritant properties. Phytochemical analysis confirmed the presence of flavonoids, phenolics, and alkaloids, contributing to antioxidant activity.

The study concludes that these herbal formulations are safe, effective, and environmentally sustainable alternatives to synthetic cosmetic products, with significant potential for cosmeceutical applications.

Keywords:

Selaginella bryopteris, *Bougainvillea glabra*, herbal sunscreen, peel-off Face mask, zinc oxide nanoparticles, green synthesis, sun protection factor, cosmeceuticals.

INTRODUCTION:

Cosmetics are substances derived from natural or synthetic sources that are applied to the human body to cleanse, enhance appearance, and improve skin health. In recent years, there has been a significant increase in the use of cosmetic products due to growing awareness of personal care and aesthetic appearance. However, conventional cosmetic formulations often contain synthetic chemicals such as parabens and oxybenzone, which may cause skin irritation, allergic reactions, and potential environmental hazards [1]

Herbs have been used by humans for a variety of purposes, including food, medicine, and cosmetics. Except for food or vegetarians who solely utilise plants and plant-based items, the usage of natural products, especially plant-based produce, has decreased due to scientific and technological advancements. Nonetheless, the usage of plants as medications and cosmetics is on the rise.[2] The lithophytic plant *Selaginella bryopteris*, sometimes referred to as "Sanjeevani," is indigenous to India and has strong antioxidant and photoprotective qualities. Similarly, the antibacterial and skin-smoothing properties of *Bougainvillea glabra* are attributed to its rich content of bioactive compounds. These plant resources are used in this study to develop safe, efficient skincare products. [3,4,5]

Sunscreens are topical formulations containing ingredients that protect the skin against ultraviolet radiation (UVR) by absorbing, reflecting, or scattering photons to prevent DNA damage and erythema. Sunscreens are topical drug formulations consisting of active filters that protect the skin from the damaging effects of ultraviolet radiation (UVR) through the following mechanisms: Prevention of Erythema and DNA Damage: Active filters act by absorbing or scattering photons, which interfere with the formation of cyclobutene pyrimidine dimers (CPDs) and oxidative stress, which are major precursors of skin carcinogenesis and sunburn-related keratinocyte apoptosis.

Research shows that cosmetics consist of a mixture of components and should adhere to safety guidelines. There are many safety regulations developed to ensure the safety and effectiveness of skin care products, thus improving safety for consumers. According to the European Regulation, a cosmetic product must be safe for use under ordinary or predictable conditions. For a safety assessment, it is important to have information on how the cosmetic is consumed, including the frequency and quantity used per day [6]

The world cosmetic industry is witnessing an enormous increase due to rising consumer interest in personal image enhancement and care. In this regard, women tend to apply more cosmetics than men, and they generally attach greater importance to their self-image. However, due to insufficient knowledge about the hazards, rigorous safety measures must be taken in this area. Although there are standards for evaluating the safety of products, side effects are still widespread [7,8].

MATERIALS AND METHODS:

The present work was designed on the basis of different approaches of guided study on herbal Sunscreen and peel-off mask. The list of ingredients was made. Then the literature review was done. The materials were collected, and the method of preparation was studied, and the identification tests for SPF for the sunscreen and film forming as well as peel ability matters for the peel-off mask was performed of various herbal sunscreen and peel-off mask formulations. The prepared formulations were evaluated for various properties, and the results were tabulated. The prepared formulations were evaluated for parameters such as pH, spreadability, viscosity, drying time, homogeneity, stability, and skin compatibility, and the results were systematically tabulated.

Plant profile:



Fig.1 *Selaginella bryopteris*

Habitat & Distribution

Native to India (Central & Northern regions), grows on rocky substrates (lithophyte) and dry deciduous forests. Found in tropical and subtropical climates.

Morphological Characteristics

Small, fern-like lycophyte. Creeping stems with microphyll leaves, reproduce via spores (not seeds), and show a poikilothermic nature (water content varies with environment).[9] This is a lithophytic plant. It is found in India.[10] It is used in Indian medicine and is one of the plants believed to be candidates for the sanjeevani (also known as "sanjeevini" or "sanjivini booti"). The aqueous extract of *S. bryopteris* has growth-stimulating and protective effects against stress-induced cell death in various experimental cell systems, including mammalian cells. [11]

Bougainvillea glabra:

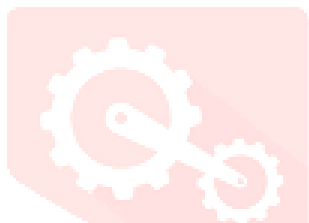
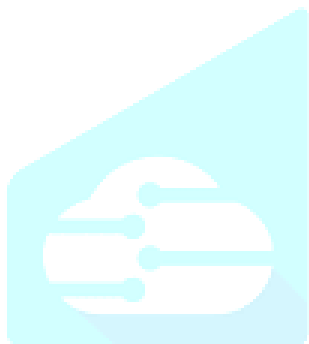


Fig. 2 *Bougainvillea glabra*

Botanical description of *Bougainvillea glabra*: They are woody or shrubby climbing plants that present leaves throughout the year. It has stems with thorns that help it climb; simple leaves, arranged alternately, entire, ovate to elliptic or lanceolate in shape; its flowers are small, tubular, appear in groups of three, white or yellow, bloom in spring and summer and even in early autumn; the flowers are surrounded by three colorful bracts, which have the consistency of paper, size and appearance of leaves; its fruit is elongated, no more than 1 cm long [12].

PREPARATION OF EXTRACTION:

Selaginella bryopteris:

Fresh plant materials of *Selaginella bryopteris* were collected, washed thoroughly with distilled water to remove impurities, and shade-dried. The dried plant materials were powdered into fine particles using a grinder. One gram of the powdered plant materials was mixed with 50 mL of distilled water. This mixture was then subjected to the decoction method by heating it for 10-15 minutes. After that, it was cooled, filtered using Whatman No.1 filter paper, and kept at 4°C.

Bougainvillea glabra:

Bougainvillea glabra bracts were collected and shade-dried for 4–5 days. The dried bracts were then ground into a fine powder using a mortar and pestle. Two grams of *Bougainvillea* bract powder were dissolved in 50 mL of distilled water, and the extract was prepared using the decoction method.

Formulation of herbal sunscreen:

The solution of water was heated to between 80°C and 85°C. Melted cetyl alcohol, zinc oxide, stearic acid, glycerin, hydroxy propyl methyl cellulose combination, and propyl paraben were gradually added to the water solution, a little at a time, while stirring continuously, after the water solution had achieved the

necessary temperature. Stirring was done repeatedly until the paste was homogeneous and smooth. The sunscreen lotion that had been made was left to cool.

Green Synthesis of Zinc Oxide Nanoparticles (ZnO-NPs):

To extract active phytochemicals such as flavonoids, phenolics, and alkaloids, the powdered herbs were combined with distilled water and heated. The aqueous extracts that served as the foundation for the cosmetic compositions were obtained by filtering the solutions.

ZnO nanoparticles mediated by plants are used as active UV filters in the herbal sunscreen: **Mixing:** A zinc precursor (such as zinc acetate) was combined with Selaginella bryopteris extract. **Adjustment:** To achieve a pH of 8, a NaOH solution was gradually added to the mixture while being continuously stirred on a magnetic stirrer. **Synthesis:** The plant's phytochemicals successfully reduced zinc ions to nanoparticles by heating the fluid until white precipitates formed.

Table 1: Composition of Sunscreen

S.No	Ingredients	Quantity (%)
1.	Zinc oxide nanoparticles	5-10%
2.	Cetyl alcohol	2-4%
3	Poly ethylene glycol	0.4%
5	Almond oil	2.5%
6.	Carbopol 940	0.5%
7.	Glycerol	3-5%
8.	EDTA	0.05%
9	Vitamin E	0.5%
10.	Phenoxy ethanol(preservative)	0.1-5%
11.	Citronella fragrance	QS

Phase A (Oil Phase): 5–10% ZnO nanoparticles, 2–4% cetyl alcohol, and 6–10% almond oil were combined. This stage was heated to 70–75°C until it was homogeneous and complete

Phase B (Gel/Water Phase): Disodium EDTA (0.05%) was added after Carbopol 940 (0.3–0.5%) was gradually mixed with glycerine (5–10%) to prevent lumps. Until the Carbopol was completely hydrated, the mixture was agitated.

Emulsification: To create a stable emulsion, Phase A and Phase B were combined and thoroughly mixed.

Phase C (Cool Down Phase): Phenoxyethanol (0.5–1%), vitamin E (0.5%), and fragrance (0.1–0.3%) were added and well mixed once the temperature fell below 40°C

Accurate quantities of cetyl alcohol, zinc oxide, stearic acid, glycerine, and hydroxypropyl methyl cellulose (HPMC) were weighed. A precise amount of water was measured and added to a 400 ml beaker. Water was mixed with 1.0 g of triethanolamine. The temperature of the water solution was raised to between 80°C and 85°C. Melted cetyl alcohol, zinc oxide, stearic acid, glycerine, hydroxy propyl methyl cellulose combination, and propyl paraben were gradually added to the water solution, a little at a time, while stirring continuously, after the water solution had achieved the necessary temperature. Stirring was done repeatedly until the paste was homogeneous and smooth. The sunscreen lotion that had been made was left to cool.

Evaluation and Characterisation of Formulated Sunscreen Cream:

Phytochemical Screening: Extracts were tested for secondary metabolites using Mayer's test (alkaloids), alkaline reagent tests (flavonoids), and ferric chloride tests (phenolics).

TEST FOR SAPONINS:

1.0ml of each extract was added to 5.9ml of distilled water and heated to a boil. The appearance of a creamy mist of small bubbles indicated the presence of saponins

TEST FOR TERPENOIDS (Salkowski Test):

1.0 ml of each extract was mixed with 2.0 ml of chloroform, and 3.0 ml of concentrated sulphuric acid was carefully added to form a layer. Reddish brown colour shows the presence of terpenoids

TEST FOR GLYCOSIDES:

0.1 ml of each extract was hydrolysed with 1.0ml of 10% of HCL solution and neutralised with 1.0 ml of 0.2M NaOH solution. A few drops of Fehling's solution A and B are added. Red precipitate shows the presence of glycosides.

TEST FOR FLAVONOIDS:

1.0 ml of each extract was dissolved in 1.0 ml of diluted 0.2 M NaOH, and 1.0 ml of 10% HCl solution was added. The presence of yellow colour turning colourless indicates the presence of flavonoids.

SPF Calculation: Spectrophotometric analysis was used to assess the sunscreen's UV protection and determine the Sun Protection Factor (SPF).

Physio-chemical measurement: The pH stability, spreadability, and viscosity of both formulations were assessed.

User Reviews: Sensory evaluations (texture, irritation, and skin feel) were conducted by ten participants.

Skin irritation test: It is carried out by applying the product on the skin for 10 min

Table 2: Formulation of herbal peel-off face mask

S.No	Ingredients	Quantity (g)
1.	Polyvinyl alcohol	12 g
2.	Distilled water	56 mL
3	Polyethene glycol	2 mL
5	Glycerine	2 mL
6.	Almond oil	pinch
7.	Niacinamide	pinch
8.	<i>Bougainvillea glabra</i> Bracts Extract	4 mL
9	Vitamin E	1 capsule
10.	Coffee extract	0.3 mL
11.	EDTA	0.3 mL
12.	Phenoxyethanol	0.5 mL

Formulation:

Phase A: Take 56 mL of distilled water in a clean beaker. Add 12 g of polyvinyl alcohol (PVA) slowly into the water. Heat the mixture in a heat mantle (70–80°C) while stirring continuously. Continue stirring until the PVA completely dissolves and forms a clear viscous solution. Allow the solution to cool slightly

Phase B (Emollient Phase): In a separate small container, mix glycerine – 2 ml, Almond oil –2ml, stir well until the mixture becomes uniform.

Phase C (Active Ingredients): In another container, mix *Bougainvillea galbra* extract – 4 ml, Vitamin E – 1 capsule / 1 ml, Coffee extract – 0.3 ml, and Niacinamide – a pinch. Mix properly to obtain a uniform solution.

Phase D (Preservative Phase): Dissolve EDTA – 0.1 g in a small quantity of distilled water if required. Add phenoxy ethanol 0.5ml and mix well.

Final mixing: Take the Phase A (PVA base) and keep stirring. Slowly add Phase B (glycerin + almond oil mixture) into Phase A and mix thoroughly. Then add Phase C (extracts and actives) while stirring continuously. Finally, add Phase D (EDTA + phenoxyethanol) and mix. until the formulation becomes smooth and homogeneous. Allow the formulation to cool to room temperature. Transfer the prepared peel of face mask gel into a clean air tight container.

RESULTS AND DISCUSSION:

1. Development of Sunscreen Based on Herbal Extracts:

Physical Properties

It was found that the sunscreen cream has a good physical appearance. The formulation was non-sticky and did not give out any bad odours. The preparation had non-greasy characteristics and was easy to apply. Moreover, the pH of the formulation was in the range of 6.5 – 7.0, suggesting that the preparation does not have any skin-irritating effects.

Sun Protection Factor (SPF)

The Sun Protection Factor (SPF) of the formulated herbal-based sun screen preparation was found to be between 48 and 50, which is considered to be high protection from UV. The UV-protecting capacity of the formulation is mainly attributed to the presence of natural compounds such as flavonoids.

Stability Studies

The formulation appeared to be stable throughout the experimental period regardless of the testing conditions employed. During the studies conducted at room temperature and at an accelerated rate, there were no variations in pH or the phase change. Therefore, it can be concluded that the formulated preparation is stable enough.

Antioxidant Capacity

It has been determined that the sunscreen formulation exhibits some level of antioxidant activity. It helps reduce the impact

Skin Irritation Test

The absence of redness, itching, and irritation upon application of the formulation on skin confirms its suitability for topical use.

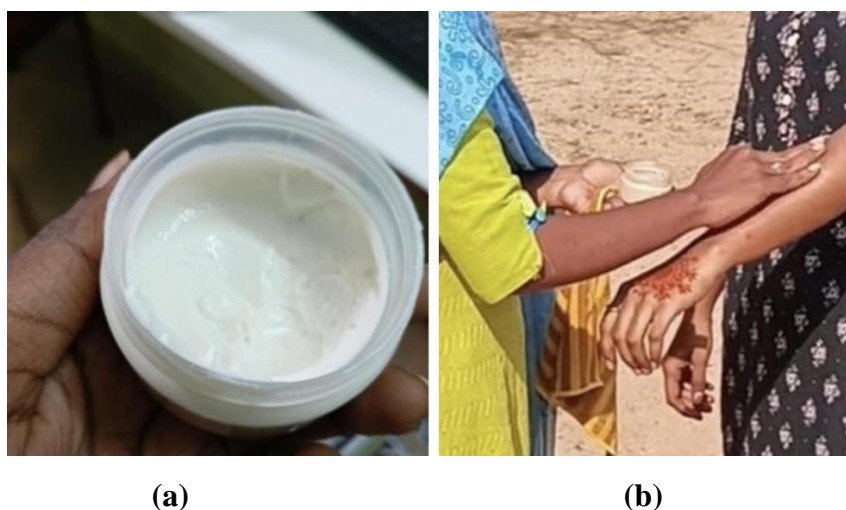


Fig.3 (a) developed herbal sunscreen(b) applying herbal sunscreen for review

2. Development of Herbal Peel-Off Face Mask

Physical Properties

The formulation prepared from the extract of *Bougainvillea glabra* exhibited good properties of film formation. It produced a uniform film on the application, which was dried completely within 15-20 min with easy peel off.

pH and Spreadability

It was observed that the pH of the formulation varied between 5.5-6.5, which is suitable for facial application. It has good spreadability property as well.

Drying Time and Peelability

It was noted that the preparation has good drying and peelability properties. A peelable mask could be obtained by proper adjustment of polymer content.

Skin Benefits

It showed the cleansing, tightening, and refreshing effect on the skin. The presence of pigments and phytochemicals in extract of *Bougainvillea glabra* provided the skin with freshness and shine.

Stability Studies

The formulation was stable with no microbial growth, phase separation, and colour and odour changes.

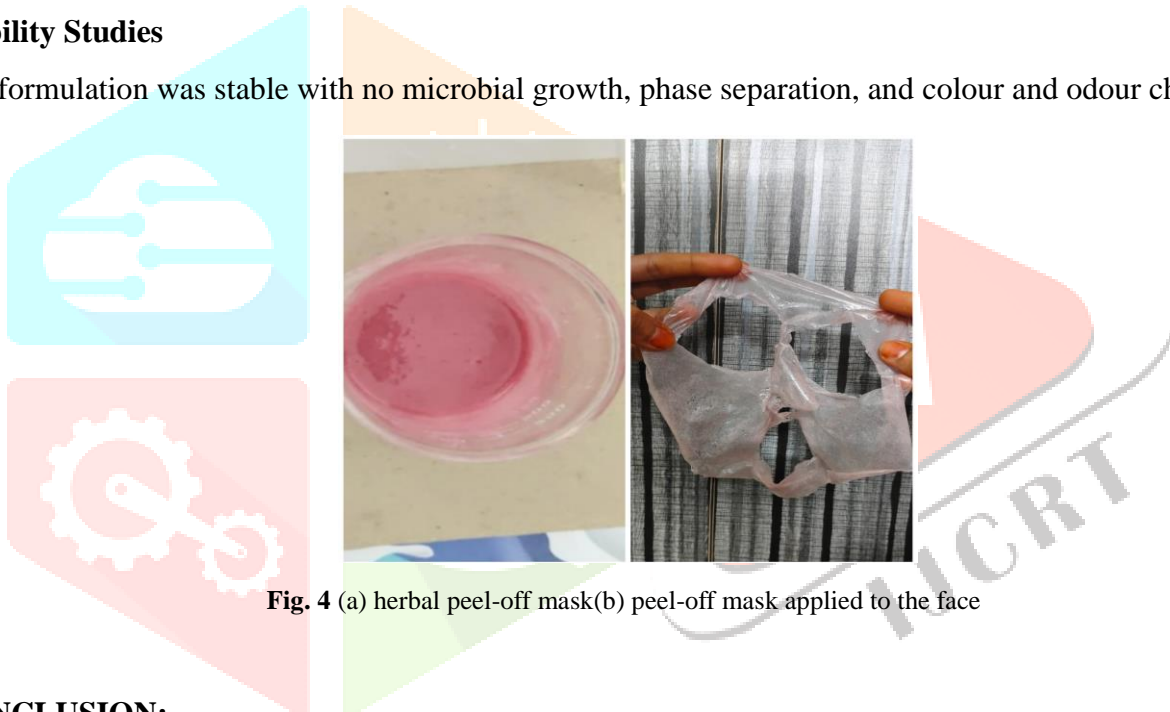


Fig. 4 (a) herbal peel-off mask(b) peel-off mask applied to the face

CONCLUSION:

The present study effectively concentrated on the development and assessment of herbal cosmetics, namely a peel-off mask made from *Bougainvillea glabra* and a sunscreen made from *Selaginella bryopteris*. The results demonstrate how plant-based chemicals may be used to create cosmetic formulations that are safe, efficient, and environmentally beneficial. With a high sun protection factor (SPF) value between 48 and 50, the sunscreen made from *Selaginella bryopteris* showed exceptional UV protection capabilities. This implies that the plant's bioactive substances, such as flavonoids and phenolics, are important for either absorbing or reflecting UV light. A viable substitute for synthetic sunscreens, the composition demonstrated high stability, spreadability, and skin compatibility.

In the same way, the peel-off mask made with *Bougainvillea glabra* demonstrated favourable cosmetic qualities, such as suitable viscosity, simple removal, smooth application, and efficient film creation. Because the mask contained natural antioxidants and phytochemicals, it helped cleanse the face, remove pollutants, and enhance the texture of the skin.

Overall, the study shows that both *Selaginella bryopteris* and *Bougainvillea glabra* may be successfully used in skincare formulations, supporting the increasing demand for herbal and natural products.

Clinical studies can be used to assess long-term dermatological safety, improve formulation stability, and increase shelf life. There is a lot of potential for future growth in the cosmeceutical business when such natural elements are included in commercial cosmetic products.

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