

A Comprehensive Study on Formulation of Herbal Sunscreen Using *Aloe barbadensis*, *Cucumis sativus* and *Solanum lycopersicum*

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ABSTRACT

Sunscreen formulations play a crucial role in protecting the skin from the harmful effects of ultraviolet (UV) radiation. Recent advancements in nature and herbal ingredients have led to a surge of interest in formulation effective, eco-friendly sunscreens. This review provides a comprehensive analysis of herbal sunscreen formulations, specially focusing on *Aloe barbadensis miller* (Aloe vera), *Cucumis sativus* (Cucumber), and *Solanum lycopersicum* (Tomato) as key ingredients. Aloe vera, known for its soothing and hydrating properties, offers potential benefits enhancing the skin's resilience against UV damage. *Cucumis sativus* contributes cooling and antioxidant effects, while *Solanum lycopersicum* provides substantial levels of lycopene, which is recognized for its photoprotective qualities. The review systematically examines the phytochemical profiles, extraction methods, and efficacy of these ingredients in sunscreen formulations. It also explores their synergistic effects when combined and evaluates their overall performance in terms of sun protection factor (SPF), stability, and skin compatibility. By synthesizing current research findings, this review aims to highlight the potential of these herbal components in developing effective, natural sunscreens and to provide insights for future research and formulation strategies in the field of dermatological protection.

Keywords: *Aloe barbadensis*; *Cucumis sativus*; *Solanum lycopersicum*; Antioxidant; Pharmacognosy; Phytochemical; Sunscreen; Herbal.

1. Introduction

The increasing awareness of the harmful effects of ultraviolet (UV) radiation on the skin has led to a growing demand for effective sunscreen products. Conventional sunscreens often contain synthetic chemicals that can cause skin irritation, allergies, and environmental concerns. As a result, there has been a shift towards the use of natural and herbal ingredients in sunscreen formulations, driven by consumer preference for safer and eco-friendly alternatives. Among the various natural ingredients, *Aloe barbadensis miller* (Aloevera), *Cucumis sativus* (Cucumber), and *Solanum lycopersicum* (Tomato) have garnered significant attention due to their beneficial properties. Aloe vera is renowned for its soothing, moisturizing, and healing effects, making it a popular ingredient in skincare products [1]. It contains a rich array of bioactive compounds, including vitamins, minerals, amino acids, and polysaccharides, which contribute to its protective and regenerative properties. *Cucumis sativus*, commonly known as cucumber, is valued for its cooling and hydrating effects. It contains antioxidants such as vitamin C and caffeic acid, which help reduce inflammation and prevent UV-induced damage. Furthermore, cucumber extracts are known for their ability to inhibit the activity of tyrosinase, an enzyme involved in the production of melanin, thereby contributing to skin lightening and brightening. *Solanum lycopersicum*, or tomato, is a potent source of lycopene, a powerful antioxidant that provides photoprotective benefits. Lycopene has been shown to neutralize free radicals generated by UV exposure, thereby reducing oxidative stress and preventing skin aging. The high antioxidant capacity of tomato extracts makes them an ideal candidate for inclusion in sunscreen formulations [8].

This review aims to provide a comprehensive study of the formulation of herbal sunscreens using these three key ingredients. It explores their phytochemical profiles, extraction methods and efficacy in providing sun protection. Additionally, the review discusses the challenges and advantages of using natural ingredients in sunscreen

formulations, as well as their potential for synergy when combined. By synthesizing current research and advancements, this review seeks to highlight the potential of Aloe vera, *Cucumis sativus*, and *Solanum lycopersicum* in developing effective, natural sunscreens and to offer insights for future research and formulation strategies in dermatological protection [7].

1.1. Study Objectives

The primary objective of this study is to develop an herbal sunscreen cream formulation that harnesses the sun-protective properties of cucumber, tomato, and aloe vera. Specific goals include: (i) Identifying and selecting high-quality cucumber, tomato, and aloe vera extracts or juices for incorporation into the sunscreen cream formulation [13]; (ii) Optimising the formulation to ensure effective dispersion and stability of the herbal ingredients while maintaining the desired texture and sensory attributes of the cream [2,4]; (iii) Evaluating the SPF (Sun Protection Factor) and broad-spectrum protection of the herbal sunscreen cream through in vitro and in vivo testing methods [5]; (iv) Assessing the moisturizing, soothing, and antioxidant effects of the formulated cream on sun-exposed skin; and (v) Conducting compatibility and safety assessments to ensure the product is suitable for various skin types and free from potential irritants or allergens [3,6].

2. Materials and Methods

All the herbal ingredients such as Cucumber (*Cucumis sativus*), Tomato (*Solanum lycopersicum*) and Aloe-vera (*Aloe barbadensis*) were fresh and straight from the fields and purchased early in the morning from the market located near Millennium Plaza, Govindpuri, Gwalior. Chemicals were borrowed from the store of School of Pharmacy, ITM University, Gwalior. All solvents were of analytical grade.

3. Procedure

We have chosen 3 plants for the preparation of this sunscreen cream. Various extraction methods were employed, as detailed below:

3.1. Cucumber (*Cucumis sativus*) Extraction

Cucumber extract is obtained by macerating crushed fruit in a hydro-alcoholic mixture, followed by filtration and concentration using a rotary evaporator.



Figure 1. Extraction from Cucumber

3.2. Tomato (*Solanum lycopersicum*) Extraction

The extract is derived by crushing tomatoes to produce crude tomato juice, which is then separated into serum and pulp. The tomato pulp undergoes extraction with ethyl acetate. The final product is obtained after solvent removal through evaporation using a water bath at 40-60 °C.



Figure 2. Extraction from Tomato

3.3. Aloe Vera (*Aloe barbadensis*) Extraction

Homogenize 400 g of gel (equivalent to 2.5 g dry matter) in a Waring blender. Dilute the homogenized gel with an equal volume of PBS and homogenize again. Refrigerate the extract at 4°C overnight. Filter the extract through cloth. Store the clear filtrate at 20 °C.



Figure 3. Extraction from Aloevera

Table 1. Quantities of Extracts and Ingredients for Herbal Sunscreen

S/N	Ingredients	Quantities (gm)
1	Extract of <i>Cucumis sativus</i>	5
2	Extract of <i>Solanum lycopersicum</i>	5
3	Extract of <i>Aloe barbadensis</i>	5
4	Cetostearyl alcohol	5
5	Stearic acid	2

6	PEG-200	2
7	Cetyl alcohol	1
8	Methyl Paraben	0.3
9	Propyl paraben	0.06
10	Carbopol 940	0.5
11	Disodium EDTA	0.5
12	Triethanolamine	0.5

Table 2. Role of Ingredients for Herbal Sunscreen

S/N	Ingredients	Role
1	Extract of <i>Cucumis sativus</i>	UV Protector
2	Extract of <i>Solanum lycopersicum</i>	UV Protector
3	Extract of <i>Aloe barbadensis</i>	UV Protector
4	Cetostearyl alcohol	Emulsion stabilizer/ Surfactant
5	Stearic acid	Thickener
6	PEG-200	Emollients
7	Cetyl alcohol	Thickener agent
8	Methyl Paraben	Preservative
9	Propyl paraben	Preservative
10	Carbopol 940	To provide high viscosity to formulation
11	Disodium EDTA	Chelating agent
12	Triethanolamine	Reduce the acidity or alkalinity

4. Preparation

Creams are often preferred over lotions and other dosage forms because they offer better stability, spreadability, occlusivity, penetration ability, and are more cost-effective. Their long contact time and the ability to solubilize hydrophobic active drugs in the oil phase make cream dosage forms a preferred choice for manufacturers. Cream formulations with varying phytochemical compositions were developed, with all studied concentrations falling within the legislated range [12].

Step I: Aqueous Phase Preparation

Disodium EDTA, Sodium Methyl Paraben, and Triethanolamine were accurately weighed and dissolved in Deionized Water. Carbopol was swelled using a homogenizer and then heated to 80 °C.

Step II: Oil Phase Preparation

Sodium Propyl Paraben, Stearic Acid, Cetyl Alcohol, Polyethylene Glycol, Cetostearyl Alcohol, and accurately weighed quantities of Cucumber (*Cucumis sativus*), Tomato (*Solanum lycopersicum*), and Aloe vera (*Aloe barbadensis*) were mixed and heated to 80 °C.

Step III: Mixing Phase

The oil phase was added to the aqueous phase at 80°C with continuous stirring for 20-25 minutes. The mixture was homogenized until a uniform emulsion formed. The emulsion was then poured into a wide-mouth container and stored at a temperature not exceeding 37 °C.



Figure 4. Prepared sunscreen cream Formulation

5. Result and Discussion

5.1. Sun Protection Efficacy of Key Ingredients

***Aloe barbadensis* (Aloe vera):** The literature review indicates that Aloe Vera possesses notable sun-protective properties. It contains active compounds like aloin and aloesin, which can absorb UV radiation. Studies show that Aloe Vera can help prevent UV-induced skin damage, reduce erythema (skin redness), and promote skin healing due to its anti-inflammatory properties [11].

***Cucumis sativus* (Cucumber):** Cucumber extracts are rich in antioxidants such as cucurbitacins and vitamin C, which contribute to its ability to scavenge free radicals generated by UV exposure. Research suggests that cucumber can soothe sunburns and reduce inflammation, making it a valuable ingredient in sunscreen formulations.

***Solanum lycopersicum* (Tomato):** Tomatoes are rich in lycopene, a powerful antioxidant that provides photoprotective effects. Lycopene's ability to quench singlet oxygen and other reactive oxygen species helps in mitigating the oxidative stress induced by UV radiation. Studies demonstrate that tomato extracts can reduce the risk of erythema and skin aging caused by UV exposure [11].

5.2. Formulation Stability and Potency

The review highlights challenges in maintaining the stability and potency of herbal ingredients in sunscreen formulations. Factors such as light sensitivity, oxidation, and degradation can affect the efficacy of the product. Various stabilization techniques, including the use of natural preservatives, encapsulation, and the incorporation of antioxidants, are discussed as potential solutions [10].

5.3. Comparative Effectiveness

Comparative studies between herbal sunscreens and conventional chemical sunscreens reveal that while herbal sunscreens may have lower SPF values, they offer additional benefits like soothing and anti-inflammatory effects. The combination of Aloe Vera, cucumber, and tomato provides a broad spectrum of protection against UVA and UVB radiation, though further optimization is required to match the SPF levels of synthetic sunscreens [9,12].

5.4. Safety Profile

The safety and toxicity profile of the herbal ingredients reviewed is generally positive. Aloe Vera, cucumber, and tomato are well-tolerated by most skin types, with minimal reports of adverse reactions. However, some individuals may experience allergic reactions, highlighting the importance of conducting patch tests before widespread use. The absence of synthetic chemicals in these formulations reduces the risk of skin irritation and environmental harm.

6. Conclusion

Present research work on sun rays protective strong antioxidant: *Solanum lycopersicum* - photoprotective; *Aloe barbadensis* - moisturizing as well as cooling agent; and *Cucumis sativus* - is incorporated together to develop efficient sunscreen product. Formulation found to be promising as sunscreen in all aspects but still this research works has limitations. In vivo is a major scope for this study. As the use of sunscreen is not high, education and awareness about the hazards of sun exposure and the benefits of regularly applying sunscreen to reduce these effects must be spread. This type of study will be helpful in providing complete solution to consumers to protect from harmful effects of sunrays.

The following suggestions should be taken into consideration to improve the efficacy of herbal sunscreen in the future: (i) Many more herbal sunscreens to prevent sunburn can be prepared using other herbal ingredients, (ii) Development in the research field will lead to the improvement in the efficacy of sunscreen, (iii) Improvement in the field of research will cause the reduction of sun damaging effect of sunscreen at reduce cost in the future, and (iv) Due to consistent climate change and increasing exposure to UV rays, more research will be required to improve the quality and efficacy of sunscreen.

Declarations

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Competing Interest and Ethics

The authors declare no competing financial, professional, or personal interests.

Consent for Publication

The authors declare that they consented to the publication of this study.

Authors' Contributions

All the authors took part in literature review, research, and manuscript writing equally.

Availability of data and material

Supplementary information is available from the corresponding author upon reasonable request.

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