

A Narrative Review on a Photoprotective Cream Enriched with Zinc Oxide and Herbal Ingredients

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Abstract: *Ultraviolet (UV) is a factor in sunburn, photoaging, pigmentation changes and skin cancer, so there is a need for broad-spectrum effective sun protection. This narrative review explores the reasons to use a cream containing zinc oxide and rosemary (Rosmarinus officinalis L.), licorice (Glycyrrhiza glabra L.) and aloe vera (Aloe barbadensis Miller). There are published data supporting the ability of zinc oxide to deliver the primary UVA/UVB attenuation, rosemary phenolics for antioxidant activity, and that aloe vera and aloe plant extracts deliver hydration and skin comfort along with a moderate level of anti-inflammatory activity, with the zinc oxide being the primary ingredient for delivering UVB/UVB protection. The SPF in-vitro data reported for other herbal sunscreen preparations vary and the variability in the extracts, concentration, vehicles, and testing methods hinders the comparison. The four components combination has not been directly tested in the literature reviewed. Therefore, standardized extracts, formulations stability, extensive testing against multiple species and safety assessment and relevant in-vivo validation must be performed prior to efficacy claims.*

Keywords: photoprotective cream, zinc oxide, rosemary, licorice, aloe vera, antioxidant activity, sun protection factor.

I. INTRODUCTION

Solar ultraviolet radiation is an important environmental stressor for skin. UVA is relatively deep penetrating radiation and a significance cause of oxidative stress and photoaging, while UVB is a major cause of erythema and direct DNA photodamage. Cumulative and excessive exposure is associated with pigmentation disorders, immunological effects and skin cancer [1,2]. A sunscreen should, therefore, offer effective protection over the range of the wavelengths of ultraviolet radiation it protects against, not just for those with antioxidant or soothing properties.

Generally, sunscreen systems incorporate either organic UV filters, inorganic mineral filters or a mixture of both. Zinc oxide is a mineral filter used for broad-spectrum attenuation. Its performance in a finished product will depend on many factors including the particle characteristics, dispersion, film uniformity and the formulation vehicle [3,4]. Interest in plant-derived ingredients has grown as the polyphenols and other ingredients may be thought to have antioxidant and anti-inflammatory properties. Such assisting activities cannot, however, serve as proof of an effective stand-alone UV filter for a plant extract.

When used together, Rosemary, liquorice and aloe vera can complement each other in a photoprotective cream. The phenolic antioxidants present in rosemary, pigment-modulating and anti-inflammatory compounds in licorice, and moisturizing and soothing properties of aloe vera gel have been studied [5–8]. The rationale that has been published for combining these botanicals with Zinc Oxide is reviewed, along with the gaps in the evidence, and testing requirements



for evaluating their formulation. It is a story literature search and not a report on the preparation of a new cream, or experiments to test the new cream.

II. REVIEW METHODOLOGY

This is a narrative review, derived from the literature and reference list provided in the source manuscript, as well as the cited review articles and studies on UV radiation, sunscreen evaluation, rosemary, licorice, aloe vera and zinc oxide. The source manuscript outlines individual search strategies in PubMed, Google Scholar, Web of Science and the websites for the publishers for the following terms: herbal sunscreen, rosemary, *Rosmarinus officinalis*, licorice, *Glycyrrhiza glabra*, aloe vera, zinc oxide, SPF and photoprotection. This article is not a systematic review, since it does not include search dates, complete search strings, or a systematic screening flow, the supplied material should be interpreted as a narrative review.

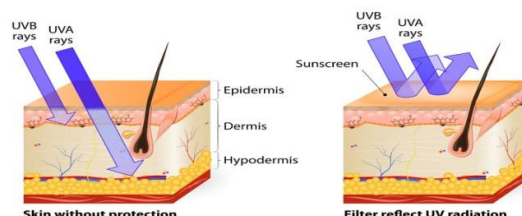
The studies included in the present review were different in terms of the botanical source, extraction solvent, concentration, vehicle, and method of photoprotection; therefore, the results were compared qualitatively. There are no direct comparisons between the reported in-vitro SPF values, nor are they considered to represent a direct proof of clinical protection.

III. UV RADIATION AND SUNSCREEN EVALUATION

3.1 Skin effects of UVA and UVB

The UVA (around 320–400 nm) is responsible for the formation of reactive oxygen species (ROS) and the damage to structural components of the dermis while the UVB (around 280–320 nm) is strongly linked to sunburn and direct DNA damage [1,2]. These processes are shared: UVA and UVB can cause oxidative damage, as well as inflammation and long-term damage. Such a product designed for regular photoprotection should be tested for both UVA and UVB efficacy.

UV penetration into the layers of the skin



3.2 SPF and its limitations

The primary measure of protection provided by SPF is against erythema (redness) caused by UV and is heavily influenced by UVB. The in-vitro spectrophotometric method, such as Mansur method [9,10] estimate SPF as absorbance readings across a UVB wavelength range. These are complimentary techniques that may be used to help screen products but do not constitute in-vivo proof of SPF, UVA protection, water resistance, photostability, or in-vivo performance. Methods to validate finished product claims based on the claim and applicable regulatory requirements.

3.3 Desired quality attributes

A cream will be homogeneous, spreadable and physically stable, have a skin compatible pH, and no undue phase separation, rancidity, odour or colour change. The appearance, pH, viscosity, spreadability, homogeneity, washability (if applicable), accelerated and long-term stability, microbial quality, packaging compatibility and skin tolerability should be included in evaluation. These attributes contribute to good product quality, but should not replace UV efficacy testing.



IV. POTENTIAL CONTRIBUTIONS OF THE SELECTED INGREDIENTS

4.1 Zinc oxide

One of the suggested main UV-protective components in the combination is zinc oxide. Absorbs and scatters UV rays, depending on particle size, surface treatment, concentration and dispersion in the final product [3,4]. A visible "white cast" may result from mineral particles, especially if not optimized for dispersion and characteristics of mineral particles. The formulation development should evaluate the uniformity, cosmetic acceptability, and photostability, not relying on the assumption that zinc oxide imparts a specific SPF.

Safety conclusions will vary based on the product use and grade and characteristics of the particles. There is no evidence, without qualification, that inhalable powders or nanoparticles can be assumed for all topical creams. The final product and its proposed application should be tested to ensure compliance to safety standards and regulatory requirements [3,4].

4.2 Rosemary (*Rosmarinus officinalis* L.; *Salvia rosmarinus*)



Figure 1. Rosemary (Rosmarinus officinalis) — illustrative image.

The leaves and extracts of Rosemary contain phenolic compounds such as rosmarinic acid, carnosic acid and carnosol. Such constituents have been found to possess antioxidant and anti-inflammatory effects. The researchers noted protective effects against certain UVB-induced changes in an experimental model with regard to rosemary extract-containing emulgel [5]. The results of this study suggest that rosemary may be a useful antioxidant component in a topical cream, but cannot verify the SPF or clinical efficacy of a cream containing rosemary and zinc oxide.

The composition of extract may change depending on the source of the plant, the time of the harvest, the type of solvent and processing. Reproducible formulation should include description of extract type and concentration, and include marker compounds for quality control if possible. Compatibility and possible irritation should also be assessed, as should odour and colour.

4.3 Licorice (*Glycyrrhiza glabra* L.)



Figure 2. Licorice (Glycyrrhiza glabra) — illustrative image.

The glycyrrhizin-related compounds and flavonoids in licorice root include glabridin and liquiritin. Pigment-modulating and anti-inflammatory activity have been reported for some constituents of lico for experimental literature [6,7]. Such effects could be related to calming UV related irritation or correcting discolored pigmentation, but should not be claimed to be direct human UV-proofing or UV-prevention.



The amount and type of active ingredients may differ between different extracts. However, due to formulation challenges such as solubility and delivery, glabridin is also a compound under scrutiny. The extract chosen should thus be characterized, its compatibility with the cream base determined and its safety at the proposed concentration should be determined.

4.4 Aloe vera (*Aloe barbadensis* Miller)



Figure 3. Aloe vera (*Aloe barbadensis* Miller) — illustrative image.

The inner-leaf gel of Aloe vera is rich in polysaccharides and other components, and is commonly applied to topical products to provide hydration and comfort [8]. The idea is to use aloe vera as a moisturizing and soothing ingredient of the proposed combination, rather than as a major UV filter. It can have an improving effect on spreadability and sensory properties depending on the vehicle and grade used.

Microbial quality and the range of composition of materials containing aloe may necessitate quality control. The formulation should state if it is a purified inner-leaf gel or a standardized extract or another commercial grade, and should contain appropriate preservation and microbiological testing.

V. EVIDENCE FROM RELATED HERBAL SUNSCREEN FORMULATIONS

The source manuscript summarizes several published herbal cream studies with reported in-vitro SPF values and physicochemical observations. These studies are heterogeneous and should be interpreted as preliminary formulation evidence, not as direct evidence for the proposed four-component product.

Study / formulation described in source	Reported result in source	Interpretation / limitation
Bansod et al. [11]: orange peel, aloe vera, carrot oil and turmeric	In-vitro SPF reported as 26; pH 6.9–7.2; no irritation reported in the source summary.	Different ingredients and test conditions; result does not predict the proposed cream's SPF.
Chavan et al. [12]: licorice, green tea, aloe vera and seed oils	In-vitro SPF approximately 13–14; pH 5.92; physical stability reported over 2–3 months.	A related botanical combination, but without rosemary plus zinc oxide in the exact proposed system.
Patni et al. [13]: bitter gourd, aloe vera, rosemary and other ingredients	Acceptable spreadability, pH and stability; SPF described as satisfactory but not quantified.	Unquantified SPF statement limits comparison and interpretation.
Kazi et al. [14]: aloe vera and oils with zinc oxide and avobenzone	pH 7.46; no oil separation or irritation reported; SPF not quantified in the source summary.	Includes zinc oxide but also an organic filter; no directly comparable SPF value.
Chaudhari et al. [15]: walnut oil and carrot seed oil	In-vitro SPF approximately 8.9–11.5 in the source summary.	Different composition; in-vitro SPF alone does not establish broad-spectrum or clinical protection.



In the studies summarized here, reported values of SPF are quite variable and methods are not standardized. Many absorbance measurements in solution for the UVB are not a comprehensive representation of the behaviour of the sunscreen film on skin. No study directly tested rosemary, licorice, aloe vera and zinc oxide was found in the literature studied in the source manuscript. This is not a research gap, but rather, an indication that the suggested mix may not be the best.

VI. FORMULATION RATIONALE AND EVALUATION FRAMEWORK

The division of ingredients in the proposed formulation is plausible: zinc oxide would be used as the active ingredient in the formulation (UV filter); rosemary would be included as an antioxidant to support; licorice would be used to support (anti-inflammatory and related to pigment); and aloe vera would be used as a hydrating and dermatological effect. The synergy of these ingredients and their combined effect have yet to be proven in practice.

6.1 Formulation development considerations

Developing the product should be started with the documentation of the specifications for each ingredient, such as botanical identity, plant part, extract solvent, content of marker-compounds if available, microbial quality and documentation of the supplier. The grade of the zinc oxide, the nature and the treatment of the particles should be noted. The mineral filter should be evenly distributed in the vehicle and have an acceptable texture and stability.

6.2 Physicochemical and stability testing

The appearance, odour and homogeneity should be evaluated, as well as pH, viscosity, spreadability, phase separation, centrifugation response (if appropriate), microbial limits, preservative effectiveness, and packaging compatibility should be pre-defined as acceptance criteria in a development study. Stability should be determined under specified storage conditions and at appropriate intervals. The stability protocol and results should be reported as transparently as possible and include any changes in colour, odour, texture, pH or viscosity.

6.3 Photoprotection and antioxidant testing

In-vitro SPF testing can be used to assist screening but method of in-vitro testing, sample preparation, dilution, wavelength range, replicate number, and calculation should be reported. The only validated method for estimating UVA protection is not just a UVB absorbance estimate, but a broad-spectrum method. Photostability should be tested under the appropriate light exposure conditions.

6.4 Safety and efficacy validation

Safety evaluation must take into consideration the quality of the ingredients, the microbial control, the risk of irritation and sensitization and the intended use pattern. If human testing is required, it must be reviewed to ensure ethical standards and compliance with relevant standards and regulation, and the informed consent of the participants. Any performance claims such as SPF, UVA protection, water resistance must be made following appropriate and validated testing on the finished product. If this information is not available, the manuscript should describe the product as 'a proposed formulation concept' instead of an 'evaluated or proven sunscreen'.

VII. DISCUSSION

A scientific foundation exists in the literature to investigate a combination type of UV protection cream that includes a mineral UV filter with some selected botanicals. The proposed partition of functions is in line with the reported functions for rosemary phenolics, constituents of the licorice and aloe vera gel [5–8]. But, biological plausibility does not equate with proven formulation performance. An antioxidant botanical ingredient might not provide any enhancement to SPF, UVA or clinical performance in a finished product.

There are three significant restrictions. First, botanicals extracts are variable in chemical composition. Second, uncertainty surrounds the ability to compare the values of SPF from various studies if there are differences in sample preparation, concentration, vehicle, and measurement technique. Third, the exact combination specified in this title is not necessarily the one necessarily found in the source literature. If a new cream is developed, there are no



experimental results supplied to enable the paper to report a measured pH, viscosity or stability profile, SPF, or a safety outcome for the product.

Future studies should evaluate the base vehicle, the zinc-oxide formulation and the appropriate botanicals according to a predetermined protocol. Both the UVB and UVA performance, the photostability, the physicochemical stability and safety of the study should be reported. The study of an appropriate control would help clarify if the benefits of the herbal ingredients are greater than that of the mineral filter and vehicle alone. There needs to be a clear separation between preliminary lab testing and finished product claims.

VIII. LIMITATIONS

There are several studies summarized in the source manuscript that lack some information on SPF and/or methodology. The combination of zinc oxide with rosemary, licorice and aloe vera was not directly tested in the literature reviewed. As such formulation rationale should be considered to be a hypothesis to be developed and tested in the future.

IX. CONCLUSION

Zinc oxide could be the main UV filter, rosemary as an antioxidant, licorice as a possible anti-inflammatory and a pigment-modulating agent and aloe vera as a hydrating and soothing agent, all of which have a complementary potential role in a photoprotective cream. In preliminary studies of similar herbal sunscreens, published results vary both in their measured SPF range and quality. The development and evaluation of a formulation thus should be carried out by a standardized characterization of the ingredients, physicochemical testing, microbiological testing, stability studies, validated UVA/UVB testing, and a formulation safety study.

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