



Formulation And Development Of Emulgel Sunscreen For Sensitive Skin

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Abstract:

These days, UVB rays can cause skin damage. Sunscreens are used to counteract or prevent UV radiations, while UVA rays impact the skin's epidermis layer. Sunscreen comes in a variety of forms, including lotions, creams, oils, sticks, and gels. Those with sensitive skin tend to have greasy, gritty, or white cast skin, and chemical sunscreen ingredients like oxybenzone, benzophenone and PABA cause irritation, redness, and inflammation in those with sensitive skin. Compared to other skin types, sensitive skin is more delicate. Additionally, sensitive skin is typically the target of sunscreens with adverse effects. To address this issue, we developed the Emulgel sunscreen, which is a balanced between water-based (gel) and oil-based emulsion components, offering lightweight and easily spreadable texture. And performed the evaluation test like pH, viscosity, spreadability, homogeneity, accelerated stability testing and sensory test are carried out for this formulation which is crucial for the sensitive skin and gives the gentle application on the skin and forms a light film on skin and prevents from the UVB radiations. In this formulation mineral based sunscreen agents are used to prevent UV radiation and added in the form of emulgel formulations and to overcome the white cast we used in combination with Hydrogenated Polydecene, TiO₂, Iron Oxides, Distearidimonium Hectorite and Propylene Carbonate.

Keywords: Sunscreen, Emulgel, Sensitive skin

Introduction:

The skin, is the body's largest organ, makes up about 15% of an adult's total weight and serves several essential functions [1]. It acts as a protective barrier against physical, chemical, and biological threats, it helps to prevent excessive water loss, and plays a key role in regulating body temperature. The skin is continuous with the mucous membranes that line the body's surface together with its associated structures, the skin forms the integumentary system. The skin layers are epidermis, dermis, and subcutaneous tissue. The outermost layer, the epidermis, is primarily made up of keratinocytes, which produce keratin, a fibrous protein that provides protection [2]. Beneath this layer is the dermis, which is largely composed of melanocytes which produce a melanin are responsible for the skin and hair colour and collagen, a structural protein that gives strength and elasticity to the skin. The subcutaneous tissue, also called the panniculus adiposus, contains clusters of lipocytes (fat cells). The thickness of these layers varies across different parts of the body. The epidermis is thinnest on the eyelids, measuring less than 0.1 mm, while it is thickest on the palms and soles, where it reaches about 1.5 mm. The dermis is particularly thick on the back, where it is 30 to 40 times thicker than the epidermis [3,4]

Dermatologically, sensitive skin is defined by increased sensitivity to outside stimuli, which results in sensations including dryness, burning, itching, and redness [5]. Among the main processes behind sensitive skin are: Skin Barrier Compromised: Water loss and increased permeability result from a drop in ceramide and lipid levels. Heightened Immune Response: Prolonged activation of inflammatory pathways, such as those involving cytokines and neuropeptides, causes discomfort and irritation. Increased Neurological Sensitivity: Simple stimuli can cause discomfort, tingling, and stinging feelings due to overactive sensory nerve endings. The formulations for sensitive skin must be hydrating and protective without including harsh preservatives, alcohol, or perfumes that irritate the skin [6, 7].

Sunscreen is a topical formulation designed to protect the skin from the harmful effects of ultraviolet (UV) radiation, including sunburn, premature aging, and skin cancer. Sunscreens function by absorbing, reflecting, or scattering UV rays.

Sunscreens are classified into two main categories based on their active ingredients:

1. Physical Sunscreens (Inorganic Filters):

Mineral-based UV filters, such as zinc oxide and titanium dioxide, function by deflecting and dispersing ultraviolet radiation [8]. They are generally well-tolerated and less likely to cause irritation, making them ideal for sensitive skin.

2. Chemical Sunscreens (Organic Filters):

Organic compounds like oxybenzone, avobenzone, and octinoxate serve as UV filters by absorbing ultraviolet radiation and transforming it into heat, which is then released [9]. These sunscreens are typically lightweight but may trigger irritation in individuals with sensitive skin.

Sunscreens protect the skin primarily by Chemical filters which absorb UV rays and prevent them from penetrating deeper into the skin. Physical sunscreens act as a protective shield reflecting and scattering harmful UV rays. Some formulations contain stabilizers to prevent degradation under UV exposure, ensuring prolonged effectiveness [10].

Emulgel is a biphasic system that combines the properties of an emulsion (oil-in-water or water-in-oil) with a gel base, resulting in an enhanced topical delivery system. Emulgel helps to enhanced Penetration Due to the gel matrix, it allows better diffusion of active ingredients into the skin. It gives non-Greasy Texture Unlike creams, it provides a smooth, non-oily finish. It has Better Stability Overcomes phase separation issues commonly seen in emulsions. Gives Prolonged Retention, the gel phase ensures prolonged contact with the skin, enhancing effectiveness [11].

Emulgel-based sunscreens are specifically beneficial for individuals with sensitive skin due to it Reduces Irritation and emulgels are free from heavy oils and irritants, minimizing allergic reactions. The gel base helps in maintaining skin hydration, reducing trans-epidermal water loss (TEWL). The emulgel formulation allows for better dispersion of UV filters, ensuring even coverage and effective protection. The gel component provides a soothing and cooling effect, reducing skin irritation and redness [12].

The development of an emulgel-based sunscreen for sensitive skin presents a promising approach to enhancing sun protection while ensuring optimal skin compatibility. Emulgel Sunscreen is non greasy and lightweight which provides smooth, matte finish, and suitable for the sensitive skin. Better Penetration and Absorption Ensures effective UV protection without clogging pores.

The combination of physical UV filters, hydrating agents, and a non-greasy emulgel base offers an ideal formulation for individuals prone to irritation. While formulation challenges exist, the benefits of improved stability, enhanced penetration, and soothing effects make emulgel sunscreens a superior alternative to conventional sunscreen formulations. Future studies should focus on optimizing ingredients to further enhance efficacy and safety [13].

Materials and method:

All the ingredients which are used to formulate the emulgel sunscreen was obtained as a gift sample from Vimal Life Sciences Pvt. Ltd., Mumbai (India). Glycerin and EDTA was used from our lab. Distilled water was used for all experiments.

1. Sodium acrylate/ Sodium Acryloyldimethyl Taurate Copolymer and Isohexadecane: It can be used to create instant emulsions by just adding water.
2. Sodium Hyaluronate: Used for instant emulsion
3. Water and Corn starch modified: Offers anionic matrix structure which is deals for product intended to deliver actives deeper into the dermis.
4. Styrene / Acrylates Copolymer: This ingredient reduces the need for UV filters while boosting UVA/UVB protection. It enhances product aesthetics, minimizes irritation, works well with both organic and inorganic UV filters, and is ideal for water-resistant formulations. It is also non-irritating, non-toxic, and non-photosensitizing. PEG / PPG -17/6 Copolymer:
5. Isododecane & Disteardimonium Hectorite & Propylene Carbonate: It is ideal in formulations with light skin feel as isododecane gives excellent glide without any residue on the skin.
6. Water and Chondrus Crispus Extract, Natto gum and Phenoxyethanol and Chlorphenesin & Citric acid: Used as texture modifier and film former, providing lubricity and a fresh sensation. It has a high tolerance for electrolytes, except when combined with certain cationic ingredients.
7. Phenoxyethanol, Ethylhexylglycerin: Preservatives
8. Betula Alba Juice and Phenoxyethanol and Chlorphenesin: It is a natural solution for achieving a smooth and glowing complexion. It enhances skin brightness and quickly provides essential nutrients to the skin.
9. Titanium dioxide & hydrogenate, polydecene & Polyhydroxystric acid & searic acid & alumina: High SPF for strong UVB protection, moderate UVA protection, and applies with a clear finish.
10. Water & melanin: Skin protecting agent
11. Hydrogenated Polydecene (and) Titanium Dioxide (and) Iron Oxides (and) Disteardimonium Hectorite (and) Propylene Carbonate: Used to overcome white cast

Formulation Table:

Sr No.	Ingredients	Qty for 100 %
1	Water	46
2	Glycerine	2
3	EDTA	0.1
4	Sodium Acrylate/Sodium Acryloyldimethyl Taurate Copolymer (and) Isohexadecane	3.5
5	Sodium Hyaluronate	8
6	Water and Corn starch modified	5
7	Styrene / Acrylates Copolymer	7.8
8	PEG / PPG -17/6 Copolymer	2
9	Isododecane & Disteardimonium Hectorite & Propylene Carbonate	2.5
10	Water and Chondrus Crispus Extract, Natto gum and Phenoxyethanol and Chlorphenesin & Citric acid	3
11	Phenoxyethanol, Ethylhexylglycerin	1
12	Betula Alba Juice and Phenoxyethanol and Chlorphenesin	2
13	Titanium dioxide & hydrogenate, polydecene & Polyhydroxystric acid & searic acid & alumina	15
14	Water & melanin	2

15	Hydrogenated Polydecene (and)Titanium Dioxide (and) Iron Oxides (and) Distearidimonium Hectorite (and) Propylene Carbonate	0.1
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Preparation of Emulgel Sunscreen:

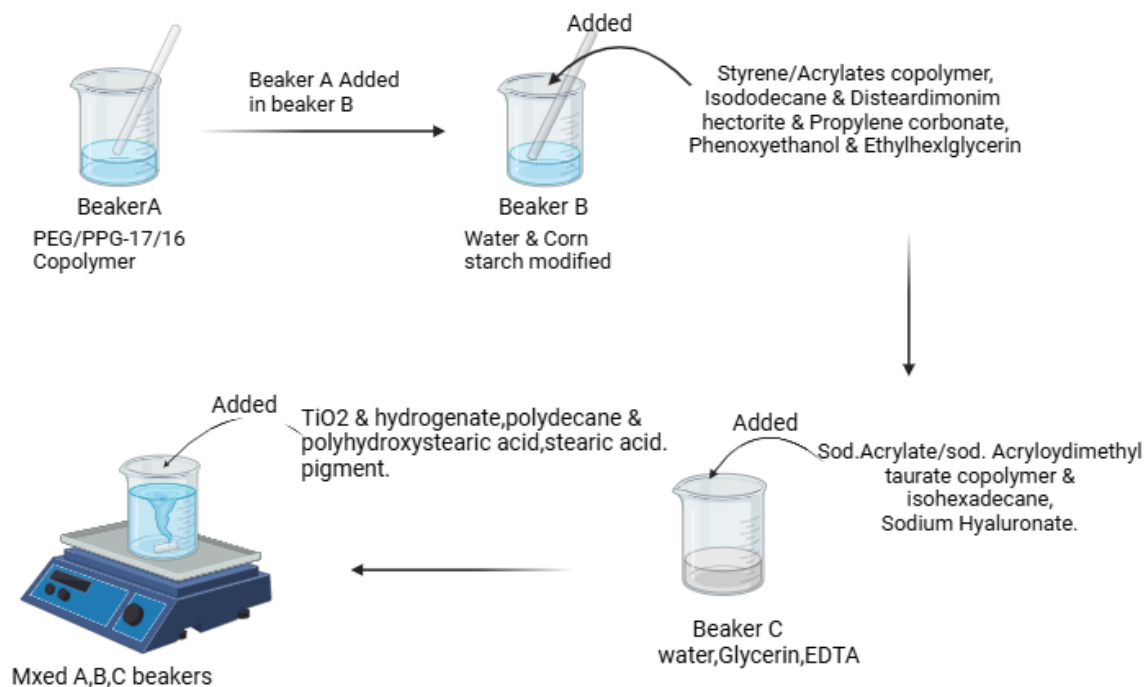


Fig. 1: Depicts the process of preparation of emulgel sunscreen.



Fig. 2: Shows the formulation which we have prepared in our lab.

Evaluation of emulgel sunscreen:

1. Physical evaluations

The prepared emulgel sunscreen was inspected visually to determine its colour, odour, Consistency and Texture. These parameters are observed in prepared emulgel sunscreen formulation [14]. The results are recorded.

2. pH

Human skin typically has a pH between 4.5 and 6.5. Therefore, a formulation must have a pH that falls within this range in order to potentially be admitted for industrial use [15]. The pH of various emulgel formulations was measured by placing the sample in a container, inserting the electrode of a pH meter and recording the results [16]. The pH of the emulgel formulation were recorded [17]. The emulgel formulated in this work was pH value is 6.2, which is close to the neutral pH [18] This was recorded.

3. Viscosity

The viscosity of the emulgel was measured using a Brookfield viscometer (DV-E VSCOMETER). The emulgel was weighed 50 gm. The emulgel was put into a measuring container and the spindle of the Brookfield viscometer was dipped into the formulation then measured the viscosity by using spindle no.7 at 100rpm.[19].

4. Spreadability

The emulgel was placed between two glass slides with a 25 g load for 1 minute, the spread diameter was measured, then additional loads of 50 g and up to 100g were applied successively for 1 minute each, with the diameter measured after each step until a constant diameter was reached [20,21].

$$S = m \cdot l / t \text{ [22].}$$

Where,

S = Spreadability, m= Weight tied to the upper slide, l =Length of glass slide, t=Time taken in seconds

The spreadability of emulgel sunscreen was 5.2 cm (easily spreadable).

5. Texture Analysis of the Emulgel Sunscreen

The texture analysis of the emulgel sunscreen was performed 12 months after its preparation. The sample were carefully Filled into the sample cup, ensuring the complete absence of air entrapment. The analysis was carried out using the instrument CT3 Texture Analyzer (Brookfield Engineering labs, Inc., USA).The experimental conditions were set as follows: 10000 g load cell, 0.5 mm/s test speed, 7.00 mm target value and 7g trigger load. For the analysis, the texture profile analysis (TAP) was selected and the cone probe TA3/100 was used. The parameters measured included, hardness during both cycle 1 and hardness cycle 2.

Hardness, define as the force needed for the deformation of the substance, was measured in grams (g). The results indicated that the hardness values for both cycle 1 and cycle 2 were consistent, with a value of 36g [23].

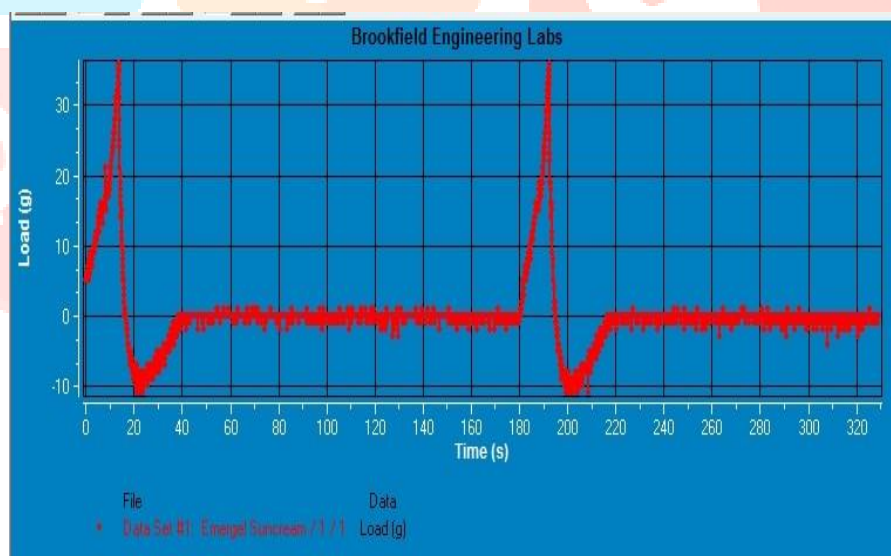


Fig. 3: Texture analysis graph

6. Homogeneity

In order to test for homogeneity, the emulgel sample is spread out on a glass object, covered with a cover glass, and the homogeneity of the emulgel is then observed homogeneity [24]. The homogeneity of this prepared formulation were recorded.

7. Centrifugation

Emulgel was put into a centrifuge tube and then centrifuged at 4800 rpm for 45 minutes at room temperature. The presence or absence of phase separation was observed [24].

8. Accelerated Stability Study

Accelerated stability study was performed as per ICH Guidelines. The test was done for a time period of 3 months, 6 months & 12 months at a temperature of $30^{\circ}\text{C} \pm 2^{\circ}\text{C}/65\% \text{ RH}$ [25, 26]. The parameters which are observed such as colour, odour and phase separation are evaluated by visually. The texture, pH, viscosity these are determined by instrumental analysis.

Table 01: Depicts Stability studies Data of formulation

Parameters	3 months	6 months	12 months
Colour	No change	No change	No change
Odour	No change	No change	No change
Phase separation	No phase separation	No phase separation	No phase separation
Texture	No change	No change	No change
pH	No change	No change	No change
Viscosity	No change	No change	No change

Results and Discussion:

Table 02: Evaluation parameters of emulgel sunscreen formulation

Sr. No.	Parameters	Result
1	Color	Creamy Peach White
2	Odor	Pleasant
3	Consistency	Semi-solid
4	Texture	Smooth
5	pH	6.2
6	Viscosity	4130 cP
7	Spreadability	Easily spreadable
8	Firmness(hardness) (cycle 1 and cycle 2)	36 g
9	Homogeneity	Homogeneous
10	Centrifugation	No phase separation
11	Stability studies	Stable(no changes)

Discussion:

The formulation of the Emulgel sunscreen for sensitive skin has demonstrated impressive results across various evaluation parameters, highlighting its suitability for delicate skin. With a creamy peach-white color and a pleasant fragrance, the sunscreen is aesthetically pleasing and gentle. Its semi-solid consistency and smooth texture ensure easy, even application, while the pH of 6.2 aligns closely with the skin's natural pH, promoting skin compatibility. The sunscreen's moderate viscosity of 4130 cP enhances its spreadability, allowing for effortless and uniform coverage without feeling greasy. The formulation is also firm, with consistent texture under different conditions, and homogeneous, ensuring even distribution of ingredients. No phase separation was observed during centrifugation, indicating strong stability, and the stability studies confirmed that the product remains unchanged over time. These characteristics collectively make the Emulgel sunscreen a stable, effective, and comfortable choice for sensitive skin, providing reliable UV protection while minimizing the risk of irritation.

Conclusion:

In conclusion, the development of the Emulgel sunscreen offers a promising solution for individuals with sensitive skin by addressing common issues associated with traditional sunscreens, such as irritation, redness, and the white cast. By combining water-based gel and oil-based emulsion components, the Emulgel formulation ensures a lightweight, easily spreadable texture that is gentle on the skin. The evaluation tests, including pH, viscosity, spreadability, homogeneity, accelerated stability, and sensory testing, confirm the formulation's effectiveness, stability, and suitability for sensitive skin. Overall, the Emulgel sunscreen offers a balanced and skin-friendly solution that provides effective protection against UVB radiation while ensuring a comfortable and irritation-free application.

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