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Formulation And Evaluation Of Moisturizing Sunscreen Spray Containing Blue Pea Flower Extract And Essential Oils

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ABSTRACT

The main cause of many skin conditions is ultraviolet (UV) light, which makes UV protection essential. Sunscreen, commonly referred to as sunblock, is a topical photoprotective substance that helps shield the skin from sunburn and prevent skin cancer. Many medical professionals recommend using sunscreen products to lessen the damage that ultraviolet radiation does to the skin. Sunscreen comes mainly as creams, lotions, gel forms; however, powders and spray forms are becoming much more popular. Sunscreens sprays are frequently less prone than lotions and mineral-based sunscreens to leave a noticeable white film on the skin. This research involves the development of moisturizing sunscreen spray containing Blue pea flower extract and essential oils in order to respond to the current demand of the consumers. The suncreeen spray was prepared by using natural ingredients as active ingredients in specific quantities.

Formulation was done by incorporating aqueous phase of glycerin and ethanol into a mixture of essential oils such as carrot seed oil and pomegranate seed oil, virgin coconut oil, aloe vera gel using tween 80 as surfactant. Four formulations (F1-F4) were prepared by varying the concentration of the ingredients like carrot seed oil, pomegranate seed oil, coconut oil and aloe vera gel. Tests were conducted to evaluate the product for its organoleptic properties, SPF determination, pH, spreadability, rancidity, viscosity, irritancy and homogeneity to ensure product quality and consistency. The formulation F4 was found to be the best among the four preparations as it showed greater SPF value, moisturizing property, consistency and homogeneity. The findings suggest that the developed sunscreen spray to be a stable, safe and effective

skin care product which can deliver multiple benefits. The formulation successfully meets the intended objectives like providing SPF, anti-inflammatory, anti-oxidant, moisturizing and skin healing properties. Using a sunscreen spray that is sulphate-free, paraben- free and silicone- free, a quick and improved way of protection from UV radiation was obtained that is abundant and sustainable. Packaging design was created and a spray bottle was used for package. The formulation was shown to be stable across all parameters after a month of stability tests. Further research and clinical studies are needed to explore its efficacy and safety in larger population.

Keywords: Sunscreen spray, Blue pea flower extract, Essential oils, SPF, Moisturizing, UV radiation

INTRODUCTION

The term “cosmetic” is derived from the Greek word “kosmeticos”, meaning to decorate or beautify. Cosmetics are defined as any substance intended to be rubbed, poured, sprayed, sprinkled or applied to the human body or any part for cleansing, beautifying, promoting attractiveness or altering the appearance. Different ingredients, from natural to synthetic, are used for formulating cosmetics and these are suitable for various types of skin including sensitive skin. Advancements in product formulations and the growing need for beauty and personal care products have propelled the cosmetics industry's tremendous growth throughout the years.

Sunscreen is a skincare product used to shield the skin from the sun's damaging rays, which are classified as follows:

• UVA: The longest wavelength, measuring between 320 and 400 nm, damages the inner cells in the epidermis, resulting in sunburn and tanning.

• UVB: This medium wavelength, which ranges from 290 to 320 nm, damages the cells in the epidermis' outermost layer, resulting in blisters and sunburn.

• UVC: This shortest wavelength, which ranges from 100–290 nm, damages the outermost cells in the epidermis, resulting in lesions, ulcers and redness.

Sunscreens offer protection from UV radiation by reflecting, absorbing and scattering the rays. Using sunscreen daily helps prevent wrinkles, skin cancer, hyperpigmentation, sunburn and premature aging. It comes in a variety of forms including lotions, creams, sprays, gels and powders.

CLASSIFICATION OF SUNSCREEN

1. Based on the mode of action

a) Physical Sunscreen: Sits on the top of skin, reflects UVA and UVB rays.
E.g.: zinc oxide and titanium dioxide

b) Chemical Sunscreen: Absorbed into the skin and convert UV rays into heat.

E.g. Avobenzone, octisalate, Homosalate, Oxybenzone

The combinations of both physical and chemical active ingredients are considered to be a best sunblock.

2. Based on application

a) Topical: It either absorbs or reflects radiation to protect from harmful radiations.
b) Oral: These types of sunscreens are consumed orally to avoid skin damage.

Based on the mechanism of protection topical sunscreens can be divided into:

a) Organic Sunscreen: They act by absorbing into the skin and converting UV rays into heat. When UV rays of a specific wavelength are absorbed by organic filters, the energy is transferred from a lower energy level to a higher energy state.

- Photostable filter- It dissipates its absorbed energy to the surroundings as heat and reverts to ground state. It then has the capacity to absorb UV radiation again.

- Photounstable filter- After absorbing UV energy, this filter degrades or changes its chemical structure. It is not capable of absorbing UV energy again.

- Photoreactive filter- In the excited state, it interacts with surrounding molecules including oxygen, skin proteins, lipids and other components producing reactive species, it may have unwanted biological effects.

Organic sunscreens further divided into:

- UVA filters- PABA derivatives, cinnamates.
- UVB filters- Avobenzone, Meradimate

a) Inorganic Sunscreen- They act by reflecting, scattering or absorbing radiation. They act as a physical barrier against ultraviolet light. Since they cover the whole UV spectrum, these sunscreens are known as 'broad spectrum sunscreens'. Micronized or ultrafine particles can be used to manage

the opaque nature and whitening effect, which are some of its limits. It is also referred to as Sunblock. Commonly used agents to protect against UV radiation include zinc oxide and titanium dioxide.

IMPORTANCE OF SUNSCREEN

UV radiations are very essential for human health as it helps in the intestinal absorption of calcium, phosphorus and for vitamin D3 production. However, these radiations are harmful for our health and cause carcinogenic effects by directly interacting with DNA, RNA proteins and lipids. In the current scenario, sunscreen has become very important because the most effective way to protect the skin from radiation is to apply an active molecule with UV absorbing or reflecting properties topically.

MECHANISM OF PHOTOPROTECTION

UV rays mediated photo oxidative damage reaches the dermal capillaries via epidermis and dermis and cause depletion of enzymatic and non-enzymatic antioxidants in Stratum corneum, epidermis and dermis. Photo oxidation of pre-existing melanin and its precursors will occur which result in immediate and persistent pigment darkening.

Sunscreen act by preventing and minimizing the damaging effects of the ultraviolet sun rays following exposure to the sunscreen have been demonstrated to increase the tolerance of the skin to UV exposure. They work on two mechanisms:

Scattering and reflection of UV energy from the skin surface. Mineral based or inorganic sunscreen works on this mechanism; they provide a coating that blocks sun rays from penetrating through the skin.

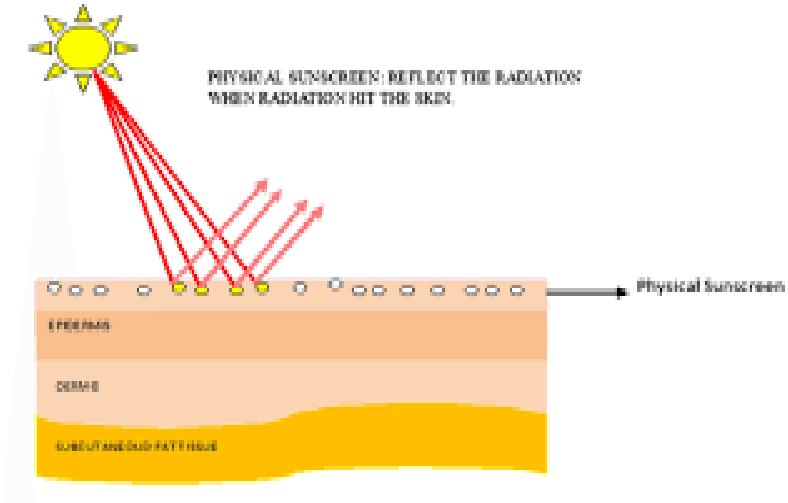

Fig 1: Mechanism of photoprotection

REQUIREMENTS OF SUNSCREEN

1. **Broad-Spectrum Protection:** It should protect against both UVA and UVB rays. The labels should specify “broad spectrum” coverage in order to ensure the protection of the skin.
2. **Adequate SPF:** Minimal SPF 30 is recommended for daily use, while SPF 50+ is ideal for outdoor exposure. The SPF must align with the skin sensitivity and degree of exposure to the sun.
3. **Lightweight and Non-Greasy:** It must absorb readily and does not leave behind any kind of thick, greasy, or sticky residue. It is an ideal factor for all skin types including oily and combination skin.
4. **Easy and Even Application:** It should be available in convenient forms such as creams or lotions for even coverage, sprays for easy, quick and large area application and sticks for targeted areas like nose or lips.

5. Long-Lasting Formula: It must remain effective for a number of hours with reapplication needed only after two hours or water exposure.

6. Non-Comedogenic: It should not clog pores or result in breakouts, making it best for acne-prone skin.

7. No White Cast: No White Cast: It is an important factor for darker skin tones. Modern formulations must offer transparent or tinted finishes.

8. Skin Compatibility: It must be compatible with all skin types such as for sensitive skin, it should be free from fragrances, alcohols and irritating chemicals; for oily or acne-prone skin, it should be

non-greasy and lightweight and in the case of dry skin, the sunscreen must have moisturizing properties.

9. Dermatologically Tested and Safe: It must be hypoallergenic and free from harmful chemicals like parabens, phthalates and synthetic fragrances.

10. Additional ingredients: In order to provide added protection against free radicals caused by UV exposure, the sunscreen must have antioxidants such as vitamin C or E.

SUN PROTECTION FACTOR (SPF)

It is a measure of how much solar energy (UV radiation) is required to produce sunburn on protected skin i.e. in the presence of sunscreen, relative to the amount of solar energy required to produce sunburn on unprotected skin.

As the SPF value increases, sunburn protection increases.

Protection Level	SPF Value
Low	6,10
Medium	15,20,25
High	30,40
Very high	50+

Table 1: SPF Classification table

SUNSCREEN SPRAY

Sunscreen sprays are a convenient alternative to traditional sunscreen creams, lotions or gels. Nowadays, they are widely used for their ease of application and portability. Sunscreen spray is an aerosol or pump bottle that delivers sunscreen in a fine mist, making it easy and quick to apply.

It's a popular choice for outdoor activities, travel and daily use, offering a protection against harmful ultraviolet (UV) rays. Sunscreen sprays are formulated to provide a lightweight, non-greasy layer of sun protection. They are available in different SPF levels and types, including chemical and mineral formulations. The spray format ensures even coverage, making it convenient for hard-to-reach areas like the back. These sprays absorb quickly into the skin, leaving no residue. These are often less messy to apply

and can be used without getting our hands greasy. The fine mist helps provide even coverage, reducing the chances of missed spots occurring due to creams or lotions.

Moisturizing sunscreen sprays combine the benefits of sun protection with hydration. They contain sunscreen agents to provide protection for the skin from harmful UV rays, while also infusing the skin with moisture through added humectants and emollients. This spray provides long-lasting hydration and soothes dry and irritated skin. Glycerin is a hydrating agent that helps in retaining moisture in the skin. Some of the main moisturizing agents used are hyaluronic acid, glycerin, ceramides, coconut oil, arganoil, etc.

USAGE OF SUNSCREEN SPRAYS

- **Shake well**- It should shake well before applying in order to ensure the ingredients are mixed.
- **Spray evenly**- It should hold 4-6 inches away from the skin and spray evenly, thus making sure to cover all exposed areas.
- **Rub it**- I t should be rubbed gently into the skin to ensure it is fully absorbed.
- **Reapply regularly**- It must be reapplied every 2 hours immediately after swimming or sweating.

Fig 2: Sunscreen spray

MAIN INGREDIENTS

➢ BLUE PEA FLOWER

Blue pea flower, also known as *Clitoriaternatea*, is a plant renowned for its vibrant blue petals and potential benefits in various traditional practices. It contains compounds like anthocyanins and flavonoids, which help protect the skin from oxidative stress and damage caused by UV radiation. It is extensively being explored for its potential use in sunscreen formulations due to its natural antioxidant and anti-inflammatory properties. Blue pea flower, renowned for its potential photoprotective properties, is a key ingredient in our moisturizing sunscreen spray. The plant's bioactive compounds, such as anthocyanins and flavonoids, can contribute to protecting the skin from UV damage in the following ways:

1. **Antioxidant Properties:** Blue pea flower extract is rich in antioxidants, particularly anthocyanins, flavonoids and polyphenols. This antioxidant helps to neutralize free radicals generated by UV radiation, thereby reducing oxidative stress and preventing damage to skin cells.

2. **Anti-inflammatory Effects:** Blue pea flower extracts exhibits anti-inflammatory properties, which helps to reduce the inflammatory response triggered by UV radiation exposure. By reducing inflammation, the extract may contribute to minimizing skin redness, swelling and discomfort associated with sunburn.

3. **UV Absorption:** Studies have shown that blue pea flower extract possesses natural UV absorbing properties, particularly in UVA and UVB ranges. This ability to absorb UV radiation can help shield the skin from direct exposure to harmful rays, reducing the risk of sunburn, premature ageing and DNA damage.

4. **Skin Barrier Protection:** Blue pea flower extract enhances the skin's natural barrier function; improving its ability to retain moisture and resist external stressors. This barrier enhancing effect can fortify the skin against UV-induced damage and maintain its overall health and integrity.

5. **Skin Brightening and Even Tone:** Anthocyanins present in blue pea flower extract have been associated with skin brightening effects and the reduction of hyperpigmentation. By inhibiting melanin production and promoting a more even skin tone, the extract may help counteract sun-induced dark spots and discoloration.

Fig 3: Blue pea flower

❖ ESSENTIAL OILS

• CARROT SEED OIL

Carrot seed oil is becoming a popular ingredient in sunscreen formulations due to its various beneficial properties. Carrot seed oil is the essential oil extract of the seed from the carrot plant *Daucuscarota*. The most essential oil content is carotol, fatty acids, β-carotene in large amounts and α and γ carotene in small amounts, α-carotene, and β-carotene are partially metabolized to vitamin A. Carrot seed oil is an antioxidant, antiseptic, antifungal, and fragrant with a high vitamin A content and can be used as a sunscreen, anti-aging, skin revitalizing, and rejuvenating ingredient.Carrot seed oil does offer several properties that may provide some support to skin health when exposed to the sun:

1. **Antioxidant and Anti-inflammatory Properties:** The antioxidants in carrot seed oil, including vitamins A and E, help neutralize free radicals that can be generated by UV exposure. This makes it useful for preventing some of the oxidative stress associated with sun damage.These properties may help reduce skin irritation and inflammation caused by sun exposure, promoting healing after sunburn or minimizing damage.
2. **Natural Sun Protection:** Beta-carotene and other carotenoids found in carrot seed oil are believed to offer a slight degree of natural defense against UV radiation. According to some research, carrot seed oil may provide an SPF equivalent of roughly 30 to 40, though this varies based on the oil's quality and concentration.Compared to physical or chemical sunscreens, which are specially made and tested for UV protection, it is less effective.
3. **Skin Regeneration and Repair:** Carrot seed oil is often used in formulations aimed at improving skin health and stimulating skin regeneration. Its high content of vitamin A and

carotenoids can support the skin's repair processes, making it a useful addition to post-sun exposure skincare routines.It may also help prevent premature signs of aging caused by UV exposure, such as fine lines and wrinkles.

4. **Skin Nourishment and Hydration:** As carrier oil, carrot seed oil is nourishing and can help maintain the skin's hydration levels after sun exposure. It supports the skin's natural barrier and may help reduce dryness and peeling.

Fig 4: Carrot seed oil

- **POMEGRANTE SEED OIL**

Pomegranate seed oil, derived from the seeds of the pomegranate fruit (Punicagranatum), has emerged as a valuable ingredient in sunscreen formulations due to its unique chemical constituents and skin benefits. Rich in punicic acid pomegranate seed oil offers potent antioxidant, anti-inflammatory, and skin-repairing properties. In addition to punicic acid, it contains polyphenols, flavonoids, and ellagic acid, which work synergistically to protect the skin from harmful UV radiation, neutralize free radicals, and reduce oxidative stress. These compounds not only enhance the skin's defense against sun damage but also promote skin regeneration, improve hydration, and soothe inflammation. As a result, pomegranate seed oil serves as a multifunctional ingredient, enhancing the efficacy of sunscreens while contributing to healthier, more resilient skin. Its uses in sunscreen include:

1. **UV Protection:** Pomegranate seed oil has been shown to help protect the skin from UV radiation due to its antioxidant content, particularly punicic acid, a polyunsaturated fatty acid. These antioxidants help to reduce free radical damage caused by sun exposure.
2. **Skin Repair and Regeneration:** The oil supports skin regeneration and may help repair sun-damaged skin. It promotes the production of collagen, which is essential for skin elasticity and the reduction of sun-related skin aging.

3. **Anti-inflammatory Benefits:** It has anti-inflammatory properties that can help soothe the skin after sun exposure, reducing redness, irritation, and potential sunburn.
4. **Reduction of Sunburn and Hyperpigmentation:** The oil is believed to help with the healing of sunburns and may also assist in reducing the appearance of dark spots and hyperpigmentation caused by the sun.
5. **Hydration:** Pomegranate seed oil is rich in essential fatty acids, which help to lock in moisture and prevent the skin from becoming dry or dehydrated from sun exposure.

Fig 5: Pomegranate seed oil

❖ MOISTURIZING AGENTS

- **ALOE VERA**

Aloe Vera, scientifically known as Aloe barbadensis miller, is a succulent plant that belongs to the family Liliaceae. The species has several synonyms: Aloe barbadensis, Aloe indica, Aloe perfoliate .The leaves of Aloe Vera contain significant amounts of the polysaccharide gel acemannan, which can be used for topical purposes. Aloe skin contains aloin which is toxic. Products made from Aloe Vera usually only use the gel. Aloe Vera, renowned for its soothing and nourishing properties, is a key ingredient in our Moisturizing Sunscreen Spray. Here are the key ways aloe vera is connected to sunscreen use:

1. **Sunburn Relief:** Aloe Vera is commonly used to treat sunburns due to its cooling and anti-inflammatory properties. When applied to sunburned skin, aloe vera can help reduce redness, pain, and swelling. Its gel contains compounds like polysaccharides that promote skin repair and hydration, making it a great after-sun care product.

2. **Moisturization and Skin Healing:** Prolonged sun exposure can dry out and damage the skin. Aloe Vera is rich in water content and has moisturizing effects that help replenish the skin's moisture balance after sun exposure. It can also accelerate healing by stimulating collagen production and improving skin regeneration, which is beneficial after a day in the sun.

Antioxidant Protection: Aloe Vera contains antioxidants such as vitamins C and E, which can help protect the skin from the damaging effects of free radicals caused by UV exposure.

1. Antioxidant Protection: Aloe Vera contains antioxidants such as vitamins C and E, which can help protect the skin from the damaging effects of free radicals caused by UV exposure.
2. Prevention of Premature Aging: UV exposure is a major cause of premature aging, and aloe vera contains compounds that have been shown to help reduce the appearance of fine lines and wrinkles. Regular use of aloe vera-based products can maintain youthful skin by promoting collagen production and preventing skin damage from UV rays.
3. Anti-inflammatory Effects: Aloe Vera has natural anti-inflammatory properties that can reduce irritation caused by prolonged sun exposure. This can help calm the skin after being in the sun and reduce the risk of inflammation, which can lead to more severe sunburns.

Fig 6: Aloe vera

- **VIRGIN COCONUT OIL**

Coconut oil is of two varieties: virgin and refined oil. Virgin coconut oil (VCO) is made by cold-pressing the liquid from the fresh part of coconut meat. It has a milky appearance. This oil extraction method prevents the loss of vitamin E, pro-vitamin A, and polyphenols. It has various properties such as analgesic, anti-inflammatory, and anti-cancer. Virgin coconut oil (VCO) has been traditionally used as moisturizer since centuries by people in the tropical region. Clinical studies have revealed that VCO improves the

symptoms of skin disorders by moisturizing and soothing the skin. The moisturizing qualities of virgin coconut oil (VCO) are widely valued, mainly because of its distinct fatty acid, vitamin, and antioxidant makeup. Virgin coconut oil is high in saturated fats due to its high fatty acid content, particularly medium-chain fatty acids (MCFAs) such as lauric acid, capric acid, and caprylic acid. These fats are easily absorbed by the skin and help to restore moisture by create a barrier on the skin, reducing water loss and keeping the skin hydrated and also improve skin texture by soften and smooth the skin, preventing it from becoming dry and flaky. Here are its key moisturizing attributes:

1. **Deep Penetration:** Unlike some oils that sit on top of the skin, virgin coconut oil is able to penetrate deeply into the skin layers due to its small molecular structure. This ensures that the moisture reaches deeper layers of the skin, enhancing its overall hydration and improving skin texture over time.

2. **Natural Emollient:** As an emollient, virgin coconut oil helps to smooth and soften the skin. It provides a soothing effect, which can be particularly beneficial for people with dry, irritated, or flaky skin.
3. **Rich in Antioxidants:** VCO contains antioxidants like vitamin E and polyphenols, which not only protect the skin from environmental damage (such as UV rays and pollution) but also support the skin's ability to retain moisture. Antioxidants can also help in repairing damaged skin cells, promoting overall skin health.
4. **Anti-inflammatory and Antibacterial Properties:** The natural anti-inflammatory and antibacterial properties of virgin coconut oil make it useful for calming irritated or inflamed skin, reducing redness, and promoting healing, all while maintaining moisture levels.
5. **Nourishing:** It contains essential fatty acids and vitamins that nourish and strengthen the skin, promoting a healthy complexion.
6. **Absorbs quickly:** Virgin coconut oil is light weight and absorbs into the skin fairly quickly, leaving it hydrated but not greasy.

Fig 7: Virgin coconut

RELEVANCE

The study of the formulation and evaluation of moisturizing sunscreen spray is highly relevant as there is a growing trend of consumer preference for safe and effective natural and plant-based skincare products.

Traditional sunscreens can sometimes feel heavy or greasy, however, these sprays offer a more convenient and appealing alternative, mainly for those with dry skin or those looking for a lighter application. They provide effective sun protection along with hydration without clogging the pores or leaving a sticky residue.

The study focuses on the development of a product using blue pea flower extract, carrot seed oil, pomegranate seed oil, virgin coconut oil and aloe vera , all of which are well known for delivering multiple skin benefits, thus contributing to the increasing demand of clean and green beauty products. Blue pea flower is a depot of powerful antioxidants such as anthocyanins, flavonoids including flavones, flavanols and flavanones, peptides, polyphenols including phenolic acids and tannins and carotenoids including beta-carotene and lutein, which has the ability to neutralize free radicals and provide protection for skin cells from oxidative and UV-induced damage and delays the appearance of signs of aging like fine lines, wrinkles and loss of elasticity. These bioactive compounds work synergistically to provide various benefits such as antioxidant protection, anti-inflammatory effects, skin health and potential UV protection, thereby promoting much healthier and youthful skin.

In this study, essential oils such as carrot seed oil and pomegranate seed oil are used as sunscreen agents. Carrot seed oil has a high concentration of beta-carotene, a precursor to vitamin A, giving it anti-aging and antioxidant properties. It also contains 3 flavones which are having antioxidant activity helpful in the treatment of skin-related problems and also protects skin from UV radiation. Pomegranate seed oil contains high amounts of unsaturated fatty acids, mainly punicic acids, which has attracted scientific interests and gained wide attention for their therapeutic potential due to its several health benefits including antioxidant activities. It also has skin beneficial tocopherols such as alpha and gama-tocopherol and phytosterols such as beta-sitosterol, campesterol and stigmasterol. Some studies have reported that pomegranate seed oil has skin beneficial effects in epidermal degeneration and UV protection enhancement.

Studies suggest that aloe vera and virgin coconut oil possess moisturizing properties. Aloe vera gel can block UV rays and maintain skin's natural moisture balance due to its hydrating properties, thus effectively soothing and replenishing the skin with moisture. Being the main ingredient, acemannan speeds up the repair phase and increases the production of collagen and fibroblasts. Virgin coconut oil moisturizes and soothes the skin as it is rich in fatty acids, vitamins and antioxidants. The combination of aloe vera and virgin coconut oil ensure hydration and nourishment, providing a good moisturizing product.

Other constituents in the formulation such as tween 80, ethanol, glycerin and rose water have different properties. Tween 80, also known as polysorbate 80, is a non-ionic surfactant and used as an emulsifier. Ethanol is used as a penetration enhancer which enhances the penetration of active ingredients into the skin. It also increases the solubility of active ingredients. Glycerin is a versatile ingredient which is widely used in cosmetics. When incorporated into the formulation, glycerin acts as a humectant, providing various

skin benefits. It increases the hydration levels of the skin by prolonging trans-epidermal water loss (TEWL) and locking moisture and thereby helps to maintain smoother and softer skin making it supple and less rough. Rose water is used as a hydrating and nourishing agent and protects the skin against harmful environmental aggressors.

Consumers are seeking multifunctional products that can bring forth various skin concerns simultaneously with proven safety and efficacy. Combining blue pea flower extract, carrot seed oil and pomegranate seed oil along with ingredients like virgin coconut oil and aloe vera extends a unique formulation that leverage synergistic effects of these ingredients to provide multifunctional skin care benefits. The relevance of this study is emphasized by its alignment with consumer predilections and market trends. By developing a natural product with extensive cosmetic benefits, the study addresses the demands and reckonings of modern consumers, extending a high-quality product that can magnify overall skin health and appearance.

AIM

The aim of the study is to formulate and evaluate moisturizing sunscreen spray containing blue pea flower extract and essential oils as main ingredients.

OBJECTIVES

The objectives of the study were the following:

- Formulate a moisturizing sunscreen spray that utilizes blue pea flower extract and essential oils with hydration, UV defense, photostability properties ASS to protect skin from harmful UV rays.
- Evaluate the physical and chemical properties of sunscreen spray such as Ph, texture, and stability.
- Assess the efficacy of sunscreen spray in preventing hyper pigmentation, dryness, wrinkles, fine lines, redness, ageing and sun burns.
- Provide a gentle and environment-friendly alternative to conventional sunscreens products.
- Develop a cost-effective, sustainable, easily applicable and portable sunscreen spray.

PLAN OF WORK

The plan of the work was as follows:

1. Preformulation study of drug and excipients

a) Effect of light

b) Viscosity

c) Effect of heat

2. Formulation of moisturizing sunscreen spray

3. Evaluation of sunscreen spray

a) Organoleptic properties

b) Type of emulsion (Dye test)

c) Homogeneity

d) Viscosity

e) pH measurement

f) Spreadability

g) Test for Rancidity

h) Irritancy test

i) SPF determination

j) Short term stability studies

PREFORMULATION STUDIES OF DRUG AND EXCIPIENTS

The objective of preformulation study was to develop an elegant, stable, effective and safe dosage form by establishing fine understanding of the physicochemical properties of new drug substances and excipients before being developed into a final formulation. A brief preformulation study was done to understand the following;

- Degradation of the ingredients upon atmospheric exposure.
- Incompatibilities of active ingredients with excipients.
- Physical and chemical stability of the formulation.

In the study following physicochemical parameters were also studied;

1. Effect of light

The ingredients were subjected to natural day light at room temperature for a fixed period of time. It was done to check whether the presence of light has any effect on the stability of the ingredients.

2. Viscosity

Viscosity study was done by Brookfield Viscometer so as to confirm that the selected ingredients are not too viscous because it might lead to incompatibility issues such as agglomeration, emulsion breaking, caking etc.

3. Effect of heat

During a predetermined amount of time, the materials were exposed to natural day light at room temperature. It was carried out in order to see if the compounds' stability was affected in any way by the temperature of the atmosphere.

MATERIALS

Sl.no.	Ingredients	Sources
1.	Carrot seed oil	Salvia Cosmeceuticals Pvt. Ltd. ,New Delhi
2.	Pomegranate seed oil	Pomenate Pvt. Ltd. , Telangana
3.	Coconut oil	Indomitra Farm Products Pvt. Ltd. , Tamilnadu
4.	Aloe Vera	Dhathri Life Sciences Pvt. Ltd. , Kayamkulam
5.	Tween 80	Chemdyes and Gamble Health Ltd, Goa
6.	Glycerin	Nice Chemicals Pvt. Ltd. , Kochi
7.	Ethanol	Isochem Laboratories, Kochi
8.	Rose water	Vishal Personal Care Pvt. Ltd. , Hyderabad
9.	Perfume	Nice Chemicals Pvt. Ltd. , Kochi
10.	Aqueous extract of blue pea flower	Collected locally

Table 2: Materials and sources

Fig 8: Materials from laboratory

Fig 9: Materials purchased

METHODOLOGY

MATERIAL COLLECTION

Blue pea flower was grown and collected locally.

PREPARATION OF BLUE PEA FLOWER EXTRACT

In this study, to prepare the blue pea flower extract for sunscreen spray about 6 to 8 fresh flowers were taken and added to the beaker containing 30 ml of distilled water. The mixture was allowed to steep for 15-20 minutes. After 15 minutes the liquid is strained and the flowers were discarded.

Fig : Fresh blue pea flowers

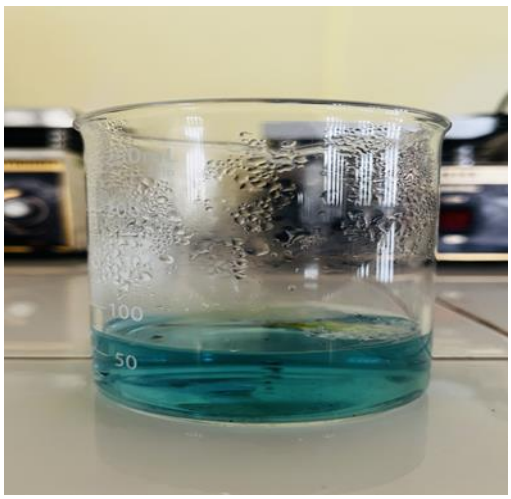

Fig 9: Aqueous extract of blue pea flower

FORMULATION OF MOISTURIZING SUNSCREEN SPRAY

- The required quantity of carrot seed oil, pomegranate seed oil and virgin coconut oil were taken in a measuring cylinder separately and transferred into a dry mortar.
- Perfuming agent was also added to it.
- The required quantity of tween 80 was then added into it and triturated rapidly so as to form a uniform mixture.
- Aloe vera and alcohol were taken in a beaker and mixed well. To it, glycerin, rose water and aqueous extract of blue pea flower were added and stirred properly. This forms an aqueous phase.
- The required quantity of aqueous phase was added to the prepared mixture and triturated vigorously till a clicking sound was produced. Thus, primary emulsion was formed.
- Now, the remaining aqueous phase was added to it to produce the required volume of sunscreen spray.
- The formulation obtained was transferred into a suitable container and labelled.

Fig 12: Formulation of moisturizing sunscreen spray

Fig 13: Formulation 1

Fig 14: Formulation 2

Fig 15: Formulation 3

Fig 16: Formulation 4

Sl.no.	Ingredients	F_1	F_2	F_3	F_4
1.	Carrot seed oil	2ml	2ml	3ml	4ml
2.	Pomegranate seed oil	1ml	1.5ml	2ml	3ml
3.	Coconut oil	1ml	2ml	1ml	2ml
4.	Tween 80	5ml	5ml	8ml	8ml
5.	Aloe Vera	10g	10g	7g	5g
6.	Glycerin	2ml	1ml	1ml	2ml
7.	Ethanol	10ml	10ml	5ml	5ml
8.	Rose water	3ml	3ml	3ml	3ml
9.	Perfume	1 drop	1 drop	1 drop	1 drop

10.	Aqueous extract of blue pea flower	20 ml	20ml	20ml	20ml

Table 3: Formulation table

EVALUATION OF MOISTURIZING SUNSCREEN SPRAY

Evaluation was conducted on the physical evaluation during 4 weeks of storage at room temperature. The following evaluation tests were conducted.

1. Organoleptic Properties

Organoleptic properties for the prepared formulations were conducted for its colour, odour and texture.

2. Type of emulsion (Dye test)

Few drops of Safranin dye is mixed with little amount of the formulation and then a drop of this mixture is placed on a microscopic slide and then covered by placing a cover slip on top.Upon observation under the microscope, if red colored globules were found to be dispersed against a colorless background then the cream is water in oil type and if it appears as colorless globules against a red background then the formulation will be oil in water type.

3. Homogeneity

The homogeneity of a prepared formulation was tested by appearance and by spraying.

4. Viscosity

The viscosity of the formulation was evaluated using Brookfield Viscometer and the values were obtained in centipoise.

5. pH

The pH meter was first calibrated using standard buffer solution. About 0.5ml of the solution was taken and dissolved in 50ml of distilled water. Then the calibrated pH meter was used to measure the pH of the cream.

6. Test for Rancidity

1ml of preparation was taken, then added 1ml of concentrated hydrochloric acid and 1ml of phloroglucinol solution and shaken for 1min.

7. Irritancy Test

The prepared formulation was sprayed on the back side of the left hand. Irritation on applied area, eczema and other rashes were observed within 24 hours after the application of sunscreen spray.

8. Sun Protection Factor (SPF) Determination

1gm of the formulation was weighed and added into 100ml volumetric flask, diluted with ethanol and ultrasonicated for 5 mins. Then the resulting solution was filtered using filter paper and then rejected first 10ml. Into a 50ml volumetric flask, an aliquot of 5ml was transferred and diluted with ethanol. To the 25ml volumetric flask, an aliquot of 5ml was transferred and diluted with ethanol. The absorbance values of the aliquot was measured from 290-320nm at 5nm interval taking ethanol as a blank. Then SPF was determined by using Mansur equation.

SPF= C F Σ_{290}^{320} E E (λ) x I (λ) Abs (λ)

Where,

CF= correction factor (which is equal to 10)

EE(λ)= Erythmagenic effect of radiation with wavelength

Abs(λ)= spirit photometric absorbance values at wavelength

EE values are constant

9. Short term stability studies

Short term stability studies were conducted on four formulations named F1, F2, F3 and F4 by storing them at room temperature. The formulations were then studied for 2 months for parameters such as pH, appearance, homogeneity and consistency. Also, phase separation was observed.

RESULTS AND DISCUSSION

1. Organoleptic Properties:

The physical properties of all formulated sunscreen sprays were judged by its color, odour and texture. The results are tabulated below:

Parameter	F_1	F_2	F_3	F_4
Color	Light Blue	Purple	Blue	Light Blue
Odour	Pleasant	Pleasant	Pleasant	Pleasant
Texture	Smooth	Smooth	Smooth	Smooth

Table 4: Organoleptic properties of the sunscreen spray

2. Dye Test

Under microscopic evaluation of the slide containing the formulation mixed with water soluble dye (safranin), it was observed that the dispersed globules appeared colourless against the continuous phase which was found to be red in color. Hence, the formulation was identified to be oil in water (o/w) type.

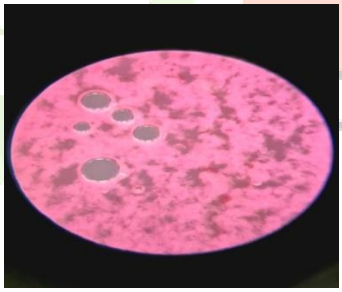

Fig 17: Dye Test

3. Homogeneity

All prepared formulations produce uniformity of spray. Homogeneity was confirmed by its physical appearance and evenly distributed droplets on spraying.

Parameter	**F_1**	**F_2**	**F_3**	**F_4**
Homogeneity	Moderate	Good	Moderate	Very good

Table 5: Homogeneity of the sunscreen spray

4. Viscosity

The viscosity of the prepared formulation was evaluated with Brookfield viscometer. The results are as follows:

Fig 18: Brookfield Viscometer

Parameter	**F_1**	**F_2**	**F_3**	**F_4**
Viscosity	16.21	13.41	10.25	9.36

Table 6: Viscosity of the sunscreen spray

5. pH of the sunscreen spray

The pH of all cosmetic preparations should be optimal to ensure the stability and safety of the formulation on application on to the skin. The readings of pH meter were found to be in between 4.0 and 6.0, which is good for skin pH. All the prepared formulations of spray are nearer to skin pH. The complete result of pH test is provided in the table below.

Fig 19: pH meter

Parameter	F_1	F_2	F_3	F_4
pH	4.37	4.56	4.6	4.91

Table 7: pH of the sunscreen spray

6. Test for Rancidity

No pink colour was developed. Therefore, the formulation was found to be free from rancidity.

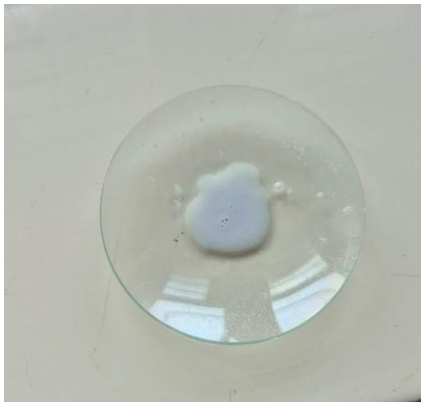

Fig 20: Test for Rancidity

Parameter	F_1	F_2	F_3	F_4
Rancidity	No Pink Colour	No Pink Colour	No Pink Colour	No Pink Colour

Table 8: Test for Rancidity

7. Irritancy test

The prepared formulations show no redness, pulp, inflammation, and irritation within 24-48 hours after application. The absence of irritation or allergic reactions suggests that the prepared formulations are safe to use.

Fig 21: Irritancy test (on application)

Fig 22: Irritancy test (after few minutes)

Parameter	**F_1**	**F_2**	**F_3**	**F_4**
Irritancy	NIL	NIL	NIL	NIL

Table 9: Irritancy of sunscreen spray

8. SPF DETERMINATION

SPF determination of the formulated sunscreen spray was done by taking ethanol as a diluent. The samples were scanned in 290-320 nm range and SPF values of all four formulations are represented in table number 9 to 12.

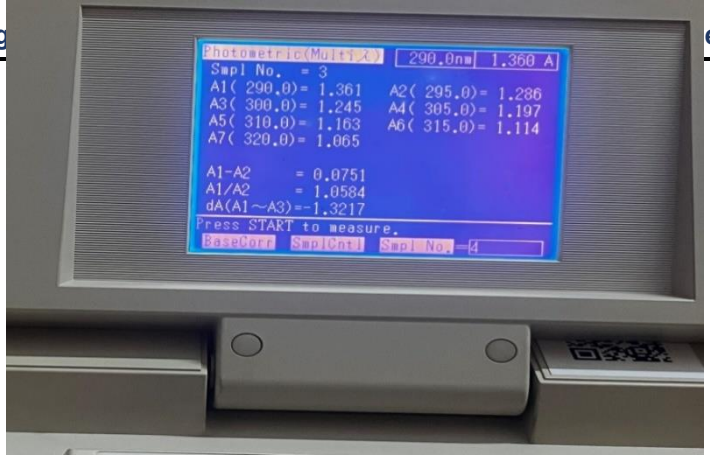

Fig 23: UV Spectrophotometer

SPF value for F_1(Formulation 1)

Wavelength	EE× I	*Dilution with ETHANOL* Abs	Abs× EE× I
290	0.015	1.165	0.017475
295	0.082	1.098	0.090036
300	0.287	1.043	0.302211
305	0.328	0.129	0.042312
310	0.186	0.119	0.022134
315	0.084	0.110	0.00924
320	0.018	0.102	0.001836
TOTAL			**0.4485244**
SPF			**4.85244**

Table 10: SPF of F_1

SPF value for F_2 (Formulation 2)

Wavelength	EE× I	*Dilution with ETHANOL* Abs	Abs× EE× I
290	0.015	1.201	0.018015
295	0.082	1.189	0.097498
300	0.287	1.162	0.333494
305	0.328	0.133	0.043624
310	0.186	0.112	0.020832
315	0.084	0.030	0.00252
320	0.018	0.009	0.000162
TOTAL			**0.516145**
SPF			**5.16145**

Table 11: SPF of F_2

SPF value for F_3(Formulation 3)

Wavelength	EE× I	*Dilution with ETHANOL* Abs	Abs× EE× I
290	0.015	1.253	0.018795
295	0.082	1.183	0.097006
300	0.287	1.121	0.321727
305	0.328	1.088	0.356864
310	0.186	1.067	0.0198462
315	0.084	0.032	0.002688
320	0.018	0.011	0.000198
TOTAL			**0.8171242**
SPF			**8.171242**

Table 12: SPF of F_3

SPF value for F_4(Formulation 4)

Wavelength	EE× I	*Dilution with ETHANOL* Abs	Abs× EE× I
290	0.015	1.361	0.020415
295	0.082	1.286	0.105452
300	0.287	1.245	0.357315
305	0.328	1.197	0.392616
310	0.186	1.163	0.216318
315	0.084	1.114	0.093576
320	0.018	1.065	0.01917
TOTAL			**1.204**
SPF			**12.04**

Table 13: SPF of F4

The SPF is the quantitative measurement of the effectiveness of the sunscreen spray formulation, to be effective in preventing sunburn and other skin damages. A sunscreen spray should have wide range absorbance between 290-320 nm. SPF determination was performed by UV spectrophotometric method and Mansur's equation.

The SPF values indicate all the formulations having good UV absorbing properties in which formulation 4 is comparatively better.

9. Short Term Stability Studies

We have conducted short term stability studies for about two months to ensure the quality, safety and efficacy of the formulation. Findings and reports were tabulated in the table.

DAYS	FORMULATIONS	pH	CONSISTENCY	APPEARANCE	PHASE SEPARATION
	F1	4.3	Good	Good	
	F2	4.5	Satisfactory	Good	
	F3	4.6	Satisfactory	Poor	
15	F4	4.9	Excellent	Excellent	NIL
	F1	4.1	Poor	Good	
	F2	4.5	Good	Satisfactory	
	F3	4.6	Good	Poor	
30	F4	4.8	Excellent	Excellent	NIL
	F1	4.5	Good	Poor	
	F2	4.6	Good	Good	
	F3	4.3	Good	Satisfactory	
45	F4	4.9	Excellent	Excellent	NIL
	F1	4.2	Poor	Poor	
	F2	4.4	Good	Good	
	F3	4.1	Good	Poor	
60	F4	4.9	Excellent	Excellent	NIL

Table 14: Short Term Stability Studies

SUMMARY AND CONCLUSION

The purpose of this study was to look into the possible benefits of carrot seed oil, pomegranate seed oil and blue pea flower extract as sunscreen agents in the form of a spray. We have also used aloe vera gel to prevent dryness and to impart moisturizing property to the skin. Our Moisturizing sunscreen spray is easier to apply and is light in weight than traditional sunscreen formulations. They do not leave any white cast on the skin. Our natural sunscreen spray harness the power of carrot seed oil, pomegranate seed oil and blue pea flower extract to provide long lasting protection against sun and provide moisturization to the skin. Our formula is free from harsh chemicals, artificial fragrances and dyes, making it perfect for those seeking a natural and effective solution for their skin care.

The results of evaluation and stability studies were satisfactory; however, only formulation (F4) met all the requisites for an ideal sunscreen spray, which was found to be the most stable and acceptable. It retains the consistency even after 1 month and is believed to be safe for topical administration. Since the methods adopted for this study were simple and economic, this method may possess industrial scalability. Evaluation of the sunscreen spray involves various tests including SPF determination, pH, organoleptic properties, rancidity, viscosity, irritancy, Spreadability and homogeneity to ensure product quality and consistency. Thus, we conclude carrot seed oil, pomegranate seed oil and blue pea flower extract is a potent sunscreen agent, its formulation and usage will be inevitable in the near future.

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