Original Article

Formulation development and evaluation of a topical photoprotective natural product

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ABSTRACT

This study's objective was to formulate a topical photoprotective cream which is a chemical substance that shields you from sunburn-causing ultraviolet (UV) radiation. Creams were preparing as emulation of two phases system (oil in water) oil phase and aqueous phase. In both phases we used natural materials such as Almond oil, Coconut oil, and Aloe vera gel. Then evaluate the formulas by using a set of tests such as visual test (Color and odor), chemical test (PH), physical test (Viscosity and spreadibility), and optical test used to measure sun protective factor (SPF). Formula F4 was the best one because it has good physicochemical properties as appearance, homogeneity, ease of removal because of o/w cream, no phase separation, desired PH and spreadability, viscosity, and the highest SPF value (36.85). Our formulation considered to be effective natural sun protective product for routine daily used.

Keywords: Photoprotective, Natural, Cream, SPF

Introduction

Photoprotective substance that helps protect the skin from the harmful effects of the sun. Over the past few decades, the way people use sunscreens to protect themselves from the sun has changed a lot. As more people learn about how sunscreen protects against sunburns, skin ageing, and melanomas, the need for sunscreen formulas will surely grow. The pharmaceutical sector has a great possibility to satisfy this need by making sunscreen that is safe, effective, looks good, and works well [1, 2]. Sunscreens protect against UV A and B rays by reflecting, absorbing, and scattering them. Lotions, creams, or gels that have sunscreen in them can help protect the skin against damage and early ageing that could lead to skin cancer [3-5]. In addition to improving the degree of sun protection factor (SPF), sun-block formulas must be developed to prevent sunburn, sun tanning, skin melanoma, and early fine lines and wrinkles. Sunscreens are commonly used to shield the skin from the sun's damaging rays and lower the chance of sun-related skin conditions. Research is currently being done on broad-spectrum sunscreens to lessen the long-term impacts of excessive UV exposure [6-8].

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In general, sunscreens are divided into two categories according on how they are applied: topical and systemic. Topical sunscreens are further divided into organic and inorganic types based on how they protect. Inorganic sunscreens are also called Sunblocks.

Organic sunscreens(chemical)

The carbonyl group often serves to link these aromatic compounds. Sunscreens may be categorised into three main groups based on the range of wavelengths they block: UVA (320-400 nm), UVB (290-320 nm), and broad-spectrum (290-400 nm) [9-11].

Octisalate and homosalate cinnamates, octinoxate and cinoxate, octocrylate, benzsulidone, and dibenzoylmenthanes are some examples of organic sunscreens that block UVB radiation. Padimate O. salicylates, a derivative of PABA, is another example. The following are examples of UVA filters: ecamsule, methyl anthranilanate, avobenzone, chlorobenzene, oxybenzone, and meradimate. The organic broad-spectrum filters besoctrizole and silatriazole are able to block both UVA and UVB radiation [12, 13].

Inorganic sunscreens(physical)

These particles scatter and reflect UV rays, sending them back into the environment. They act as a physical shield, preventing the passage of UV light. Particle sunscreens with zinc oxide and titanium dioxide are the most popular [14]. They are considered broad spectrum because they cover the whole ultraviolet (UV) range. The photoprotective properties of the inorganic sunscreens led to their alternative name, Sunblocks.

Hybrid compound-based sunscreen (organic + inorganic)

Hybrid Compound-based sunscreens are created as multipurpose solutions with the goal of producing particular advantages and qualities including sun protection, anti-aging, and anti-pollution [15]. These hybrid goods, which combine inorganic (physical) and organic (chemical) substances, serve as UV filters. Recently, hybrid UV filters have been discovered. These include mineral and organic UV filters with broad-spectrum protection, excellent UV protection, and water resistance that hold up well in a variety of settings. Lipid and silica hybrid nanoparticles raised the SPF of sunscreens.

Systemic sunscreen

These sunscreens provide protection from UV rays by accumulating in the skin after being absorbed by the body. Systemic sunscreens are rarely used on a daily basis [16-18].

The term "Sun Protection Factor" (SPF) stands for The SPF value tells you how well it protects against UV B rays. Higher SPF sunscreens protect you from the sun better. The sun protection factor (SPF) measures the amount of ultraviolet radiation that is needed to cause sunburn when using sunscreen, as opposed to when the skin is not covered. However, sun protection factor does not indicate how much time you can spend outside without sunburn [13, 19, 20]. The SPF values tell you how long you can be in the sun. A higher SPF rating gives you more protection, but it's not as simple as a math problem.

SPF tells you how much UV radiation there is, not how long you've been exposed to it. Throughout the day, the sun's rays fluctuate in intensity. Between nine and ten in the morning, you may soak up as much ultraviolet light as you would in fifteen minutes of early afternoon sun. An SPF 30 sunscreen won't protect you from the sun for twice as long as an SPF 15 sunscreen. Even while SPF 30 provides twice the protection of SPF 15, it doesn't imply you may spend twice as much time outside.

Also, each person has a different level of UV exposure that is safe for them. Dark skin absorbs less UV rays than pale skin, which makes it burn more quickly. This is because the outer layer of skin has a pigment called melanin that protects against UV radiation. The darker the skin, the more melanin it has, which protects it better from the sun. Black skin can still receive sunburns that make it warm, hurt, peel, and damage the skin, even though pale skin burns faster and more obviously than darker skin tones [16, 21, 22].

A higher SPF rating means that sunscreen blocks more UV rays. But the extra benefits get smaller as the SPF ratings get up [23-27].

The goal of the present study was to prepare different formulations of photoprotective cream containing natural ingredients and evaluate them in order to optimize and select the good one.

Materials and Methods

This part consists of choosing natural additives and all materials used in the experimental part in the preparation of sunscreen cream show in **Table 1**.

Table 1. The Materials Used and Their Properties

Material	Properties
Water	Primary solvent
Glycerol	Moisturizer
Cetyl alcohol	Emulsifier and stabilizer
Starch	Enhanced retention and efficacy of topical sunscreen
Sodium lauryl sulfate (SLS)	Anionic Surfactant
Stearic acid	Lubricant
Aloe vera gel	Natural Protection, Moisturizing, Anti-inflammatory and Antioxidant
Almond oil	used as a standalone ingredient to protect skin from sun, hydrating the skin, prevent stretch marks or reduce the appearance of dark spots and wrinkles
Coconut oil	Limited sun protection: Coconut oil offers some degree of sun protection Moisturizing properties: Coconut oil is known for its moisturizing properties, which can help keep the skin hydrated and prevent dryness
Methyl paraben	Preservative

Method of preparation of photoprotective cream

Preparation of aqueous phase

This phase is the first stage in preparing the cream, it is called the aqueous or water phase because of the use of water in a large proportion, as well as liquids such as glycerin and other organic materials in powder form. The preparation of aqueous phase includes the addition of water, glycerin on the magnetic stirrer around 200 rpm and then added SLS, starch and aloe vera gel [28-31].

Preparation of oil phase

This phase is called the oily phase because it contains all the oils that must be added to the cream. These materials should not be placed directly in the cream mixture as in the first phase because of the density of these materials and to ensure their homogeneity with other materials. Therefore, they must be melted first in this phase using a water bath. The preparation of oil phase includes the addition of all oils such as (almond oil and coconut oil) and stearic acid and cetyl alcohol on the water bath at temperature around 70°C then added the mixture to aqueous phase and blending the mixture until reach to the creamy texture by the electrical blender [28, 32, 33]. **Table 2** show the formulas and their ingredient.

Table 2. Composition of Photoprotective Cream Formulas

Ingredient	F1	F2	F3	F4
Cetyl alcohol (gm)	3.5	3.5	3.5	3.5
Starch (gm)	1.5	1.5	1.5	1.5
Sodium lauryl sulfate (SLS) (gm)	1	1	1	1
Stearic acid (gm)	8.5	8.5	8.5	8.5
Aloe vera gel (gm)	-	-	15	15
Almond oil (gm)	15	-	-	7.5
Coconut oil (gm)	-	15	15	7.5
Methyl paraben(gm)	0.02	0.02	0.02	0.02
Glycerol (gm)	3	3	3	3
Water (Up to 100 gm)	100	100	100	100

Evaluation of photoprotective cream

VIsual test

Odor

To find To find out what color the compound is, 0.2g of it was put against a white background in diffuse daylight and looked at by eye. The colour should be determined that way [34-36].

out what the chemical smelt like, 0.4g of it was put in a 5cm diameter watch glass and kept there for 15 minutes. Then, the air above the sample was breathed in slowly and repeatedly [34, 37].

Color

To find out what color the compound is, 0.2g of it was put against a white background in diffuse daylight and looked at by eye. The colour should be determined that way [34, 38, 39].

Chemical test

pH determination

Weighing about 1 gram of cream and mixing it with 100 ml of clean water was done correctly. We utilized a digital pH meter (Digital pH meter) to find out the pH of the emulation [40-42].

Physical tests

Viscosity test

Photoprotective cream quality could be measurement by its consistency. One of the most important rheological tests for cream is viscosity. We used a Digital Viscometer (NDJ-5S) to measure the formulation's viscosity at room temperature and at different angular speeds (6, 12, 30, and 60 rpm) with a spindle [43].

Spreadability test

A 0.1 g sample of each cream formulation was compressed between two slides using 500 g weights and allowed to rest for approximately 5 minutes until further spreading was deemed unlikely. The diameters of the spread circles were measured in centimeters and utilized as comparison values for spreadability (diameter of the spread circle relative to the initial diameter) [44].

Optical test

Assessment of sun protection factor (SPF)

The sun protection factor (SPF) quantifies the proportion of sunburn attributable to solar radiation. The SPF ratings should indicate the duration of protection the product offers against the harmful effects of ultraviolet (UV) radiation. In this procedure, 1 g of cream was precisely weighed, and 90% ethanol was added to get a final amount of 10 ml. A 90% ethanol solution was used as a blank to test the absorbance values of each formed sample from 290 nm to 320 nm at 5 nm intervals. The SPF was determined using a straightforward equation formulated by Mansur *et al*. (1979), which replaces the in vitro method suggested by Sayre *et al*. (1979), employing UV spectrophotometry and the following equation: [45-47]

$$\mathrm{SPF}_{\text{in vitro}} = \mathrm{CF} \times \lambda = \sum_{290}^{320} \mathrm{EE}(\lambda) \times \mathrm{I}(\lambda) \times \mathrm{abs}(\lambda) \quad (1)$$

Where (I) denotes the solar intensity spectrum, (EE) represents the erythemal effect spectrum, (CF) is the correction factor (=10), and (Abs) indicates the absorption of the sunscreen.

Results and Discussion

Visual test

Odor

All formulas have pleasant odor due to the natural ingredients we used in it.

Color

All formulas have creamy white color.

Chemical test

pH determination

The pH results for all creams ranged from 6.04 to 7.23. These findings demonstrate that all products remain within the safe range (6-9) for use as sunscreen on the skin [48-50].

Physical test

Viscosity

viscosity results obtained for the creams shown in **Table 3**. The viscosity was decrease with the increase of rpm (Speed) [43].

Table 3. Viscosity of Photoprotective Cream

Formula	Viscosity (mPa.s)			
	6 rpm	12 rpm	30 rpm	60 rpm
F1	7.98	6.3	3.03	1.7
F 2	65.8	34.3	16.2	8.1
F 3	76.3	40.1	17.9	9.93
F 4	13.1	6.61	3.56	2.2

Spreadability

The effectiveness of a topical treatment relies on the patient applying the drug formulation in a uniform layer to deliver a consistent dose. Spreadability is a crucial attribute of these formulations, facilitating accurate dose transfer to the target region and ensuring simplicity of application on the substrate [51]. The spreadability results indicated that the creams exhibited excellent and consistent spreadability properties. All were readily disseminable.

Optical test

Assessment of sun protection factor (SPF)

The results of SPF ranged (15.13, 17.97, 16.53, 36.85) respectively for F1-F4. Formula 4 has the highest SPF value (36.85) when compared to other creams. Because it contains all the ingredients responsible for the protection activity [52]. **Tables 4-7** displayed all the results needed to compute SPF for formulas.

Table 4. Obtained Result of Formula 1 to Calculate SPF

Wavelength (nm)	EE x I	Absorbance	EE x I x Abs.
290	0.015	1.663	0.0249
295	0.0817	1.640	0.1339
300	0.2874	1.633	0.4693
305	0.3278	1.611	0.5280
310	0.1864	1.595	0.2973
315	0.0839	0.588	0.0493
320	0.018	0.575	0.0103

SPF for F1 =15.13

Table 5. Obtained Result of Formula 2 to Calculate SPF

Wavelength (nm)	EE x I	Absorbance	EE x I x Abs.
290	0.015	1.863	0.0279
295	0.0817	1.844	0.1506
300	0.2874	1.823	0.5232
305	0.3278	1.790	0.5867
310	0.1864	1.771	0.3301
315	0.0839	1.763	0.1479
320	0.018	1.755	0.0315

SPF for F2 =17.97

Table 6. Obtained Result of Formula 3 to Calculate SPF

Wavelength (nm)	EE x I	Absorbance	EE x I x Abs.
290	0.015	1.783	0.0267
295	0.0817	1.775	0.1450
300	0.2874	1.767	0.5078
305	0.3278	1.753	0.5746
310	0.1864	1.744	0.3250
315	0.0839	0.732	0.0614
320	0.018	0.701	0.0126

SPF for F3=16.53

Table 7. Obtained Result of Formula 4 to Calculate SPF

Wavelength (nm)	EE x I	Absorbance	EE x I x Abs.

295	0.0817	1.975	0.1613
300	0.2874	1.957	0.5624
305	0.3278	1.931	0.6329
310	0.1864	1.922	2.1084
315	0.0839	1.877	0.1574
320	0.018	1.852	0.0333

SPF for F4=36.85

Selection of the best formula

Among four formulas of photoprotective cream, the best formula was F4, which contain Almond oil, Coconut oil and Aloe Vera, selected on the basis of good visual, chemical, and physical tests. Furthermore, the formula F4 is optimal as it possesses the maximum SPF value. The formulation is deemed appropriate as a photoprotective cream for daily use due to its SPF rating.

Conclusion

The study sought to create and enhance photoprotective creams utilizing natural oils such as coconut oil and almond oil, together with aloe vera gel, both alone and in conjunction. The formulas F1, F2, F3, and F4 were created by changing the ingredients and then tested for their SPF and other physical and chemical qualities. The investigation demonstrated that formulation F4, with all the constituents, exhibited the maximum SPF rating. The pH of all the mixtures was closer to the pH of the skin. The formulations are uniform and not greasy, which means that people of various ages can use them.

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Conflict of interest: None

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Ethics statement: The Research Ethics Committee of the University of Baghdad College of Pharmacy formally approved the study

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