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HERBAL SUNSCREEN FORMULATION: OPTIMIZING EFFICACY OF UVB AND UVA PROTECTION

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ABSTRACT

Natural compounds are frequently used as skin protectors, especially in topical antioxidant applications, suggesting that they may be able to lessen the appearance of aging on the skin. Consumer perceptions of cosmetics' value are significantly influenced by their tactile feel. The long-term benefits of regular sunscreen use on healthy skin, including skin barrier function, sun protection, a lower chance of developing skin cancer, skin hydration, and irritation, are the main topic of this study. Through the use of a biological test for bacteria, the study investigated the relationship between the organisms' antibacterial activity and the pH levels of creams. The findings indicate that because the pH values of the three formulations range from 4.0 to 8.0, they can be employed as skin-protective compositions. The study aims to create a novel sunscreen cream formulation with lemon juice, flax seed extract, and green tea extract and evaluate how well it works to improve the texture, sun ray protection [UVA & UVB], and hydration of the skin by carefully optimizing the formulation and carefully analyzing its stability, physicochemical qualities, and skin compatibility.

Keywords: Herbal sunscreen, SPF, anti-aging properties, anti-oxidant, anti-microbial, UV Spectrophotometry

INTRODUCTION:

UV exposure accelerates skin aging, causing wrinkles and decreased suppleness. Sunscreen usage prevents aging, but more research is needed to develop effective

medications **[1]**. Skin cancer awareness drives global use of chemical sunscreen agents like emulsions, gels, oils, and lipsticks. Formulations vary in skin penetration, penetration, and retention, improving stability in stratum corneum **[2]**. UV-A and UV-B radiation cause skin damage, with UV-B causing sunburn, cancer, and aging, while UV-A modifies fibrin and elastin structure, causing more damage **[3]**.

Natural extracts like tea polyphenols offer skin benefits like anti-aging, healing, and softening, while sunscreen with natural raw materials provides UV protection and absorption **[4]**. Seed-based sunscreens offer photoprotection, anti-inflammatory, and anti-photoaging benefits, reducing wrinkles and promoting skin flexibility by shielding it from UV radiation, inflammatory cytokines, and DNA damage **[5]**. Natural ingredients like lime fruit peel extract and soursop fruit juice extract are increasingly used in sunscreen formulations due to their ability to increase SPF values and UV protection **[6]**. Catechins, polyphenolic compounds in green tea, with EGCG being the most prevalent form, offer significant pharmacological benefits and antioxidant capacity, surpassing vitamin C and vitamin E **[7]**. Due to their antioxidant properties and ability to stabilize the EGCG molecule in green tea, lemons are good for both gazes and health **[8]**.

Recent studies are incorporating natural antioxidant compounds like fruit ellagitannin and anthocyanins to enhance the effectiveness of sun care products in reducing sunburn damage **[9]**. Sunscreens provide primary UV-B protection through short-wave UVA, necessitating broad-spectrum UVA filters and natural ingredients for optimal efficacy **[10]**. The study aimed to develop a sunscreen-containing Phyto cosmetic with enhanced flavonoid concentration, focusing on photostability, physicochemical stability, antioxidant activity, sun protection factor, and cutaneous retention **[11]**.

Flax seeds contain lignans that possess antioxidant and anti-inflammatory properties to shield the skin from early aging and harmful skin cancer. Omega-3 fatty acid and alpha-linolenic acid (ALA) in flax seeds promote skin hydration and help reduce pesky wrinkles. Furthermore, the presence of vitamin E safeguards against UV rays and environmental aggressors, keeping the skin healthy and radiant **[12–14]**.

Green tea phytochemicals (GTPs) are crucial in safeguarding the skin against the harmful effects of excessive sun exposure. They have been proven to protect the skin by utilizing anti-inflammatory, antioxidant, and DNA repair attributes. These properties make GTPs a powerful solution for protecting the skin **[15]**. One of the fundamental properties of GTPs is their

ability to reduce inflammation caused by sun exposure, a common factor in skin damage and cancer. With powerful antioxidant abilities, these phytochemicals combat the reactive oxygen species (ROS) produced by the sun, preventing oxidative stress and DNA damage. Green tea phytochemicals work at all skin cancer development stages, effectively intervening and protecting the skin. Furthermore, they aid in DNA repair, an essential process in minimizing the risk of skin cancer from UV rays. In short, incorporating green tea phytochemicals into the skincare routine is vital for achieving and maintaining healthy skin **[16, 17]**.

EXPERIMENTAL SECTION:

Preparation of base: Bees wax and paraffin pallets were heated by double boiling method at low temperature. Coconut oil, lanoline and petroleum jelly were added into this mixture with constant stirring until it gives smooth texture.

Formulation 1: Prepared base was heated at lower temperature and lemon juice extract was added with constant stirring. Rose water was added for a fragrance. Whole the mixture was stirred continually until it gives creamy texture and after that the mixture was cooled at room temperature.

Formulation 2: Prepared base was heated at lower temperature. Lemon juice extract and flex seeds extract were added with constant stirring. Rose water was added for a fragrance. Whole the mixture was stirred continually until it gives creamy texture and after that the mixture was cooled at room temperature.

Formulation 3: Prepared base was heated at lower temperature. Lemon juice extract, flex seeds extract and green tea extract were added with constant stirring. Rose water was added for a fragrance. Whole the mixture was stirred continually until it gives creamy texture and after that the mixture was cooled at room temperature.

Anti-bacterial activity: Antibacterial study of both formulations had been done using Disc plate method. This technique assesses the efficacy of antibiotics against a specific type of bacteria. The antibacterial study was done using E. coli (gm-Ve), Pseudomonas aeruginosa (gm-Ve), Staphylococcus aureus (gm+Ve), Bacillus subtilis (gm+Ve) bacterial strains.

The antibacterial activity of the organisms was assessed using cultures that had been cultivated for the organisms for 24 hours. The nutrient agar medium plates were created using 15 to 20 ml of nutrient agar media and 90 cm of sterile petri dishes. The dishes were allowed to solidify for 5 to 10 minutes before being injected with 0.1 percent inoculum. Agar discs with a 5 mm diameter were made using the agar disc diffusion method, and they were autoclaved with No. 1 Whatman filter paper or newspaper to sterilize them. The discs were then treated with Varied amounts of plant

extracts in the following phase. The plates were then incubated for 24 hours at 37 °C. The plates were let to stand for 30 minutes before being incubated for 24 hours at 37 °C. Antibacterial activity was assessed by calculating the Width of the inhibitory zone in millimetre.

Table 1: List of ingredients used in formulation 1,2 and 3

No.	Substance	F_1	F_2	F_3
1.	Lemon juice extract	4.5 ml	4.5 ml	4.5 ml
2.	Flax seed extract	-	4.5 ml	4.5 ml
3.	Green tea extract	-	-	4.5 ml
4.	Bees wax	0.9 gm	0.9 gm	0.9 gm
5.	Paraffine wax pallets	9.0 gm	9.0 gm	9.0 gm
6.	Coconut oil	18 ml	18 ml	18 ml
7.	Petroleum white jelly	9.0 gm	9.0 gm	9.0 gm
8.	Lanoline	4.5 gm	4.5 gm	4.5 gm
9.	Rose water	1-2 ml	1-2 ml	1-2 ml

Table 2: Antibacterial Activity of F_1, F_2, F_3

Name of sample	Conc. (µg/ml)	Microorganisms and zone of inhibition(mm)			
		Gram-positive bacteria		Gram-negative bacteria	
		Staphylococcus aureus	*Bacillus subtilis*	*Escherichia. coli*	*Pseudomonas aeruginosa*
F1	10	13	16	17	15
F2	10	14	16	16	15
F3	10	13	12	12	14
Control (Penicillin G)	10	8	10	12	12

Physical parameters: This is basically used to check colour, odour, texture and stability of cream.

Stability Test: Prepared sample was kept for 30 days at both room temperature (25.0 ± 3.0 ºC) and refrigeration (4± 2.0 ºC) for accelerated stability testing.

Solubility: The prepared sample was dissolved in different organic solvents to check the solubility.

Melting point: The melting point of an organic solid can be determined by introducing a tiny amount into a small capillary tube, attaching this to the stem of a thermometer centered in a heating bath, heating the bath slowly, and observing the temperatures at which melting begins and is complete.

Measurement of pH value: This is basically refers to acidity levels of substances. The normal value of Ph (cream)) is pH 4 - 7. This test was measured either by using digital pH meter.

Measurement of Saponification Value: Saponification value is determined by the number of milligrams of KOH required to completely hydrolyse one gram of the oil/fat. Saponification number can be calculated by the difference between blank titration (except fat) and actual titration (with fat) multiplied by the molecular weight of KOH. Take 1 g of fat and dissolve

in 3 ml of ethanol. Filter it and wash with 7 ml of ethanol. Take an RBF and reflux the residue with 25 ml of alcoholic KOH for 30 min, add 0.1 ml of phenolphthalein and titrate against 0.5N HCl. Take the blank reading in the same way as before.

Measurement of Acid value: Take 1 g of fat in a 250 ml conical flask add 25 ml of ethanol and then place in a heating metal for methanol to dissolve the fat. Cool the solution, add 0.1 mL phenolphthalein indicator, and titrate against 0.1 N methanolic KOH.

Ester value: The Ester value is the number if milli grams of potassium hydroxide required to saponify the esters in 1gm of substance. Also, the difference between Saponification value and acid value represents the Ester Value.

Irritancy: This is used to check the quality of materials as well as chemicals and whether it is harmful to skin/mucosal or not. First of all, we have to mark area on left hand (dorsal surface). After that we have to applied formulation of cream to that area and time was noted. Then we have to leave formulation for few minutes by this we can checked for irritancy.

Washability: This test is also used to check quality of cream. In this first of all we have to add small amount of cream which was applied on the hand. After that we have to washed with tap water.

Phase separation: This test is basically checked in 24 hr to 30 hr. For this we have to put cream in a closed container at a temperature (30–80°C). Keep this formulation away from light.

Viscosity: This test is basically used to check or predict how materials used in cream will behave in the real world. It is mainly used to check efficacy.

Greasiness: This test is basically used to check nature of cream either oily or greased. According to result we can say that all formulations were non greasy.

Table 3: Evaluation of physical parameters

Sr. No.	Parameters	F1	F2	F3
1	Colour	Faint green	Faint green	Faint green
2	Odor	Pleasant	Pleasant	Pleasant
3	Texture	Smooth	Smooth	Smooth
4	State	Semisolid	Semisolid	Semisolid

Table 4: Stability study of formulation

Sr. No.	Formulation	April 2024	May 2024	June 2024	July 2024
1	F1	64gm	63.5gm	62gm	62gm
2	F2	60gm	59gm	58.9gm	58.9gm
3	F3	70gm	69.4gm	68gm	68gm

Table 5: Solubility

Sr. No.	Formulation	Iso-propyl alcohol	Ethanol	n-hexane	Ethyl acetate
1	F1	Soluble	Insoluble	Soluble	Soluble
2	F2	Soluble	Insoluble	Soluble	Soluble
3	F3	Soluble	Insoluble	Soluble	Soluble

Table 6: Melting point and pH value

Sr. No.	Formulation	M.P	pH
1	F1	80°C	5.6
2	F2	87°C	5.8
3	F3	85°C	6.1

Table 7: Evaluation of chemical parameters

Sr. No.	Formulation	Saponification value	Acid value	Ester value
1	F1	80.00	39.3822	40.6178
2	F2	83.15	45.9459	37.2041
3	F3	84.01	46.4995	37.5105

Table 8: Irritancy, Washability, Phase separation, Viscosity and Greasiness of moisturising cream

Sr. No.	Parameters	F1	F2	F3
1	Irritant effect	Nil	Nil	Nil
2	Washability (sec)	9	8	8
3	Phase separation	No Phase Separation	No Phase Separation	No Phase Separation
4	Viscosity (cps)	2345	4322	4300
5	Greasiness	No greasy	No greasy	No greasy

Determination of the SPF value: Both with and without exposing the cream to UV light, the SPF value was determined in vitro. The product was dissolved in n-hexane to get it to a concentration of 200 g/mL. The solution's absorbance was measured in the 290–320 nm region at 5 nm intervals in comparison to n-hexane, which served as a control. The data was processed using the Mansur equation, which is described in more detail below:

$$SPF = CE \sum_{290}^{320} EE(\lambda) \times I(\lambda) \times A(\lambda)$$

Where,

EE = erythemal effect spectrum

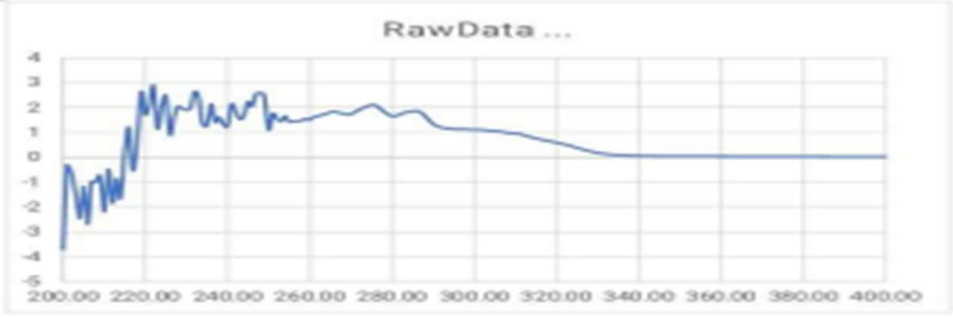
I = Intensity of spectrum

Abs = Absorbance of sunscreen product

CF = correction factor

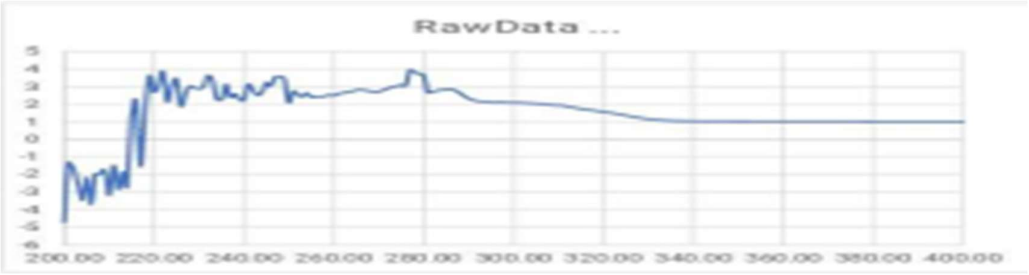
The values of EE x I are constant

According to the findings of our research, 71% of the identified natural sun protection is constant in the ultraviolet (UVA) and ultraviolet (UVB) ranges, and 100% of them are photostable in the UVB range.



UV spectrograph for F1

UV spectrograph for F2



UV spectrograph for formula-3

Table 9: With the help of the UV spectrophotometer graph Calculation of SPF

Wavelength (nm)	E × I (Normalised)	Absorbance (A)			E × I × A		
		F1	F2	F3	F1	F2	F3
290	0.0150	1.341	2.351	2.341	0.201	0.0352	0.035
295	0.0817	1.132	2.459	2.132	0.092	0.2038	0.1748
300	0.2874	1.902	2.503	2.908	0.3184	0.7193	0.605
305	0.3278	1.056	2.489	2.050	0.3469	0.8158	0.6719
310	0.1864	0.955	2.483	1.955	0.1780	0.4628	0.3644
315	0.0839	0.762	2.477	1.762	0.0639	0.2078	0.1469
320	0.0180	0.593	2.470	1.593	0.0106	0.044	0.0280
					=1.2108 =1.2108×10 =12.108	=2.4887 =2.4887×10 =24.887	=2.026 =2.026×10 =20.26

Table 10: Costing of formulations F1, F2 & F3

Ingredients	Quantity	Price/1 gm or ml	Price/ quantity (F1)	Price/ quantity (F2)	Price/ quantity (F3)
Bees wax	0.9gm	1.8Rs	1.62Rs	1.62Rs	1.62Rs
Paraffine wax pallets	9.0gm	0.419 Rs	3.78 Rs	3.78 Rs	3.78 Rs
Petroleum white jelly	9.0gm	0.565 Rs	5.08 Rs	5.08 Rs	5.08 Rs
Coconut oil	18ml	0.3 Rs	5.4 Rs	5.4 Rs	5.4 Rs
Lanoline	4.5gm	3.558 Rs	16.01 Rs	16.01 Rs	16.01 Rs
Rose water	1ml	0.15 Rs	0.15 Rs	0.15 Rs	0.15 Rs
Lemon juice extract	4.5ml	0.35 Rs	1.575 Rs	1.575 Rs	1.575 Rs
Flax seed extract	4.5ml	0.4 Rs	_	1.8 Rs	1.8 Rs
Green tea extract	4.5ml	0.8 Rs	_	_	3.6 Rs
TOTAL COST			33.615 Rs	35.415 Rs	39.015 Rs

CONCLUSION:

The findings show that the pH values of sunscreen creams vary, and that the three formulations have pH ranges between 4.0 and 8.0, making them appropriate for use as skin-protecting compositions. The two processes have differing saponification and acid values. Irritation was prevented by the cream's natural components. According to the results, all the three formulations give

good anti-bacterial activity against microbes. According to the research, F2 and F3 have greater SPF value than F1. Formulated sunscreen creams have comparatively less costly than market sunscreen products hence, have a great commercial scope.

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