

FORMULATION AND EVALUATION OF HERBAL SUNSCREEN GEL

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ABSTRACT

Herbal sunscreen gels, formulated from natural plant extracts, provide a protective barrier against harmful UV radiation while offering the skin therapeutic benefits like hydration and antioxidant protection. Unlike synthetic sunscreens, herbal formulations are often preferred for being safer for long-term topical application and less likely to cause irritation. In this study, a sunscreen gel containing *Phaleria macrocarpa*, *Phyllanthus emblica*, *Camellia sinensis* and *Aloe barbadensis* was prepared and evaluated for its physicochemical properties, Sun Protection Factor (SPF), and stability. Antioxidant potential was confirmed by DPPH assay, with formulation F11 showing the strongest activity. Antimicrobial testing revealed inhibition zones up to 18.3 mm. The active extracts to ensure a stable product with uniform spreadability. The optimized formulation showed significant UV protection and antioxidant potential.

Keywords: *Phaleria macrocarpa*, *Phyllanthus emblica*, *Camellia sinensis* and *Aloe barbadensis*, DPPH assay, SPF, Antioxidant.

INTRODUCTION

Sunscreen products are essential for protecting the skin from UV-induced damage, including premature aging and skin cancer. Herbal sunscreens utilize phytochemicals like alkaloids, flavonoids and tannins, which possess natural UV-absorbing and antioxidant properties. Formulating these actives into a gel base ensures a cooling effect, non-greasy application, and enhanced skin penetration. This study focuses on developing a stable herbal sunscreen gel and evaluating its effectiveness through standardized parameters.

LIST OF MATERIALS

Table No : 1 List of materials used for the preparation of formulations

Sl. No	List of materials	Role
1	Amla	Anti-oxidant, Anti-ageing
2	Phaleria macrocarpa	UV protective action
3	Aloe vera	Moisturizing property and anti-oxidant
4	Carrot seed oil	Boost UV protection and prevent photoaging
5	Sodium benzoate	Preseervative
6	Carbopol 940	Thickening agent
7	Triethanolamine	pH adjuster
8	Distilled water	Solvent
9	Propylene glycol	Humectant

Extraction of Phaleria macrocarpa extract

Phaleria macrocarpa extract was prepared by using cold maceration method. 20 g of powdered fruit material was taken for cold maceration with 200ml of methanol for 48 hours at room temperature. Filter through Whatmann filter paper and collect the filtrate and concentrate the filtrate using a rotary evaporator.

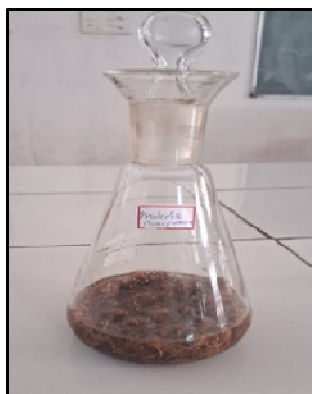


Fig No : 1 Maceration of Phaleria macrocarpa

Extraction of Phyllanthus emblica extract

For the extraction, dried fruit of amla was powdered and sieved. Then took 20g of this powder and transfer it into a cleaned and dried stoppered conical flask. Then added 200ml of distilled water to it and kept for 2-3 days. During this period shaking was done occasionally. After this period, the liquid was strained and marc was pressed. Then the collected extract was evaporated in a rotary evaporator.

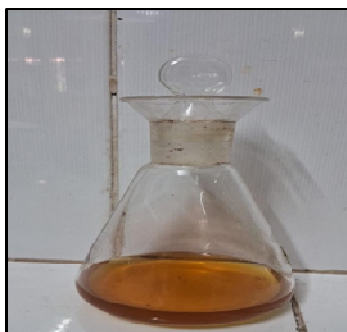


Fig No : 2 Amla extract

Extraction of Aloe vera gel

Aloe vera gel was extracted by simple drain procedure where 2-4 leaves of aloe vera cut at about half inch from the base so as to drain out all the yellow sap materials. The mucilage was stirred vigorously in a blender to make it uniform. This solution was strained through a muslin cloth and filtered and the filtrate is stored.



Fig No : 3 Aloe vera gel

FORMULATION TABLE**Table no: 2 formulation of herbal sunscreen gel**

Ingredients	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14
Carbopol 940 (g)	0.1	0.2	0.1	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1
		4	7	4	7	4	4				4	7	7	
Propylene glycol(ml)	0.4	0.4	1	0.4	1	1.6	1	0.4	1.6	1.6	1.6	0.4	1.6	1
Triethanol amine (ml)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	5	7	8	6	9	7	7	4	2	6	5	4	9	8
Sodium benzoate(g)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Carrot seed oil(g)	0.4	0.4	0.4	2	1.2	0.4	0.8	1.2	0.4	1.2	1.2	0.8	0.8	0.8
<i>P.Macrocarpa</i> extract(ml)	1	1	1	3	3	1	2	3	1	3	3	2	2	2
Amla extract(ml)	1	1	1	3	3	1	2	3	1	3	3	2	2	2
Aloe vera gel(g)	1.5	1.5	1.5	3	3	1.5	2	3	1.5	3	3	2	2	2
Distilled Water(ml)	18	17	18	16.5	17	17	17	17.5	17	16.5	16.5	17	17	17.5

PHYTOCHEMICAL SCREENING

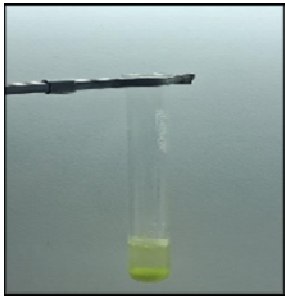
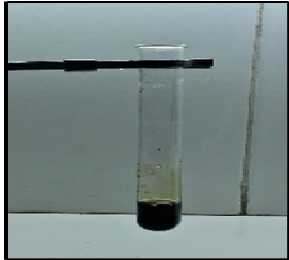
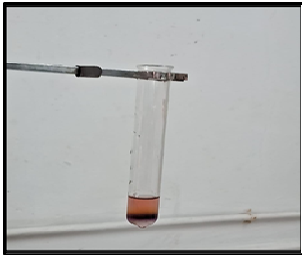
SL.NO	Phytoconstituent	Observation	Inference	Picture
1	Alkaloids	Orange-red precipitate.	Presence of Alkaloids.	
2	Flavonoids	White or yellow precipitate.	Presence of flavonoids.	
3	Tannins	Blue green/Black colour.	Presence of tannins.	
4	Carbohydrates	Formation of violet or purple ring at the junction of two layers.	Presence of carbohydrate.	

Table no : 3 phytochemical screening

RESULT AND DISCUSSIONS

ORGANOLEPTIC EVALUATION

Table No: 4 Organoleptic evaluation

SL NO	PARAMETERS	FORMULATION
1	Colour	Pale yellow
2	Odour	Pleasant odour
3	Texture	Smooth
4	State	Gel



Fig No : 4 Formulation of herbal sunscreen gel

Table no: 5 Evaluation parameters data

SL NO	Formulation(F11)	Mean±SD
pH	Good	5.34±0.02
Viscosity	Good	9600±0.82(cps)
Spredability	Good	19.8±0.20
Homogeneity	Good	Good
SPF	Good	11.76±0.60

ANTIMICROBIAL ACTIVITY

Antimicrobial activity was evaluated using S.aureus against tetracycline as control.

Table No: 6 Antimicrobial Activity

SL.NO	FORMULATION	ZONE OF INHIBITION(mm)
1	Sample	25.0
2	Control	17.0

Fig No : 5 Anti-microbial activity

ANTIOXIDANT ACTIVITY

Antioxidant activity in the sample herbal sunscreen gel was estimated for its free radical scavenging activity by using DPPH (2, 2-Diphenyl-2, Picryl-Hydrazyl) free radicals. An arrangement of DPPH at a concentration of $6 \times 10^{-5} \text{M}$ in methanol was made by dissolving 7.89mg in 100ml. From each test arrangement, 500 μl was set into an Eppendorf tube, and each concentration was done three times. Following, 500 μl of the DPPH solution was included to the test arrangement and blended well. This blend was shaken and cleared out at room temperature for half an hour. The absorbance was measured at 520nm. Ascorbic corrosive served as the positive control, whereas refined water acted as the negative control. The rate restraint compared to the standard was calculated utilizing the condition underneath, and the IC₅₀ values were too decided. The best set of values is showed below:

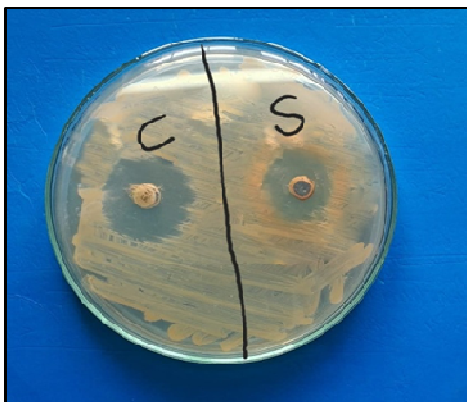


Table No:7 Antioxidant Values

Sl. No.	Concentration(mg)	COD	SOD	%inhibition	Average	IC ₅₀ (mg/ml)
1	50 mg	0.29	0.08	72%	68 ± 3.51	60.13
2		0.29	0.10	65%		
3		0.29	0.09	68%		
1		0.29	0.12	58%		

2	100 mg	0.29	0.13	55%	57 ± 1.73	mg/ml
3		0.29	0.12	58%		
1	150 mg	0.29	0.14	51%	54 ± 6.35	
2		0.29	0.14	51%		
3		0.29	0.11	62%		
In vitro Standard vitamin C						
1	100 mg	0.29	0.04	86%	87 ± 1.73	
2		0.29	0.04	86%		
3		0.29	0.03	89%		



Fig No : 6 Herbal sunscreen gel antioxidant activity IC50 Value (mg/ml)

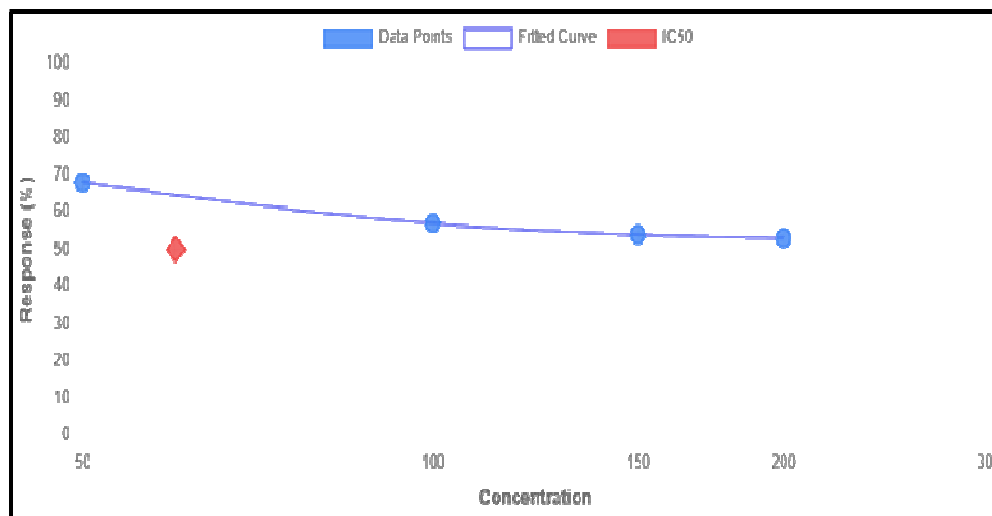


Fig No : 7 Herbal Sunscreen Gel (HSG) Anti-inflammatory Activity IC₅₀ Value (mg/ml)

IN VITRO ANTI- INFLAMMATORY ACTIVITY

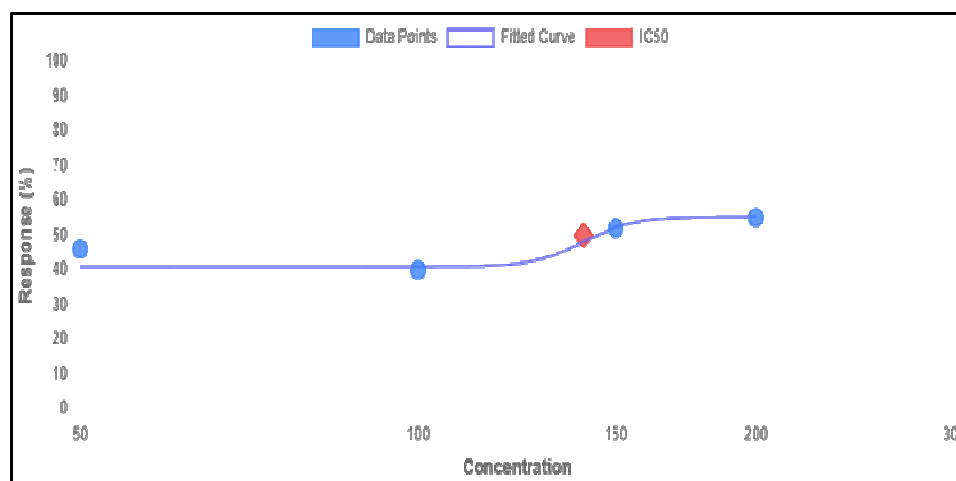
The in-vitro anti-inflammatory activity was determined by egg albumin denaturation method. The herbal sunscreen gel, measuring 0.5 ml, was combined with 0.45 ml of a fluid arrangement containing 5% bovine egg whites to create the response blend. With a starting value of 6.3, the blend's pH was adjusted utilising a little sum of 0.1N HCl while being kept at 37 °C for a period of 20 minutes. Following this, the blend experienced warming to 57 °C for a length of 30 minutes. Upon cooling, the arrangement was allocated into 96-well plates, and the absorbance levels were decided at a wavelength of 660 nm. As a benchmark, Diclofenac sodium (at a concentration of 1000µg/ml) was utilised, while the control comprised 0.05ml of purified water. The best set of value is showing below.

Table No : 8 Herbal Sunscreen Gel (HSG) In vitro anti-inflammatory activity

Sl.no	Concentration (mg)	COD	SOD	%inhibition	Average	IC ₅₀ (mg/ml)
1	50 mg	0.30	0.14	53%	46 ± 6.50	140.50 mg/ml
2		0.30	0.16	46%		
3		0.30	0.18	40%		
1		0.30	0.18	40%		

2	100 mg	0.30	0.19	36%	40 ± 5.05		
3		0.30	0.16	46%			
1	150 mg	0.30	0.15	50%	52 ± 1.73		
2		0.30	0.14	53%			
3		0.30	0.14	53%			
Standard Diclofenac Sodium							
1	100 mg	0.30	0.07	76%	73 ± 1.73		
2		0.30	0.09	70%			
3		0.30	0.08	73%			



Fig No : 8 Anti-inflammatory activity**Fig No : 9 Herbal Sunscreen Gel (HSG) Anti-inflammatory Activity IC50 Value (mg/ml)**

STABILITY STUDY

The stability studies were conducted for formulation F11 for a period of 1 month. No significant changes were found for the tested parameters like pH, viscosity, spreadability, homogeneity at temperature 40°C and humidity 75% RH for 1 month.

Table No: 9 Stability study

PARAMETERS	INITIAL DAYS	1 MONTH
State	Gel	Gel
Homogeneity	Homogenous	Homogenous
Odour	Characteristic	Characteristic
Colour	Pale yellow	Pale yellow

Centrifugation test	No separation	No separation
Viscosity	9600	9610
pH	5.34	5.37
Spreadability	19.80	19.65
Loss on drying	2.19	2.17

COMPARATIVE STUDY

The results of comparison of herbal sunscreen gel and marketed synthetic herbal sunscreen gel are listed below.

Table No : 10 Comparative study

Parameter	Herbal Sunscreen Gel	Marketed Sunscreen gel [UV Doux Gel SPF 50]
Composition	Plant based	UV filters
Colour	Light yellow	White
Odour	Characteristic	Added perfume
Spreadability	19.80 g.cm/sec	18.60 g.cm/sec

Homogeneity	Homogenous	Homogenous
Centrifugation test	No separation	No separation
SPF	11.76	50

CONCLUSION

The present study successfully formulated and evaluated an herbal sunscreen gel incorporating *Phaleria macrocarpa*, *Aloe barbadensis*, *Phyllanthus emblica*, carrot seed oil using both methanolic and aqueous extracts. Fifteen formulations (F1–F15) were prepared with varying concentrations of the selected herbal extracts to assess their suitability as a safe and effective topical sunscreen preparation. All formulated herbal sunscreen gels were subjected to comprehensive physicochemical evaluation, including pH, viscosity, homogeneity, spreadability, loss on drying, and centrifugation test, and the results indicated acceptable formulation characteristics. The pH values were found to be within the skin-compatible range, confirming their suitability for topical application without causing irritation. The formulations also demonstrated good homogeneity, appropriate viscosity, ease of spreadability, and satisfactory stability, indicating uniform distribution of active ingredients and desirable cosmetic acceptability. The antioxidant potential of the formulations was evaluated using the DPPH free radical scavenging assay and the results confirmed that the herbal sunscreen gels possessed significant antioxidant activity. This antioxidant property can be attributed to the presence of polyphenols, flavonoids, and other bioactive constituents present in the selected herbal extracts. Among all formulations, the optimized formulation showed good physicochemical stability. The anti-inflammatory activity, assessed using the egg albumin denaturation method, revealed that the herbal sunscreen gel exhibited moderate anti-inflammatory activity when compared with the standard drug diclofenac sodium. This suggests the formulation's potential to reduce skin inflammation caused by UV radiation and environmental stress. Furthermore, the antimicrobial activity evaluated by the agar plate

diffusion method demonstrated significant inhibitory activity against *Staphylococcus aureus*, indicating that the formulation can provide additional protection against microbial contamination and skin infections. Since the herbal sunscreen gel formulations were prepared using natural ingredients with minimal chemical additives, they are considered safe for regular topical use. Overall, the study concludes that all formulated herbal sunscreen gels exhibited promising antioxidant, anti-inflammatory, antimicrobial properties, along with good physicochemical stability. Among the fifteen formulations, F11 was identified as the best formulation, showing superior overall performance and stability. Thus, the developed herbal sunscreen gel can be considered a promising alternative to synthetic sunscreen products, offering effective skin protection with reduced risk of adverse effects.

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