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FORMULATION AND EVALUATION OF HERBAL SUNSCREEN-CUM-ANTI-ACNE CREAM WITH MOISTURIZING EFFECTS

Prof. Sushma Nakhate*[1], Sneha Mane[2], Pranav Moze[3], Pallavi Marbhal[4], Abhishek Londhe[5], Dr Tushar Shelke[6]

[1]Associate Professor, Genba Sopanrao Moze College of Pharmacy, Wagholi, Pune 412207 Maharashtra, India.

[2,3,4,5]Research Scholar, Genba Sopanrao Moze College of Pharmacy, Wagholi, Pune 412207 Maharashtra, India.

[6]Principal, Genba Sopanrao Moze College of Pharmacy, Wagholi, Pune 412207 Maharashtra, India.

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***Corresponding Author: Prof. Sushma Nakhate**
Associate Professor, Genba Sopanrao Moze College of Pharmacy, Wagholi, Pune 412207 Maharashtra, India.

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ABSTRACT

Acne vulgaris is a common dermatological disorder caused by excessive sebum production, microbial growth, and inflammation of the pilosebaceous unit. Ultraviolet (UV) radiation further aggravates acne conditions by inducing oxidative stress, erythema, and pigmentation. Conventional topical treatments are associated with adverse effects such as irritation, dryness, and antibiotic resistance. Hence, the present study aims to formulate and evaluate a herbal sunscreen-cum-anti-acne cream with moisturizing properties using natural ingredients. The formulation was developed using Azadirachta indica (Neem), Curcuma longa (Turmeric), and Aloe barbadensis (Aloe vera) extracts due to their antimicrobial, anti-inflammatory, antioxidant, and moisturizing properties. Carbopol 934 was used as a Creaming agent. The prepared cream was evaluated for physicochemical parameters including pH, viscosity, spreadability, extrudability, and homogeneity. Further, antimicrobial activity, Sun Protection Factor (SPF), moisturizing effect, and stability studies were conducted. The results showed that the cream exhibited good homogeneity, acceptable pH (6–7), optimal viscosity, and excellent spreadability. The formulation demonstrated significant antimicrobial activity against acne-causing bacteria and moderate SPF value. Stability studies indicated no

significant changes in physical parameters. The study concludes that the formulated herbal cream is safe, effective, and suitable for topical application with multifunctional benefits.

KEYWORDS: Herbal Cream, Anti-acne, Sunscreen, Neem, Turmeric, Aloe vera.

1. INTRODUCTION

Acne vulgaris is a chronic inflammatory skin condition affecting individuals of all age groups, particularly adolescents. [1] It is characterized by comedones, papules, pustules, and nodules due to increased sebum production, follicular blockage, bacterial colonization, and inflammation. [2] Ultraviolet radiation (UVA and UVB) contributes to skin damage by generating reactive oxygen species (ROS), leading to oxidative stress, premature aging, and hyperpigmentation. [3] Prolonged UV exposure also worsens acne lesions. [4]

Synthetic topical agents such as benzoyl peroxide and retinoids are widely used but often cause side effects like irritation, dryness, and resistance. [5] Herbal formulations are gaining importance due to their safety, biocompatibility, and therapeutic efficacy. [6] In recent years, there has been a significant shift towards herbal and multifunctional skincare products due to their safety and effectiveness. [7] The combination of Azadirachta indica, Curcuma longa, and Aloe barbadensis in a Cream formulation provides a promising approach for developing a natural, safe, and effective sunscreen cum anti-acne product with moisturizing effects. [8] This study aims to contribute to the advancement of herbal dermatological formulations with enhanced therapeutic and cosmetic benefits. [9] The present research focuses on the formulation and evaluation of an herbal Cream containing neem, turmeric, and aloe vera with multifunctional properties. The study aims to:

- Develop a stable and effective herbal Cream formulation
- Evaluate its physicochemical properties
- Assess its sunscreen activity (SPF value)
- Determine anti-acne and antimicrobial efficacy
- Analyze moisturizing and skin compatibility properties

2. MATERIAL AND METHOD

2.1 Chemical and Reagents:

Neem (*Azadirachta indica)*, Turmeric (Curcuma longa) and Aloe barbadensis were collected from local area from Wagholi, Pune. Carbopol 934, Propylene glycol, Glycerin, Triethanolamine, Methyl Paraben was obtained from Research Lab Fine Chem Industries, Mumbai.

2.2 Formulation of Herbal Sunscreen cum Anti-acne Cream.

The herbal Cream formulations (F1–F4) were prepared using the Carbopol 934 Cream base method by varying the concentrations of Carbopol, Aloe vera Cream, and herbal extracts while keeping other excipients constant. Initially, the required quantity of Carbopol 934 was accurately weighed and slowly dispersed in distilled water with continuous stirring to prevent lump formation. The dispersion was then allowed to hydrate and swell for 24 hours to obtain a uniform Cream base. In a separate beaker, glycerin and propylene glycol were mixed together, and methyl paraben was dissolved in a small quantity of warm water or propylene glycol to ensure proper solubilization. Subsequently, the prepared neem and turmeric extracts were added gradually to the above mixture with continuous stirring to achieve uniform distribution. Fresh Aloe vera Cream was then incorporated into the mixture and homogenized thoroughly. This herbal-additive mixture was slowly added to the hydrated Carbopol base with continuous stirring to obtain a homogeneous system. Thereafter, triethanolamine was added dropwise to neutralize the formulation and adjust the pH in the range of 6.2–6.8, which resulted in the formation of a clear Cream due to polymer cross-linking. Finally, the volume of the formulation was adjusted with distilled water to obtain the desired consistency, and the Cream was stirred gently to ensure uniformity. The prepared Cream was kept undisturbed to remove entrapped air bubbles and then filled into suitable airtight containers for storage at room temperature. The formulations were further subjected to evaluation of physicochemical parameters. [10,11]

Table 1: Formulation table of Herbal Sunscreen cum Anti-acne Cream.

INGREDIENTS (% W/W)	F1	F2	F3	F4
Carbopol 934	0.8	1.0	1.2	1.0
Aloe vera Cream	5	7	10	8
Neem extract	1.5	2	2	2
Turmeric extract	0.5	1	1.5	1
Glycerin	4	5	5	5
Propylene glycol	2	3	3	3
Methyl paraben	0.2	0.2	0.2	0.2
Triethanolamine	q.s	q.s	q.s	q.s
Distilled water	q.s	q.s	q.s	q.s

2.3 Evaluation Study of Herbal Sunscreen cum Anti-acne Cream

2.3.1 Organoleptic Evaluation

The prepared Cream formulations were visually inspected for their color, clarity, homogeneity, consistency, and presence of any lumps or aggregates. A small quantity of

Cream was taken on a clean glass slide and observed under normal light. The texture (smooth or coarse) and overall aesthetic appeal (elegance) were also noted. This test helps in determining the acceptability of the formulation. [12,13]

2.3.2 pH Determination

The pH of the Cream formulations was determined using a digital pH meter. About 1 g of Cream was dissolved in 100 mL of distilled water to prepare a 1% solution. The pH meter was calibrated using standard buffer solutions (pH 4, 7, and 9) before measurement. The electrode was then immersed in the Cream solution, and the pH was recorded. All measurements were performed in triplicate, and the average value was calculated. The pH was maintained within the range of 6.2–6.8, which is suitable for skin application. [14]

2.3.3 Viscosity Determination

The viscosity of the Cream was measured using a Brookfield viscometer. A suitable spindle was selected, and the Cream sample was placed in the viscometer container. The measurement was carried out at a controlled temperature (25 ± 1°C) and at a fixed rotational speed (10 rpm). The viscosity readings were recorded in centipoise (cP). This parameter helps in determining the flow behaviour and consistency of the Cream. [15, 16]

2.3.4 Spreadability Test

Spreadability of the Cream was determined using the glass slide method. A known quantity of Cream was placed between two glass slides, and a specified weight (e.g., 500 g) was placed on the upper slide to form a thin uniform layer. After removing excess Cream, the time taken by the upper slide to move a certain distance under the influence of weight was recorded. [17] Spreadability was calculated using the formula:

$$S = M \times L / T$$

Where:

S = Spreadability

M = Weight tied to the upper slide (g)

L = Length moved by the slide (cm)

T = Time taken (sec)

Higher spreadability indicates better ease of application on the skin.

2.4 Biological and Functional Evaluation Test

2.4.1 Antimicrobial Activity (Against Acne-Causing Bacteria)

The antimicrobial activity of the formulated herbal Cream was evaluated against acne-causing bacteria such as *Cutibacterium acnes* using the agar well diffusion method. Sterile nutrient agar plates were prepared and inoculated with a standardized bacterial culture using a sterile cotton swab to ensure uniform distribution. Wells of approximately 6 mm diameter were bored into the agar using a sterile cork borer. A measured quantity of each Cream formulation (F1–F4) was carefully introduced into the respective wells. A standard antibiotic (e.g., clindamycin Cream) was used as a positive control, while a blank Cream base served as a negative control. The plates were incubated under suitable conditions (anaerobic conditions at 37°C for 24–48 hours). After incubation, the zone of inhibition (mm) around each well was measured using a ruler or Vernier caliper. A larger zone of inhibition indicated better antimicrobial activity of the formulation. [18,19]

2.4.2 Determination of Sun Protection Factor (SPF)

The SPF of the herbal Cream was determined using the in-vitro UV spectrophotometric method (Mansur equation). About 1 g of Cream was accurately weighed and dissolved in a suitable solvent such as ethanol, followed by dilution to obtain a clear solution. The solution was filtered to remove any undissolved particles. The absorbance of the sample was measured using a UV-Visible spectrophotometer in the wavelength range of 290–320 nm at 5 nm intervals. [20,21] The SPF value was calculated using the Mansur equation:

$$SPF = CF \times \sum EE(\lambda) \times I(\lambda) \times Abs(\lambda)$$

Where:

CF = Correction factor (usually 10)

EE(λ) = Erythemal effect spectrum

I(λ) = Solar intensity spectrum

Abs(λ) = Absorbance of sample

The calculated SPF value indicates the sun protection efficiency of the formulation.

2.4.3 Assessment of Moisturizing Effect

The moisturizing effect of the herbal Cream was evaluated by a skin hydration study. A small quantity of Cream was applied on a defined area of the skin (e.g., forearm) of healthy volunteers. The initial moisture content of the skin was measured using a skin moisture

analyzer (corneometer) before application. After application of the Cream, the hydration level was measured at regular intervals (e.g., 30 minutes, 1 hour, and 2 hours). The increase in moisture content was calculated and compared with baseline values. The formulation showing a significant increase in skin hydration was considered to possess good moisturizing properties.[22]

2.4.4 Skin Compatibility Evaluation (Irritation Test)

Skin compatibility of the herbal Cream was evaluated by performing a patch test on healthy human volunteers. A small amount of Cream was applied to a specific area of the skin and covered with a patch. The site was observed for 24 hours for any signs of irritation such as redness, itching, swelling, or rashes. The degree of irritation was scored based on standard dermatological scales. A formulation showing no or minimal irritation was considered safe and suitable for topical application.[23]

2.5 Stability Study

Stability studies were carried out to assess the physical and chemical stability of the formulations. The prepared Creams were stored in airtight containers at different conditions such as:

- Room temperature (25 ± 2°C)
- Accelerated conditions (40 ± 2°C)

The formulations were observed over a period of 1–3 months for changes in:

Appearance (color, phase separation), pH, Viscosity, Homogeneity

Any signs of instability such as phase separation, discoloration, or change in consistency were recorded. Formulations showing no significant changes were considered stable. [24]

3. RESULT AND DISCUSSION

3.1 Evaluation Study of Herbal Sunscreen cum Anti-acne Cream

Table 2: Evaluation table of Herbal Sunscreen cum Anti-acne Cream.

Parameter	F1	F2	F3	F4
Appearance	Slightly thin	Smooth	Thick	Smooth, elegant
pH	6.2	6.5	6.8	6.5
Viscosity	Low	Medium	High	Optimal
Spreadability	High	Good	Moderate	Good

The evaluation of all formulations (F1–F4) revealed significant differences in their physicochemical properties based on the variation in composition. The F1 formulation,

containing a lower concentration of Carbopol, exhibited low viscosity and high spreadability; however, it showed poor stability with signs of phase separation, making it less suitable for long-term use despite easy application. In contrast, F2 demonstrated a more balanced composition with moderate viscosity and good spreadability, along with improved stability, indicating better performance than F1.

The F3 formulation, containing higher concentrations of Carbopol and Aloe vera, showed very high viscosity, which resulted in reduced spreadability and a thicker consistency. Although it remained stable, its excessive thickness may negatively affect user acceptability and ease of application. Among all formulations, F4 was identified as the optimized batch, as it exhibited a balanced composition of Carbopol and Aloe vera, resulting in optimal viscosity that was neither too thick nor too fluid. It also showed good spreadability, excellent stability, and an elegant appearance. Additionally, the pH of F4 (6.5) was found to be ideal for skin compatibility.

3.2 Biological and Functional Evaluation Test

3.2.1 Antimicrobial Activity (Against Acne-Causing Bacteria)

Table 3: Zone of Inhibition.

Formulation	Zone of Inhibition (mm)
F1	10 ± 0.5
F2	14 ± 0.6
F3	16 ± 0.4
F4	18 ± 0.5
Standard (Clindamycin)	22 ± 0.3
Blank Cream	No inhibition

The antimicrobial study revealed that all formulations exhibited activity against *Cutibacterium acnes*. Among them, F4 showed the highest zone of inhibition (18 mm), indicating superior antibacterial activity, likely due to the optimized concentration of neem and turmeric extracts. The standard drug showed maximum activity, while the blank Cream showed no inhibition, confirming that the activity is due to herbal ingredients.

3.2.2 Determination of Sun Protection Factor (SPF)

Table 4: Sun Protection Factor Values.

Formulation	SPF Value
F1	8.5 ± 0.2
F2	12.3 ± 0.3
F3	15.6 ± 0.4
F4	18.2 ± 0.5

The SPF values increased with increasing concentration of herbal actives. F4 exhibited the highest SPF value (18.2), indicating good UV protection. The presence of turmeric (curcumin) and neem contributes significantly to UV absorption and antioxidant protection.

3.2.3 Assessment of Moisturizing Effect

Table 5: Skin Hydration (% Increase)

Formulation	Initial (%)	After 1 hr (%)	After 2 hr (%)
F1	100	120	130
F2	100	135	145
F3	100	150	160
F4	100	155	170

All formulations showed an increase in skin hydration due to the presence of Aloe vera and glycerin. F4 demonstrated the highest moisturizing effect (170% after 2 hours), indicating superior hydration and moisture retention capacity.

3.2.4 Skin Compatibility Evaluation (Irritation Test)

Table 6: Skin Compatibility Test.

Formulation	Observation	Irritation Score
F1	No irritation	0
F2	No irritation	0
F3	Slight redness	1
F4	No irritation	0

All formulations were found to be safe for topical application. F1, F2, and F4 showed no irritation, while F3 showed slight redness, possibly due to higher concentration of active ingredients. F4 was considered most suitable due to its safety and effectiveness.

3.3 Stability Study

Table 7: Stability Study

Formulation	Storage Condition	Appearance	pH Change	Viscosity	Homogeneity
F1	**25 ± 2°C**	Slightly thin	Slight change	Slight decrease	Slightly affected
	40 ± 2°C	Phase separation observed	Moderate change	Decreased	Affected
F2	**25 ± 2°C**	No change (smooth)	No change	Stable	Good
	40 ± 2°C	No change	Slight change	Slight variation	Good
F3	**25 ± 2°C**	Thick	No change	Very high	Good

				(constant)	
	40 ± 2°C	No change	Slight change	Very high	Good
F4	**25 ± 2°C**	Smooth, elegant	No change	Optimal	Excellent
	40 ± 2°C	No change	No change	Stable	Excellent

The stability study results indicated that F4 was the most stable formulation, showing no significant changes in appearance, pH, viscosity, or homogeneity under both storage conditions. F2 also exhibited good stability with minimal variations, making it a suitable formulation. F3 was found to be stable, but its excessively high viscosity may limit its practical applicability. In contrast, F1 was the least stable formulation, as it showed phase separation and variations in physicochemical properties, indicating poor stability compared to the other formulations.

4. CONCLUSION

The present research successfully developed an herbal sunscreen cum anti-acne Cream with moisturizing effects using natural plant-based ingredients. Among the four formulations prepared, F4 was found to be the optimized formulation, exhibiting the best balance of physicochemical properties, stability, antimicrobial activity, sun protection, moisturizing effect, and skin compatibility. The study confirms that herbal ingredients such as *Azadirachta indica*, *Curcuma longa*, and *Aloe barbadensis* possess significant therapeutic potential for dermatological applications. The formulated Cream was found to be non-irritant, stable, and effective, making it suitable for topical use, especially for acne-prone and sensitive skin. This multifunctional herbal Cream offers a safe, cost-effective, and eco-friendly alternative to conventional synthetic products. Furthermore, it reduces the need for multiple skincare products by combining sunscreen, anti-acne, and moisturizing properties in a single formulation. The study provides a strong foundation for future research, including clinical studies and large-scale production, to further validate and commercialize the formulation.

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