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Formulation, Evaluation And Development Of Sandalwood Oil Containing Sunshield Cream

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This research centers on developing and analyzing a sunshield cream formulated with sandalwood oil, recognized for its natural UV-protective and soothing properties. The cream was crafted using a combination of emollients, stabilizers, and preservatives to ensure desirable texture, smooth application, and compatibility with diverse skin types. The formulation underwent evaluations for key physicochemical attributes such as pH, viscosity, and uniformity, in addition to SPF analysis via spectroscopy. Stability assessments were performed under varied conditions to confirm product reliability, while patch tests ensured safety for different skin profiles. The findings revealed that the inclusion of sandalwood oil significantly enhances UV protection and provides therapeutic benefits. This study underscores a sustainable and nature-inspired approach to sun protection, resonating with consumer preferences for environmentally conscious skincare solutions.

Keywords: α-santalol, β-santalol, Soxhlet Extraction, Sun Protection Factor.

INTRODUCTION: Topical formulations are specifically designed to provide a localized effect, delivering active drugs to the underlying layers of the skin or mucous membrane. These formulations are tailored for site-specific drug delivery, making them particularly effective for treating skin disorders. As pharmaceutical products, creams are developed using advanced techniques from the pharmaceutical industry. Both medicated and unmedicated variants are extensively employed to address various dermatological conditions or dermatoses. Depending on individual preferences and skin requirements, creams may be ayurvedic, herbal, or allopathic in nature. They incorporate one or more active ingredients, which are either dissolved or dispersed within an appropriate base. Based on their emulsion type, creams can be classified as either oil-in-water (o/w) or water-in-oil (w/o) formulations. [1]

Sunscreen and UV Protection [2] Ultraviolet (UV) radiation in sunlight is a major contributor to skin damage, categorized into three types based on wavelength: UVC (270–290 nm), UVB (290–320 nm), and UVA (320–400 nm). While UVC is absorbed by the ozone layer, both

UVA and UVB reach the Earth's surface, causing sunburns, photoaging, and even skin cancers. Sunscreen application is essential for protection, especially as UV radiation can also impact skin pigmentation by activating alpha-melanocyte-stimulating hormones.

Sunscreen Formulation and Efficacy [3,4]

Sunscreens incorporate **UV filters** categorized into:

1. **Organic (chemical) filters** that absorb UV radiation.

2. **Inorganic (physical) filters** that reflect and scatter UV light.

Innovative approaches like **nanotechnology** and combining UV filters enhance SPF efficacy while maintaining practical formulation methods. SPF (Sun Protection Factor) measures the protective efficiency of sunscreens, indicating the relative duration a sunscreen can prevent erythema compared to unprotected skin.

Ingredients & Testing [5]

In studies, anisotriazine (organic filter) and titanium dioxide (inorganic filter) were evaluated for their synergistic SPF performance. Anisotriazine absorbs UV across broad wavelengths, while titanium dioxide blocks UV via reflection. In vitro SPF testing utilizes spectral transmittance measurements to assess protection levels of sunscreen formulations.

Impact of UV on Skin [6]

Short-term exposure results in erythema (sunburn) and melanization (tanning), while prolonged exposure can lead to irreversible loss of elasticity and heightened risks of skin cancers (e.g., melanoma). Factors like exposure duration, intensity, geographic location, and skin type influence damage severity.

Clinical Importance of Sunscreens [7]

The increased use of sunscreens has been driven by greater awareness of their protective role against skin cancers and photoaging. Clinical studies affirm their effectiveness, particularly in reducing melanoma and squamous cell carcinoma risks, alongside improving skin aesthetics and health.

Sunscreens have evolved significantly in formulation science, driven by advancements in safety, efficacy, and aesthetic appeal. Regulatory standards and economic incentives further emphasize their importance in skin protection and overall well-being.

MATERIALS AND METHODS:

Methods:

Selection of Base:

The primary goal of this study was to develop a sunshield cream formulation incorporating sandalwood oil. As such, suitable cream bases were chosen to effectively integrate the oil into the final product. [8]

Formulation of Sandalwood Oil Containing Sunshield Cream:

Table.1: Formulation Of Sandalwood Oil Containing Sunshield Cream

Ingredients	Parts Used	Category	Qty%
Sandalwood 	Heartwood	Anti-inflammatory	5
EDTA	-	Chelating Agent	0.1
Allantoin	-	Moisturizing agent	0.1
Aristoflex Polymer	-	Gelling agent	1
Glycerin	-	Humectant	5
Propendiol	-	Humectant	5
Cetyl Alcohol	-	Emulsifier	5
Arlacel 165	-	Emulsifier	3
Glyceryl Mono Stearate		Emulsifier	2
Sepigen	-	Thickener	2
TEA	-	Neutralizer	0.1
Octyl Salicylate	-	Sunscreen Agent	2
Water	-	Solvent	69.7

EXPERIMENTAL WORK:

Evaluation of extract
Preliminary phytochemical screening:

a) Flavonoids: To test for flavonoids, a few drops of sodium hydroxide (NaOH) solution were added to the test solution. The formation of a dilute acid confirmed the presence of flavonoids. [9]

b) Glycosides: A small quantity of the alcoholic extract of the sample was dissolved in 1 mL of water, followed by the addition of aqueous sodium hydroxide. The formation of a yellow color indicated the presence of glycosides. [10]

c) Alkaloids (Mayer's Test): To prepare Mayer's reagent, 1.36 g of mercuric chloride was dissolved in 60 mL of distilled water, while 5 g of potassium iodide was dissolved in 10 mL of water. These solutions were mixed and diluted to 100 mL with distilled water. A few drops of Mayer's reagent were added to 1 mL of the acidic aqueous solution of the sample. The appearance of a blue or green color indicated the presence of alkaloids. [11]

d) Phenols (Ferric Chloride Test): To 1 mL of the sample in alcoholic solution, 2 mL of distilled water and a few drops of a 10% aqueous ferric chloride solution were added. The formation of a blue or green color indicated the presence of phenols. [12]

e) Tannins (Lead Acetate Test): An aqueous extract (5 mL) was mixed with a few drops of a 1% lead acetate solution in a test tube. A yellow or red precipitate confirmed the presence of tannins. [13]

f) Lipids: Five drops of the sample were placed in a test tube, and a pinch of sodium hydrogen sulfate was added. The presence of lipids was indicated by the release of a pungent odor, suggesting that glycerin had been produced during hydrolysis of the fixed oil. [14]

i) Fourier Transform Infrared (FT-IR) Spectroscopy: FT-IR spectra showed no significant differences in the polymer (Aristoflex Polymer) and essential oil-containing formulations. Peaks in the 3000–3500/cm range corresponded to alkane groups ($-CH_3$) and were sharper across spectra, except for the polymer due to coordination linkages. Peaks in the 1600–2395/cm range indicated the presence of alkene groups (C=C), which appeared sharper in the polymer spectrum than in others. [15]

ii) Thermal Analysis: The stability of essential oil-containing formulations in acrylic matrices was evaluated using thermogravimetric analysis (TGA) thermograms.

iii) In Vitro Drug Release Study: The drug release from essential oil-containing formulations was studied over 24 hours, and the release amount was calculated using a regression equation derived from the calibration curve. [16]

iv) Drug Release Kinetics: The drug release followed the Korsmeyer-Peppas model, identified as the most appropriate model for essential oil-containing formulations. [17]

v) RSM Optimization Data Modeling: A multiple linear regression approach was utilized to establish a mathematical relationship, expressed as a polynomial equation. [18]

vi) Effect of Enhancers on % Drug Release at Response Y: Statistical significance analysis revealed that linear participation had no significant effect ($p > 0.05$), while quadratic contributions showed antagonistic effects. A^2 was significant ($p > 0.05$), while B^2 was not ($p < 0.05$). [19,20]

vii) Optimization of Essential Oil-Containing Formulations: The drug release profiles of essential oil-containing formulations through cellophane membranes showed distinct differences within a 24-hour period. [21,22]

viii) Stability Study of Cream: Cream samples were stored at 5°C, room temperature, and 40°C. Observations of changes in physical appearance, color, and texture were recorded. [23,24]

ix) SPF Determination: Aliquots were scanned in the range of 290–320 nm, and absorbance values were multiplied by respective EE (λ) values. The summation was multiplied by the correction factor (10), with data expressed as mean ± SEM. [25]

Sandalwood Extraction via Vacuum Distillation

Vacuum Distillation: Vacuum distillation is a technique conducted under reduced pressure, enabling the purification of compounds that cannot be readily distilled at standard atmospheric pressures. This process is particularly useful when the boiling point of a compound is challenging to achieve under normal conditions or risks decomposition at high temperatures. By lowering the pressure, the boiling point is significantly reduced, facilitating safer and more efficient separation based on differences in boiling points.

The reduction in boiling point due to pressure changes can be determined using a temperature-pressure relationship. Industrial-scale vacuum distillation offers several benefits, particularly for separating components with close boiling points. Employing vacuum distillation reduces the number of equilibrium stages required, simplifying the process and improving efficiency. [26]

In industrial applications, vacuum distillation units can be substantial in size, with columns reaching diameters of up to 14 meters (46 feet), heights of around 50 meters (164 feet), and processing capacities of up to 25,400 cubic meters per day (160,000 barrels per day). This scale ensures the effective extraction and purification of substances such as sandalwood oil, enabling high-quality outcomes in large volumes. [27,28]

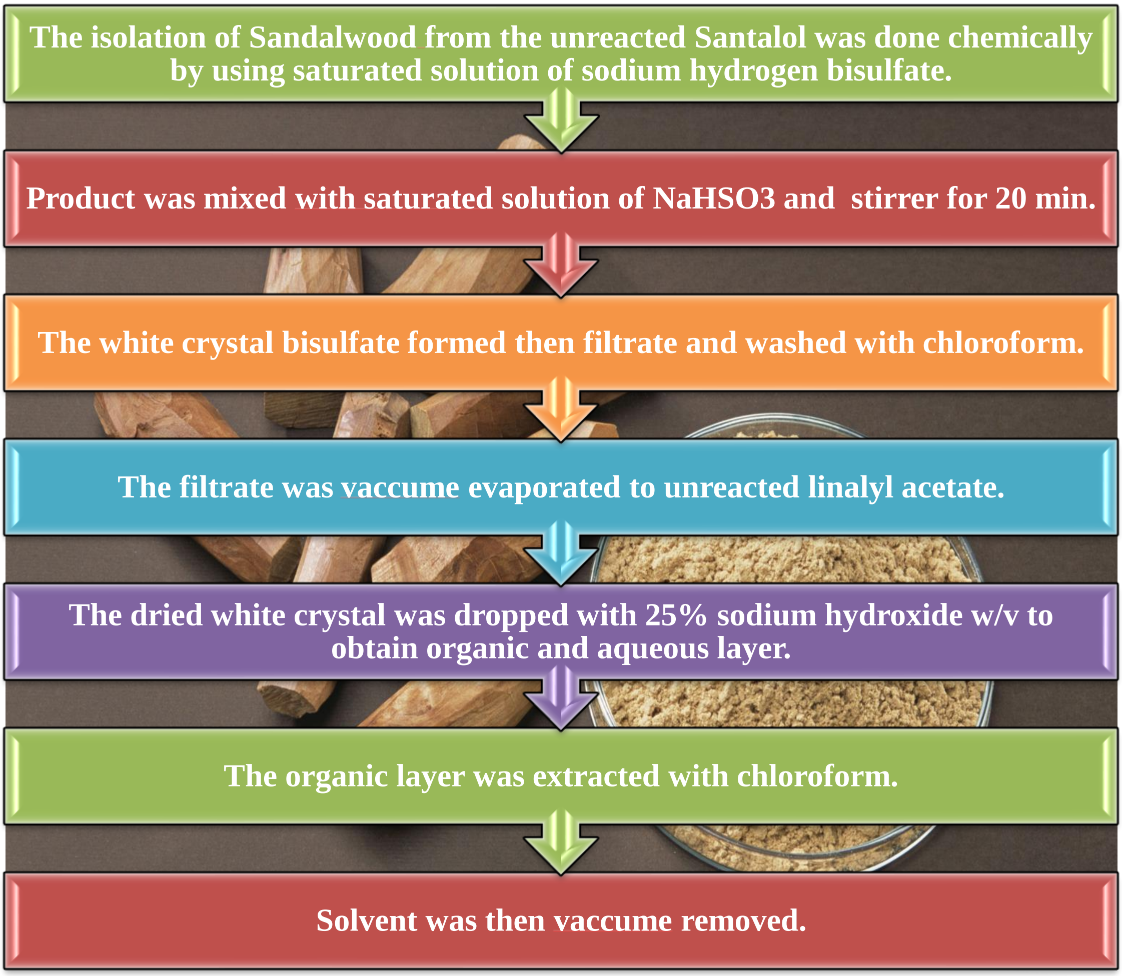

Fig.No.1: Extraction of Sandalwood Oil by Vaccume Distillation

RESULTS AND DISCUSSION

Determination of Evaluation parameters of prepared sunscreen cream

Table No. 1: Determination of Evaluation Parameters of Prepared Sunscreen Cream

Parameters	**F1**	**F2**	**F3**
Appearance	Cream like	Cream like	Cream like
Color	Bright white	Slightly white	Slightly white

Odor	Characteristic	Characteristic	Characteristic
Homogeneity	Uniform and homogenous	Uniform and homogenous	Uniform and homogenous
Consistency	Good	Good	Good
Texture	Smooth	Smooth	Smooth
Irritation	No	No	No
Spread ability	23.23	20.91	22.38
Wash ability	Good	Good	Good
pH	8.40	8.07	9.08
Rancidity	No pink color, no rancidity	No pink color, no rancidity	No pink color, no rancidity
Viscosity	46900	42648	44652
SPF	0.64	0.08	1.36
LOD	11.7%	11%	11.3%

i) Fourier Transform Infrared spectroscopy (FT- IR):
The FT-IR spectra in no significant difference in polymer (Aristoflex Polymer), pure Essential oils formulations.

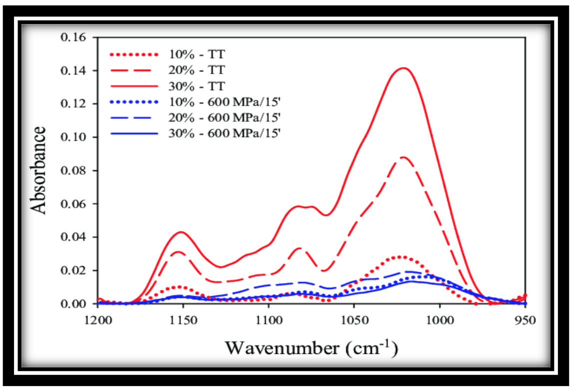

Fig. No. 2: Fourier Transform Infrared Spectroscopy (FT- IR)

ii) Thermal analysis:
The stability of essential oil-containing formulations within acrylic matrices was evaluated using thermal analysis, specifically TGA thermograms. The melting point of the drug-loaded, optimized EG6 essential oil formulation was identified as an exothermic single sharp peak at -23°C. Additionally, the loading temperature for this formulation was recorded at 30°C. [29]

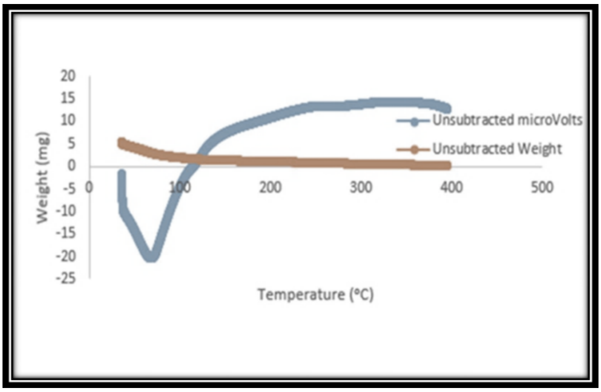

Fig. No. 3: Thermal Analysis

iii) In vitro drug release study:

The release of Essential Oils Containing Formulation was analyzed for 24 h and calculated the release amount by using regression equation for calibration curve.

Table No.2: In Vitro Drug Release Study

Trial#	Coded Factor levels
	X 1 (Extract)
EG1	0
EG2	2
EG3	1
EG4	1

Code level	-2	-1	0	1
X 1 (Oil Extract) (gm)	0.5	0.75	1.25	1.8

Drug release kinetics:

The drug release of the formulated essential oil-containing formulation followed the Korsmeyer-Peppas model, which was identified as the most suitable model at a pH of 8.0. This conclusion was based on the model's highest coefficient of determination value (R^2) and lowest AIC value compared to other models. [30] The results indicated that the mode of drug release was independent of drug concentration. Additionally, the formulation exhibited Fickian diffusion, as demonstrated by the diffusional exponent $n<0.45$ [30]

Table No.3: Determination of Wavelength [SPF]

	F1	F2	F3

Wave length (λ)	**EE (λ) × I (λ)**	Abs (λ)	EE (λ)×I (λ)× Abs(λ)	Abs (λ)	EE (λ)×I (λ)× Abs(λ)	Abs (λ)	EE (λ)×I (λ)× Abs(λ)
290	**0.015**	1.123	0.01685	1.389	0.02084	1.186	0.01779
295	**0.0817**	1.276	0.10425	1.475	0.12051	1.248	0.10196
300	**0.2874**	1.395	0.40092	0.863	0.24803	1.365	0.39230
305	**0.3278**	1.189	0.38975	0.773	0.25339	1.166	0.38221
310	**0.1864**	0.886	0.16515	0.849	0.15825	0.893	0.16646
315	**0.0837**	0.915	0.07659	1.295	0.10839	0.765	0.06403
320	**0.018**	0.864	0.01555	0.942	0.01696	0.589	0.01060
Total		1.16906		0.92636		1.13536	
SPF		11.69		9.26		11.35	

Stability study of Cream

The sample of Cream was kept at 5®C, room temperature 40®C. The changes in physical appearance, colour, feel etc were studied.

Table No. 4: Stability Studies of Cream

Sr. No.	**rameters**	M**1**	**M2**
1	pearance	Opaque	Opaque
2	lour	White	White
3	readability	Good	Very good

9.3 Vaccume Distillation:

9.3.1 Result obtained by is shown in Table below:

Table No.5: weight of oil with respect to time

Weight (g)	**Time (mins)**
0.35	250
0.40	500
0.50	750
0.55	100

0.65	1200

The oil produced by Vaccume Distillation Method is 2.45g weight of oil per 100g of Sandalwood thereby producing 2.45% oil yield at 780 C

Table No.6: Result of Essential Oils Extraction

Method of extraction	**% yield**
vacuum Distillation	2.45

Calculation of Percentage Yield of Volatile Oil:

Material Balance for Vacuum Distillation Method

- Weight of Sandalwood = 100g
- Quantity of hexane used= 600ml, Quantity of Ethanol used= 200ml
- Weight of beaker= 105.26g
- Weight ethanol and essential oil= 202.7g
- The weight of oil obtained= 2.45g
- %yield = ME/MS x 100
- Where, ME = Mass of essential oil MS = Mass of Sandalwood sample
- ME = 2.45g ML = 100g
- By substituting values
- %yield = 2.45/100 x 100 =3.02%
- Therefore % yield= 2.45%
- The graph below shows the plot of the weight of essential oil with respect to time for solvent extraction method

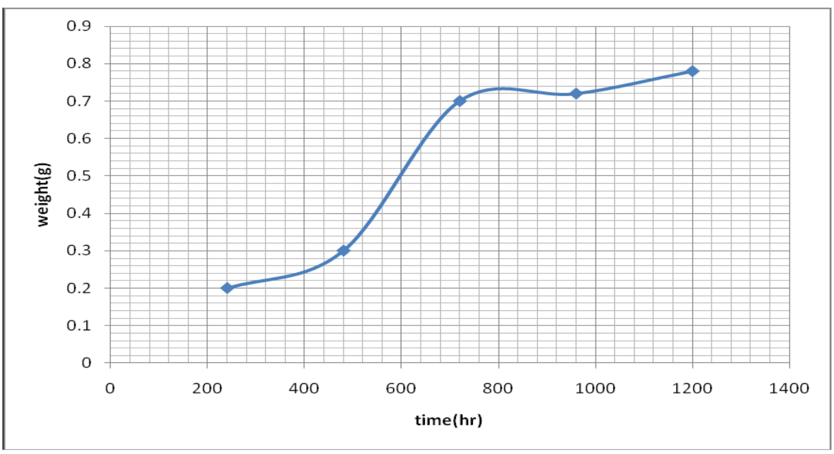

Fig.No.4: Graph below shows the plot of the weight of essential oil with respect to time for Vacuum Distillation Method

CONCLUSION: The development of a sandalwood oil-containing sunshield cream successfully integrates the natural benefits of sandalwood oil with effective UV protection. This cream offers a pleasant sensory experience, promotes skin health, and provides broad-spectrum sun defense. Such a formulation holds great potential in the market, particularly for consumers seeking natural and reliable sun protection solutions.

Stability studies revealed no significant changes in the viscosity, homogeneity, or pH of the formulations, demonstrating their stability. In conclusion, the formulation meets cosmeceutical requirements and is considered safe for skin application.

Soxhlet extraction methods were employed as an effective and efficient technique for obtaining essential oils for the sunshield cream. This method is widely used in the modern herbal industry due to its simplicity and cost-effectiveness.

The primary aim of the study was to formulate and develop a herbal sunscreen cream using sandalwood oil. Three formulations, labeled F1, F2, and F3, were prepared with varying compositions and evaluated for their physicochemical properties and SPF. Among these, formulation F1 demonstrated the highest SPF value compared to the other two batches.

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CONFLICTS OF INTEREST: Authors have no conflicts of interest to declare.

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