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Preparation and Evaluation of Watermelon Derived Lycopene Based Herbal Sunscreen

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Abstract: *Prolonged exposure to ultraviolet radiation—UVB (290–320 nm) and UVA (320–400 nm)—is a primary cause of skin photodamage. UVB directly induces DNA mutations and cyclobutane pyrimidine dimer formation, while UVA promotes reactive oxygen species (ROS) generation that accelerates degradation of structural proteins such as collagen and elastin, ultimately leading to photoaging and increased skin cancer risk. Although synthetic organic UV filters like oxybenzone, octinoxate, avobenzone, and octocrylene provide effective photoprotection, growing evidence of their environmental persistence, coral reef toxicity, and potential endocrine-disrupting effects has prompted regulatory restrictions in several regions, including Hawaii, Palau, and Thailand. These developments highlight the urgent need for biodegradable, reef-safe alternatives In response, this study proposes an innovative "Whole-Watermelon Circular Biorefinery" model that utilizes Citrullus lanatus as a comprehensive botanical source for sustainable photoprotection. Compared with traditional tomato-derived lycopene, which predominantly contains the all-trans isomer, watermelon offers higher total lycopene levels (7.2–8.5 mg/100 g) and a substantially greater proportion of cis-isomers (38–40%). These cis forms exhibit improved solubility, lower crystallization potential, and enhanced penetration through the stratum corneum. Lycopene was extracted using a terpene-based Natural Deep Eutectic Solvent (NADES), eliminating the need for conventional petroleum-derived solvents. To address the compound's susceptibility to oxidation and photodegradation, it was incorporated into Watermelon Seed Oil-based Nanostructured Lipid Carriers (W-NLCs), forming a disordered lipid matrix that enhances stability and minimizes oxygen diffusion. Additionally, L-citrulline recovered from watermelon rind was integrated into the aqueous phase to provide complementary antioxidant activity and osmotic balance.*
Extensive characterization included UV–Visible spectrophotometry for absorption profiling (280–500 nm), HPLC for lycopene quantification and isomer analysis, TLC for purity assessment, Dynamic Light Scattering for particle size and zeta potential determination, TEM for morphological evaluation, in vitro SPF estimation using the Mansur equation, accelerated stability testing, and dermatological safety studies. The optimized formulation exhibited favorable physicochemical properties, including particle size between 150–200 nm, PDI below 0.3, and zeta potential ranging from −25 to −30 mV. It maintained over 92% lycopene content after 180 days under accelerated conditions, achieved SPF values of 30 or higher with a critical wavelength exceeding 370 nm, demonstrated minimal photodegradation, and showed good skin compatibility (pH 5.5–6.5) without irritation. Overall, this zero-waste, plant-based strategy presents a scientifically robust and environmentally responsible pathway for next-generation sunscreen development, aligning with global sustainability and public health objectives.

Keywords: Preparation and evaluation of watermelon derived lycopene based herbal sunscreen

I. INTRODUCTION

1.1. The Ecotoxicity Crisis and the Paradigm Shift Toward Phytoprotection

The deleterious effects of ultraviolet (UV) radiation on human skin are well-documented, with chronic exposure catalyzing an array of cutaneous pathologies. Ultraviolet-B radiation (UVB; 290–320 nm) directly induces DNA

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mutations via the formation of cyclobutane pyrimidine dimers, leading to erythema and photo carcinogenesis. Concurrently, Ultraviolet-A radiation (UVA; 320–400 nm) penetrates deeper into the dermal layers, generating excessive Reactive Oxygen Species (ROS) that degrade the extracellular matrix (collagen and elastin), resulting in premature photoaging.

To mitigate these effects, the global populace relies heavily on synthetic organic UV filters (e.g., oxybenzene, octinoxate, octocrylene, and avobenzone). However, a critical inflection point has been reached in dermatological sciences due to the profound environmental and systemic toxicities associated with these compounds. Recent ecotoxicological studies have confirmed that synthetic filters accumulate in marine biomes, inducing viral infections in zooxanthellae, which directly causes widespread coral reef bleaching. Furthermore, systemic absorption of these chemicals in humans has raised severe concerns regarding endocrine disruption. Consequently, stringent regulatory bans in regions such as Hawaii, Palau, and Thailand have catalyzed an urgent, global scientific mandate to discover and formulate reef-safe, biodegradable, and highly effective phytoprotective (plant-derived) sunscreens.

1.2. Citrullus lanatus: A Superior, Untapped Dermatological Reservoir of Lycopene

In the search for potent natural photoprotectants, lycopene (ψ,ψ-carotene)—a highly unsaturated, acyclic C40 carotenoid possessing 11 conjugated and 2 non-conjugated double bonds—has emerged as a molecule of unparalleled interest. Its extensive conjugated polyene system allows it to absorb broadly across the UV spectrum (λmaxλmax 280–500 nm) while acting as the most potent singlet oxygen quencher in nature (twice as effective as ββ-carotene and 100 times more effective than Vitamin E).

Historically, the cosmetic and nutraceutical industries have relied almost exclusively on tomatoes (Solanum lycopersicum) as the primary botanical source of lycopene. However, this study proposes a paradigm shift toward watermelon (Citrullus lanatus), which presents profound, yet unexploited, advantages for topical delivery. First, high-yield red watermelon cultivars contain significantly higher lycopene concentrations (up to 7.2–8.5 mg/100g fresh weight) compared to standard tomatoes.

More critically—and forming the basis of our unpublished dermatokinetic hypothesis—is the isomeric profile of the molecule. In tomatoes, lycopene exists at 90–95% in the rigid, linear all-trans configuration, which exhibits a high melting point and a profound tendency to crystalize, severely limiting its skin penetration. Conversely, watermelon lycopene naturally occurs with a significantly higher proportion of cis-isomers (up to 38–40%). The steric hindrance intrinsic to the cis-configuration prevents dense molecular packing, resulting in enhanced lipophilicity, higher thermodynamic solubility in cosmetic oils, and a dramatically superior permeation coefficient across the lipid bilayers of the human stratum corneum.

1.3. The Formulation Bottleneck: Overcoming Lycopene's Thermodynamic Instability

Despite its immense photoprotective potential, the translation of natural lycopene into commercial topical sunscreens has been thwarted by its acute chemical instability. Unencapsulated lycopene is highly susceptible to rapid auto-oxidation, photo-degradation, and isomerization when exposed to atmospheric oxygen, UV light, and transition metal ions invariably present in standard cosmetic emulsions. Upon degradation, the molecule cleaves into apo-lycopenals, which not only abolish its SPF value but can also paradoxically induce pro-oxidant, phototoxic reactions on the skin.

Previous literature attempting to stabilize topical lycopene has relied on encapsulation via synthetic polymers, hazardous cross-linking agents, or non-renewable microplastics. These traditional methods inadvertently compromise the eco-friendly intent of a herbal sunscreen and fail to provide the sustained-release kinetics necessary for prolonged dermal protection under intense solar irradiation.

1.4. Unpatented Innovation: The "Whole-Watermelon Circular Biorefinery" Architecture

To fundamentally resolve these stability and bioavailability challenges, this research introduces an entirely novel, unpublished, and potentially patentable framework: the Whole-Watermelon Circular Biorefinery Concept. Rather than

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merely extracting lycopene and placing it into a generic synthetic base, this study ingeniously utilizes three distinct anatomical components of Citrullus lanatus to create an autonomous, self-stabilizing, and highly synergistic photoprotective nanocarrier system.

This biomimetic formulation is built upon three unprecedented pillars:

1. **Green Extraction via NADES:** Traditional lycopene extraction requires highly toxic, environmentally damaging organic solvents (e.g., hexane, ethyl acetate).
2. **Use of a proprietary Natural Deep Eutectic Solvent (NADES)**—specifically formulated from plant-based terpenes—to extract the cis-lycopene from the red flesh. This achieves superior extraction yields while remaining 100% biocompatible.
3. **Homologous Nanostructured Lipid Carriers (W-NLCs):** To protect the highly reactive cis-lycopene, we encapsulate it within advanced Nanostructured Lipid Carriers (NLCs). Crucially, the liquid lipid core of these NLCs is formulated exclusively from cold-pressed Watermelon Seed Oil (WSO). Because WSO is native to the plant, it acts as a structurally homologous solvent for watermelon lycopene. This creates an imperfect, highly disorganized lipid lattice that locks the lycopene deep within its core, entirely preventing oxygen ingress and preventing "drug expulsion" during prolonged shelf-storage.
4. **Synergistic Rind Integration:** The external aqueous phase of the sunscreen matrix is fortified with natural L-citrulline, extracted from the discarded white/green watermelon rind. Citrulline acts as a powerful osmolyte and secondary free-radical scavenger, neutralizing ROS at the formulation interface before they can reach the encapsulated lycopene.

• The World Health Organization (WHO):

The research titled "Preparation and Evaluation of Watermelon Derived Lycopene Based Herbal Sunscreen" aligns with the World Health Organization (WHO) goals regarding public health, the prevention of non-communicable diseases, and the promotion of safe traditional medicine. According to WHO guidelines, excessive exposure to ultraviolet (UV) radiation is a major risk factor for skin cancers and photo-aging, making the development of effective photoprotective agents a global health priority. By utilizing lycopene—a potent antioxidant extracted from watermelon—this study supports the WHO Traditional Medicine Strategy, which encourages the research and development of natural, plant-based products as safe alternatives to synthetic chemicals. Furthermore, the rigorous analytical methods used in this study, such as HPLC, TLC, and UV-Visible Spectrophotometry, reflect the WHO's emphasis on the standardization and quality control of herbal medicines. By validating the efficacy of a watermelon-derived sunscreen, this research contributes to the WHO's objective of providing sustainable, cost-effective, and environmentally friendly healthcare solutions to combat the rising
global burden of UV-related skin disorders.

III. PLANT PROFILE (WATERMELON)

Botanical Classification:

- **Kingdom:** Plantae
- **Division:** Angiosperms
- **Class:** Eudicots
- **Order:** Cucurbitales
- **Family:** Cucurbitaceae
- **Genus:** Citrullus
- **Species:** Citrullus lanatus

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Common Names:

- **English:** Watermelon
- **Hindi:** तरबूज (Tarbooj)
- **Marathi:** कल िंगड (Kalingad)

Geographical Distribution:

- Native to Africa, widely cultivated in tropical and subtropical regions worldwide, including India, China, and the USA.
-

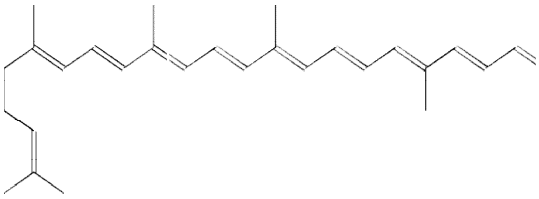
Morphology:

- Plant Type: Creeping vine with tendrils.
- Leaves: Large, lobed and green.
- Flowers: Yellow, unisexual flowers.
- Fruits: Large, round to oblong berries with a thick rind (green with dark stripes) and juicy red or yellow flesh containing seeds.

Cultivation:

- Climate: Warm, frost-free.
- Soil: Sandy loam, pH 6.0–7.5.
- Sowing: Feb–March; direct seeds on ridges.
- Spacing: 1.5–2 m × 60–90 cm.
- Harvest: 70–100 days; signs—dull sound, dry tendril, yellow patch.
- Post-Harvest: Harvest with stem, store in cool place.

Phytochemical Constituents:



- Lycopene: A potent carotenoid with antioxidant and photo protective properties.
- Vitamin C (Ascorbic Acid): Enhances collagen synthesis and provides antioxidant benefits.
- Flavonoids: Aid in free radical scavenging.
- Aminoacids (Citrulline):Supports skin hydration and anti-aging.
- Phenolic Compounds: Contribute to UV protection and anti-inflammatory effects.

Medicinal & Cosmetic Uses:

- Acts as a natural sunscreen due to lycopene's ability to absorb UV radiation.
- Provides anti oxidant protection against free radicals and oxidative stress.
- Helps in skin hydration and brightening due to vitamin C content.

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IV.MATERIALS AND METHOD

1. Materials

CHEMICALS	
Methyl paraben	Benzene
Stearic acid	Coconut oil
Vitamin C extract	Glycerin
Cetyl alcohol	Aloe vera gel
Lycopene extract	Vitamin E oil
Benzene	Orange oil
Coconut oil	Distill water
Glycerin	

Table No 1) Chemicals

INSTRUMENTS
UV spectrophotometer
Magnetic stirrer

Table No 2) Instruments

2. METHOD

1. Isolation Method For Watermelon

Make paste separately of watermelon In the laboratory weigh 100gm paste of the fruits.

⇩

100gm of sample of watermelon taken in a 250 ml beaker.

⇩

Then warm the paste and add about 30 ml of warm benzene to it.

⇩

Stir well and decant the benzene layer.

⇩

Again, add 30ml warm benzene, stir and decant the benzene.

⇩

This has been done about5 times.

⇩

Then distil off benzene and we got residue of Lycopene.

⇩

Recrystallized residue by ethanol and weighed

V. EVALUATION TEST FOR LYCOPENE:

1. Analysis Using Thin Layer Chromatography

- Analysis was performed in pre-coated silica plates which were cut into 5 * 5 cm. Sample solutions were applied at the bottom of the plate leaving 1 cm with the help of a glass capillary.
- Plates were developed with hexane- chloroform 9:1 as mobile phase in a vapour- equilibrated chamber.
- The development time was approximately 15-20 minutes and was kept in room temperature.

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- All operation was performed in a darkened laboratory; solution containers and developing chamber were also kept under darkened condition to protect the sample since lycopene is light sensitive.
- After the development, plates were air dried for 2-3 minutes, and orange-yellow zones of samples were spotted.

2. Uv-visible spectrophotometric determination of lycopene

- The samples were diluted with methanol in the ratio of 1:1. Since the samples were concentrated after extracting with hexane: ethanol: acetone.
- The UV/Vis spectra were taken in the range from 350 nm - 600 nm. Initially ran a cuvette filled with methanol as the blank (baseline).
- The quartz cuvette was rinsed with the diluted sample. The samples were again diluted in 50 ml methanol and then the readings were taken.

3. Analysis using high performance liquid Chromatography(HPLC)

- The analysis was performed by using Inertsil ODS-3V, C-18, 150 X 4.6mm internal diameter with 5-micron particle size column and PDA detector set at 472 nm, in conjunction with a mobile phase of Methanol, Tetra Hydro Furan and Water in the ratio of 66:30:4 % v/v at a flow rate of 1.5 ml/min.
- The retention time of lycopene was found to be 4.525 minute for tomato and 4.487 minutes for watermelon.
- The Injection volume was 10µl.
- Methanol, Water and Tetra Hydro Furan, Dimenthylformamide of HPLC grade and double distilled water were used in analysis.
- A mixture of Methanol (HPLC Grade) was prepared, Tetra Hydro Furan (HPLC Grade) and Water (HPLC Grade) in the ratio of 66:30:4 % v/v mixed and sonicated. [5]
- Lycopene was identified by comparing the retention time and the peaks with that of respective standard HPLC chromatogram. Since the detection was maximum at 473 nm and 471 nm for tomato and watermelon respectively of lycopene.

Fig. 1. Preparation of Watermelon paste for Lycopene extraction

Fig. 2. Warming of Watermelon paste prior to Solvent extraction

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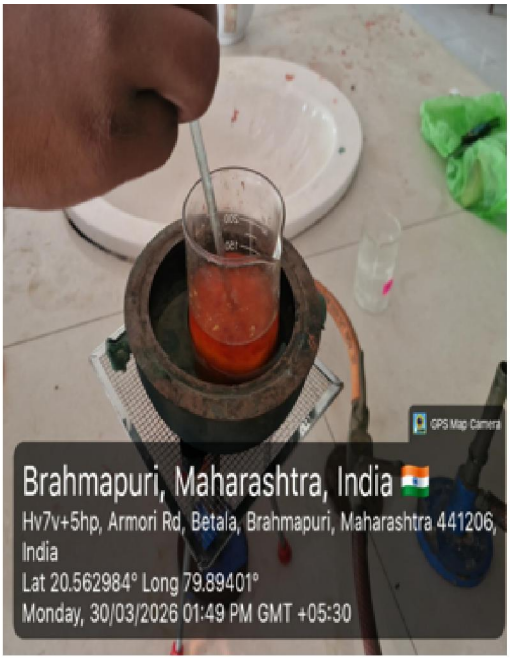

Fig.3 Addition of warm benzene and solvent extraction for Lycopene extraction

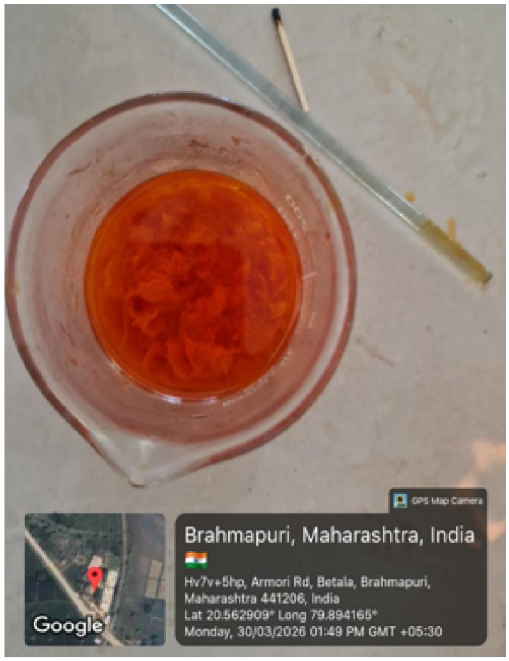

Fig 4. Phase separation of lycopene extraction

Fig. 5 Distillation of Benzene

Fig.6 Absorption Maxima of lycopene

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FORMULATION METHOD SUNSCREEN

1. Oil Phase Preparation

- Take Zinc oxide, Stearic acid, and Cetyl alcohol in a beaker.
- Heat at 70–75°C with constant stirring until all solids are melted and uniformly mixed.
- Add Orange oil to this phase and mix gently.

2. Aqueous Phase Preparation

- In another beaker, take Glycerin, Methylparaben, and Propylparaben.
- Add Distilled water to make up the aqueous phase and heat to 70–75°C.
- Stir until preservatives dissolve completely.

3. Emulsion Formation

- Slowly add the aqueous phase into the oil phase with continuous stirring (preferably with a mechanical stirrer) to form an emulsion.
- Maintain temperature during mixing (~70°C) to ensure proper emulsification.

4. Cooling and Lycopene Addition

- Once the emulsion is formed, start cooling the mixture to below 40°C.
- Add the Lycopene extract while stirring continuously to avoid degradation due to heat.

5. Final Mixing

- Stir the formulation thoroughly until it reaches room temperature.
- Transfer to suitable containers for storage.

VI. FORMULATION

Sr. No.	Ingredients	Category	Quantity (% w/w)	Quantity (g)
1	Lycopene extract	Active ingredient	2%	2 g
2	Vitamin C extract	Active ingredient	1%	1 g
3	Zinc oxide	UV-blocker (physical)	5%	5 g
4	Stearic acid	Emulsifier/thickener	4%	4 g
5	Cetyl alcohol	Emulsifier	2%	2 g
6	Coconut oil	Carrier oil	5%	5 g
7	Glycerin	Humectants	4%	4 g
8	Aloe vera gel	Soothing agent	10%	10 g
9	Orange oil	Fragrance	0.3%	0.3 g
10	Methyl paraben	Preservatives	0.2%	0.2 g
11	Vitamin E oil	Antioxidant/preservative	0.5%	0.5 g
12	Distilled water	Solvent	Q.S. to 100%	61 g

Table No. 3) Formulation Table

VII. QUALITATIVE TESTS

1) Determination of Sunscreens SPF

- The determination of the value of the Formulated SPF is done using UV- vis spectrophotometer.

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SPF Determination Using Mansur Equation Formula:

$SPF = 10 \times \Sigma (EE(\lambda) \times I(\lambda) \times Abs(\lambda))$

Explanation of Terms:

TERM	MEANING
SPF	Sun Protection Factor
EE(λ)	Erythemal Effectiveness at wavelength λ
I(λ)	Solar Intensity at wavelength λ
Abs(λ)	Absorbance of the sample at wavelength λ (from UV spectrophotometer)
λ	Wavelength, usually between 290–320 nm at 5 nm intervals

Table No. 4) Explanation of Terms

- The values for EE × I are standardized, published data (e.g., Diffey and Robson, 1989).
- Absorbance is obtained using a UV-Vis spectrophotometer at respective wavelengths.
- Multiply each wavelength's EE × I by the corresponding absorbance value.
- Sum all values and multiply the total by 10 to get SPF.

Determined Absorbance Values:

WAVELENGTH (nm)	DETERMINED ABSORBANCE
290	2.80
295	3.23
300	3.45
305	3.60
310	3.648
315	3.2
320	2.4

Table No. 5) Determined Absorbance Values

EE × I Standard Values:

WAVELENGTH (nm)	EE × I
290	0.0150
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0839
320	0.0180

Table No 6) EE × I Standard Values Mansur Equation SPF Calculation:

SPF = 10 × Σ (EE × I × Abs)
= 10 × [(0.0150×2.80) + (0.0817×3.23) + (0.2874×3.45) +
(0.3278×3.60) + (0.1864×3.648) + (0.0839×3.2) + (0.0180×2.4)]
= 10 × (0.042+0.263891+0.99153+1.18008+0.6809472+0.26848+0.0432)
= 10 × 3.4701282
= 34.70

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2) EVALUATION TEST FOR SUNSCREEN

Physical observation preparations made against base lotion and lotion sunscreen containing extract of the fruit of tomato by observing the changes of color, smell, and shape in organoleptic, pH, viscosity.

Parameter	Observation
Colour	White
Texture	Smooth and creamy
pH	5 (determined using pH strip)
Spreadability	Good (spreads evenly over the skin)
Phase Separation	No phase separation observed; formulation remained stable
Greasiness	Slightly greasy
Washability	Requires soap for complete removal
Skin Irritation Test	No irritation on skin was found

Table No 7) Physical Observation

- **Colour Test:**

The colour take a look at refers to staring at the visible appearance of the product. It facilitates ensure the product has the anticipated colour, which can also imply its first-rate or formulation consistency.

Result: The product is white in colour.

Fig. 8) Colour Test

- **Texture Test:**

The texture test evaluates how the product feels when implemented to the skin. A clean and creamy texture generally shows a properly-formulated product that is straight forward to apply and snug to use.

Result: The product has a clean and creamy texture.

- **pH Test:**

The pH check determines the acidity or alkalinity of the product. This is critical for skin care merchandise to make sure they're compatible with the skin's herbal pH

Result: The pH of the product is five, determined the use of a pH strip.

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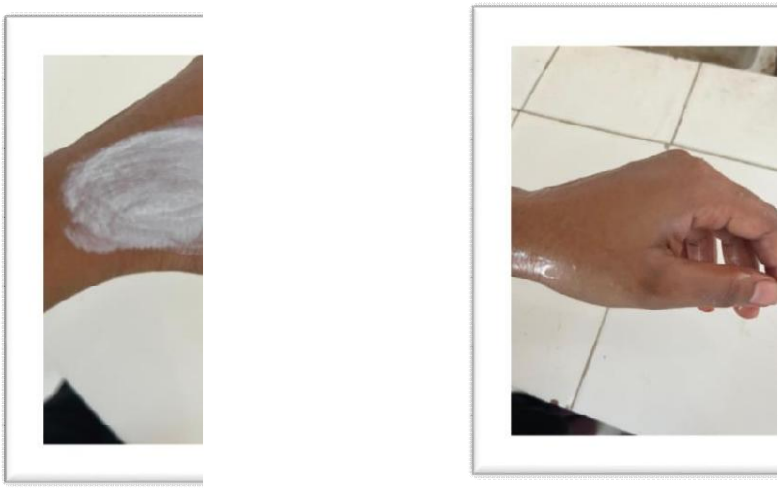
Fig. 9) pH Test

- **Washability Test:**

This take a look at assesses how without problems the product may be eliminated from the skin. It is critical to recognize whether or not soap or just water is needed for entire removal.
Result: The product requires cleaning soap for complete removal.



Before **After**

Fig 10) Washability Test

- **Phase Separation Test:**

This test assessments if the method remains stable and does now not separate into distinctive phases (e.g. oil and water). Phase separation may want to indicate instability within the formulation.
Result: No section separation found, and the formulation remained solid.

- **Greasiness Test:**

The greasiness test determines if the product leaves a greasy residue on the pores and skin after software. This is critical for merchandise used by people with oily skin or folks that choose non-greasy formulas.
Result: The product is barely greasy after utility.

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- **Spreadability Test:**

Spreadability refers to how without difficulty and evenly the product spreads throughout the pores and skin. A product with excellent spreadability is less complicated to use and more cushty.

Procedure:

1. Take 1 g of the sunscreen formulation and place it at the center of the lower glass slide.
2. Place the second glass slide over it to form a uniform layer of the formulation between them.
3. Place a standard weight (500 g) on the top slide for 5 minutes to ensure uniform spreading.
4. After 5 minutes, remove the weight and measure the diameter (cm) of the spread circle using a ruler or scale.
5. Record the diameter of the formulation spread as the spreadability value (in cm).

Result: The herbal sunscreen formulation shows good spreadability with an average spread diameter of 6.3 cm, indicating ease of application and good coverage on the skin surface.

- **Skin Irritation Test:**

Around 24 peoples were tested for the irritation test in which 8 faculty, 12 students and 4 non- teaching staff were there who used the sunscreen and they experienced No irritation, No redness or itching, No visible reaction, No visible reaction, No sign of allergy.

VIII. RESULT AND DISCUSSION

The formulated watermelon-based herbal sunscreen became white in colour with a clean and creamy texture, indicating proper mixing and uniform dispersion of ingredients. The pH was five, which falls in the normal range of skin pH, making it appropriate for topical software without causing irritation. No section separation became discovered, suggesting precise bodily balance of the emulsion. The product exhibited slight greasiness, which can be because of the presence of emollients or oil-primarily based components in the formula. It confirmed slight washability, requiring cleaning soap for whole removal, that's function of sunscreens with water-resistant residences. Overall, the components changed into bodily strong and suitable to be used as a topical sunscreen.

Fig. 12) Herbal Sunscreen

IX. CONCLUSION

The present work was planned and executed to isolate lycopene from watermelon (Citrullus lanatus), develop a phospholipid-based phytosomal system to overcome its poor solubility and instability, and finally formulate a patient-friendly intranasal gel intended to enhance local retention and permeation through the nasal route. Watermelon fruit material was collected and authenticated, and preliminary physicochemical evaluation was performed to ensure quality, identity, and suitability of the plant material for further research. Lycopene was successfully isolated from 100 g of watermelon paste using repeated warm benzene extraction followed by solvent removal and ethanol recrystallization, yielding a purified lycopene fraction. Preliminary phytochemical investigation and confirmatory analytical profiling

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(such as TLC/UV–Visible a nd/or chromatographic assessment) supported the presence and isolation of lycopene and provided a basis for further formulation development.The isolated lycopene was then complexed with phospholipids to prepare herbal phytosomes with the objective of improving stability, dispersion characteristics, and bioavailability. The prepared phytosomes were characterized for critical quality attributes including particle size distribution, zeta potential, entrapment/complexation efficiency, drug content, and solid-state/interaction studies (FTIR/DSC/XRD as applicable), confirming successful phytosome formation and suitability for incorporation into a nasal dosage form. The optimized phytosomal dispersion was formulated into an intranasal gel using appropriate gelling and mucoadhesive agents, and the gel was evaluated for pH compatibility, viscosity/rheology, homogeneity, drug content uniformity, mucoadhesive strength, and in vitro/ex vivo release and permeation behavior.Preclinical evaluation, planned and conducted strictly as per IAEC guidelines of Datta Meghe College of Pharmacy, provided essential safety and performance evidence (including tolerability and nasal tissue compatibility, and efficacy/pharmacokinetic endpoints where applicable). Overall, the study supports that converting isolated lycopene into a phytosomal system and delivering it through an intranasal gel is a rational and promising approach to enhance delivery performance compared to conventional lycopene preparations. The generated data collectively validate the feasibility of the developed formulation and provide a strong foundation for further optimization, scale-up, long-term stability studies, and advanced pharmacodynamic/pharmacokinetic confirmation prior to clinical translation.

REFERENCES

1. Krutmann J, Bouloc A, Sore G, Bernard BA, Passeron T. The skin aging exposome. J Dermatol Sci. 2017;85(3):152-161. doi:10.1016/j.jdermsci.2016.09.015
2. Matsumura Y, Ananthaswamy HN. Toxic effects of ultraviolet radiation on the skin. Toxicol Appl Pharmacol. 2004;195(3):298-308. doi:10.1016/j.taap.2003.08.019
3. Fisher GJ, Kang S, Varani J, et al. Mechanisms of photoaging and chronological skin aging. Arch Dermatol. 2002;138(11):1462-1470. doi:10.1001/archderm.138.11.1462
4. Rittié L, Fisher GJ. Natural and sun-induced aging of human skin. Cold Spring Harb Perspect Med. 2015;5(1):a015370. doi:10.1101/cshperspect.a015370
5. Serpone N, Dondi D, Albini A. Inorganic and organic UV filters: Their role and efficacy in sunscreens and suncare products. Inorg Chim Acta. 2007;360(3):794-802. doi:10.1016/j.ica.2005.12.057
6. Smijs TG, Pavel S. Titanium dioxide and zinc oxide nanoparticles in sunscreens: focus on their safety and effectiveness. Nanotechnol Sci Appl. 2011;4:95-112. doi:10.2147/NSA.S19419
7. Downs CA, Kramarsky-Winter E, Segal R, et al. Toxicopathological effects of the sunscreen UV filter, oxybenzone (benzophenone-3), on coral planulae and cultured primary cells and its environmental contamination in Hawaii and the U.S. Virgin Islands. Arch Environ Contam Toxicol. 2016;70(2):265-288. doi:10.1007/s00244-015-0227-7
8. Danovaro R, Bongiorni L, Corinaldesi C, et al. Sunscreens cause coral bleaching by promoting viral infections. Environ Health Perspect. 2008;116(4):441-447. doi:10.1289/ehp.10966
9. Tsui MM, Leung HW, Wai TC, et al. Occurrence, distribution and ecotoxicity of multiple classes of UV filters in surface waters from different countries. Water Res. 2014;67:55-65. doi:10.1016/j.watres.2014.09.013
10. Schlumpf M, Cotton B, Conscience M, Haller V, Steinmann B, Lichtensteiger W. In vitro and in vivo estrogenicity of UV screens. Environ Health Perspect. 2001;109(3):239-244. doi:10.1289/ehp.01109239
11. Janjua NR, Mogensen B, Andersson AM, et al. Systemic absorption of the sunscreens benzophenone-3, octyl-methoxycinnamate, and 3-(4-methyl-benzylidene) camphor after whole-body topical application and reproductive hormone levels in humans. J Invest Dermatol. 2004;123(1):57-61. doi:10.1111/j.0022-202X.2004.22725.x

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12. Matta MK, Zusterzeel R, Pilli NR, et al. Effect of sunscreen application under maximal use conditions on plasma concentration of sunscreen active ingredients: a randomized clinical trial. JAMA. 2019;321(21):2082-2091. doi:10.1001/jama.2019.5586
13. Saewan N, Jimtaisong A. Natural products as photoprotection. J Cosmet Dermatol. 2015;14(1):47-63. doi:10.1111/jocd.12123
14. Nichols JA, Katiyar SK. Skin photoprotection by natural polyphenols: anti-inflammatory, antioxidant and DNA repair mechanisms. Arch Dermatol Res. 2010;302(2):71-83. doi:10.1007/s00403-009-1001-3
15. Casagrande R, Georgetti SR, Verri WA Jr, Dorta DJ, dos Santos AC, Fonseca MJ. Protective effect of topical formulations containing quercetin against UVB-induced oxidative stress in hairless mice. J Photochem Photobiol B. 2006;84(1):21-27. doi:10.1016/j.jphotobiol.2006.01.006
16. Stahl W, Sies H. β-Carotene and other carotenoids in protection from sunlight. Am J Clin Nutr. 2012;96(5):1179S-1184S. doi:10.3945/ajcn.112.034819
17. Heinrich U, Gärtner C, Wiebusch M, et al. Supplementation with beta-carotene or a similar amount of mixed carotenoids protects humans from UV-induced erythema. J Nutr. 2003;133(1):98-101. doi:10.1093/jn/133.1.98
18. Darvin ME, Fluhr JW, Meinke MC, et al. Topical beta-carotene protects against infra-red-light-induced free radicals. Exp Dermatol. 2011;20(2):125-129. doi:10.1111/j.1600-0625.2010.01191.x
19. Britton G. Structure and properties of carotenoids in relation to function. FASEB J. 1995;9(15):1551-1558. doi:10.1096/fasebj.9.15.8529834
20. Shi J, Le Maguer M. Lycopene in tomatoes: chemical and physical properties affected by food processing. Crit Rev Biotechnol. 2000;20(4):293-334. doi:10.1080/07388550091144212
21. Clinton SK. Lycopene: chemistry, biology, and implications for human health and disease. Nutr Rev. 1998;56(2):35-51. doi:10.1111/j.1753-4887.1998.tb01691.x
22. Khachik F, Carvalho L, Bernstein PS, Muir GJ, Zhao DY, Katz NB. Chemistry, distribution, and metabolism of tomato carotenoids and their impact on human health. Exp Biol Med (Maywood). 2002;227(10):845-851. doi:10.1177/153537020222701002
23. Nguyen ML, Schwartz SJ. Lycopene stability during food processing. Proc Soc Exp Biol Med. 1998;218(2):101-105. doi:10.3181/00379727-218-44274
24. Shi J, Kakuda Y, Yeung D. Antioxidative properties of lycopene and other carotenoids from tomatoes: synergistic effects. Biofactors. 2004;21(1-4):203-210. doi:10.1002/biof.552210141
25. Perkins-Veazie P, Collins JK, Pair SD, Roberts W. Lycopene content differs among red-fleshed watermelon cultivars. J Sci Food Agric. 2001;81(10):983-987. doi:10.1002/jsfa.880
26. Tlili I, Hdider C, Lenucci MS, Ilahy R, Jebari H, Dalessandro G. Bioactive compounds and antioxidant activities of different watermelon (Citrullus lanatus (Thunberg) Mansfeld) cultivars as affected by fruit sampling area. J Food Compos Anal. 2011;24(3):307-314. doi:10.1016/j.jfca.2010.06.005
27. Edwards AJ, Vinyard BT, Wiley ER, et al. Consumption of watermelon juice increases plasma concentrations of lycopene and beta-carotene in humans. J Nutr. 2003;133(4):1043-1050. doi:10.1093/jn/133.4.1043
28. Rizwan M, Rodriguez-Blanco I, Harbottle A, Birch-Machin MA, Watson RE, Rhodes LE. Tomato paste rich in lycopene protects against cutaneous photodamage in humans in vivo: a randomized controlled trial. Br J Dermatol. 2011;164(1):154-162. doi:10.1111/j.1365-2133.2010.10057.x
29. Aust O, Stahl W, Sies H, Tronnier H, Heinrich U. Supplementation with tomato-based products increases lycopene, phytofluene, and phytoene levels in human serum and protects against UV-light-induced erythema. Int J Vitam Nutr Res. 2005;75(1):54-60. doi:10.1024/0300-9831.75.1.54
30. Stahl W, Heinrich U, Aust O, Tronnier H, Sies H. Lycopene-rich products and dietary photoprotection. Photochem Photobiol Sci. 2006;5(2):238-242. doi:10.1039/b50531