Formulation And Evaluation of Anti- Ageing Sunscreen by Using Amla

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***Abstract*—Skin ageing is an inevitable, complex, and multifactorial biological process that manifests as progressive loss of skin elasticity, formation of wrinkles, hyperpigmentation, skin laxity, dryness, and diminished skin radiance. It is driven by two distinct but interconnected processes— intrinsic (chronological) ageing, which results from the natural decline of cellular renewal and collagen synthesis over time, and extrinsic ageing (photoageing), which is primarily caused by chronic ultraviolet (UV) radiation exposure. UV radiation is the single most significant external contributor to skin ageing, responsible for approximately 80% of visible facial ageing signs through mechanisms including oxidative stress, DNA damage, matrix metalloproteinase (MMP) activation, and collagen degradation.**

The global cosmetic and cosmeceutical industry have responded to the growing demand for effective anti-ageing and photoprotection products with a wide variety of synthetic sunscreen formulations. However, synthetic UV filters such as oxybenzone, avobenzone, and octinoxate are increasingly associated with concerns regarding skin sensitization, endocrine disruption, environmental toxicity — particularly to coral reefs — and consumer preference for natural, clean-label cosmetic alternatives. This has driven significant scientific interest in developing effective sunscreen formulations using natural active ingredients with proven photoprotective and anti-ageing properties.

Amla (Emblica officinalis Gaertn., Family: Phyllanthaceae), commonly known as Indian Gooseberry, is one of the most revered medicinal plants in Ayurvedic medicine and is recognized as the richest natural source of Vitamin C, with a Vitamin C content of 600–900 mg per 100 g of fresh fruit — significantly higher than citrus fruits. Amla also contains a unique combination of tannins, emblicanin A and B, gallic acid, ellagic acid, quercetin, and rutin that collectively provide exceptional antioxidant, anti-inflammatory, photoprotective, collagen- stimulating, and anti-melanogenic properties — making it an ideal natural active ingredient for anti-ageing sunscreen formulations.

The present work focuses on the formulation and evaluation of an anti-ageing sunscreen cream containing standardized Amla powder as the primary active ingredient, combined with Zinc Oxide IP (micronized) as a broad-spectrum mineral UV filter, Aloe vera gel as a soothing and hydrating base, Glycerin IP as a humectant, Rose water as a hydrating and fragrance agent, Beeswax IP as a natural emulsifier and stabilizer, Phenoxyethanol as a preservative, and Purified Water IP as the vehicle. Three formulations (F1, F2, F3) were prepared by varying the concentrations of Amla powder and Zinc Oxide to optimize the balance between photoprotection, anti-ageing activity, and cosmetic elegance.

The prepared formulations were evaluated for organoleptic properties, pH, viscosity, spreadability, homogeneity, Sun Protection Factor (SPF), drug content, skin irritation, stability, and in-vitro antioxidant activity. Results indicated that the optimized formulation produced a smooth, stable, elegantly finished, and photoprotective anti-ageing sunscreen cream with excellent physicochemical properties, satisfactory SPF, and potent antioxidant activity — representing a promising natural alternative to conventional synthetic sunscreen preparations.

***Index Terms*—Amla, Emblica officinalis, Anti-ageing, Sunscreen, UV Protection, Zinc Oxide, Photoprotection, SPF, Antioxidant, Vitamin C, Collagen, Skin Ageing, Natural Cosmeceutical**

I. INTRODUCTION

The word "ageing" is derived from the Old French word aagier meaning "to grow old," and in the context of skin biology, it encompasses the progressive and multidimensional changes that occur in the structure, function, and appearance of human skin as a consequence of the passage of time and cumulative environmental exposures.

The skin is the largest organ of the human body and serves as the primary interface between the internal biological environment and the external world. It performs critical functions including barrier protection, thermoregulation, immune surveillance, sensory perception, and vitamin D synthesis. As the most externally visible organ, the skin is also the primary site where the visible signs of ageing — wrinkles, sagging, discoloration, and loss of radiance — manifest, making skin ageing a topic of enormous personal, social, and commercial significance worldwide.

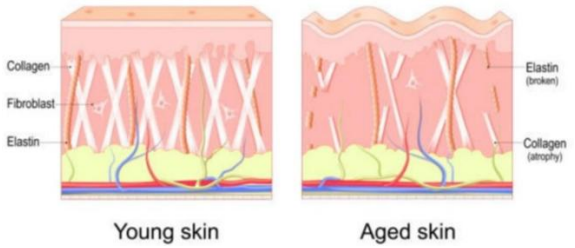

Fig.NO. 1 Skin Deference

Skin ageing is not a single uniform process but rather the result of two distinct and superimposed mechanisms that interact throughout life. Intrinsic or chronological ageing is a genetically programmed, time-dependent process that affects all skin layers and is characterized by progressive decline in cellular proliferation, reduced collagen and elastin synthesis by dermal fibroblasts, diminished production of hyaluronic acid and other glycosaminoglycans, flattening of the dermo-epidermal junction, and decreased numbers and activity of melanocytes and Langerhans cells. Intrinsically aged skin appears thin, dry, fine- wrinkled, and lax, with reduced vascularity and impaired wound healing.

Extrinsic ageing, in contrast, is driven primarily by environmental factors — foremost among which is chronic exposure to ultraviolet (UV) radiation from the sun. Photoageing, as UV- induced skin ageing is termed, produces changes that are qualitatively and quantitatively distinct from intrinsic ageing, characterized by coarse deep wrinkles, irregular pigmentation (solar lentigines, melasma), rough leathery texture, telangiectasias, and precancerous lesions (actinic keratoses). Photoageing is mediated through multiple molecular mechanisms including direct UV-induced DNA damage, generation of reactive oxygen species (ROS), activation of matrix metalloproteinase (MMP) enzymes that degrade collagen and elastin, suppression of collagen neosynthesis, and induction of chronic subclinical inflammation in the dermis.

Ultraviolet radiation reaching the earth's surface is composed of UVB (290–320 nm) and UVA (320–400 nm) wavelengths. UVB radiation is primarily responsible for sunburn and direct DNA damage (cyclobutane pyrimidine dimer formation), while UVA penetrates more deeply into the dermis and is the major driver of photoageing through oxidative damage, MMP activation, and dermal collagen degradation. Effective photoprotection therefore requires both UVB and UVA coverage — so-called broad-spectrum sun protection.

Sunscreens are the most widely used and scientifically validated means of photoprotection. They function either through chemical (organic) UV filters that absorb UV photons and dissipate them as heat, or through physical (mineral/inorganic) UV filters — primarily Zinc Oxide and Titanium Dioxide — that reflect and scatter UV radiation. Micronized Zinc Oxide offers the distinct advantages of true broad-spectrum UVA and UVB protection, photostability, excellent safety profile (generally recognized as safe and effective — GRASE — by the FDA), and compatibility with sensitive skin — making it the preferred mineral UV filter in natural and clean-label sunscreen formulations.

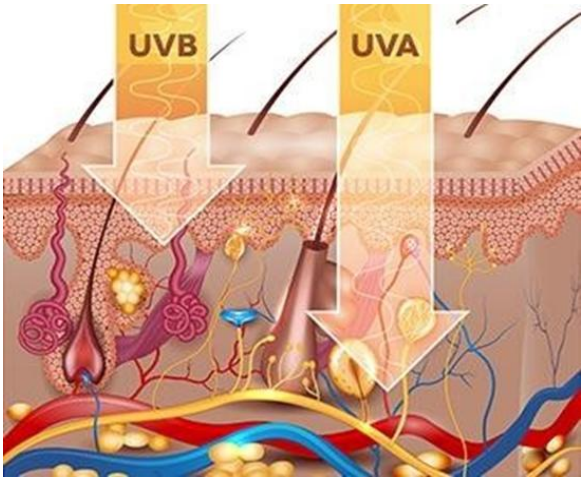

Fig.No.2 UVB and UVA Effect on Skin

Amla (Emblica officinalis Gaertn.) is the cornerstone active ingredient in this formulation and represents the most pharmacologically comprehensive natural anti-ageing and photoprotective ingredient available in the

Indian botanical pharmacopoeia. Its extraordinarily high Vitamin C content provides potent antioxidant activity that neutralizes UV-induced ROS, stimulates collagen synthesis by dermal fibroblasts (Vitamin C is an essential cofactor for prolyl and lysyl hydroxylase — the enzymes responsible for collagen cross-linking and stabilization), and inhibits melanogenesis by blocking tyrosinase enzyme activity. Its tannins — particularly emblicanins A and B — have been shown to possess UV-absorbing properties in the UVB range (280–320 nm), providing direct photoprotection. Its gallic and ellagic acid content inhibits MMP-1 (collagenase) and MMP-3 (stromelysin) enzymes, protecting dermal collagen from UV-induced degradation.

The development of an Amla-based anti-ageing sunscreen cream using natural excipients — Aloe vera gel, Rose water, Beeswax, and Glycerin — addresses the growing consumer demand for natural, clean, and effective cosmeceutical photoprotection products while offering a scientifically grounded multi-mechanistic approach to both UV protection and anti-ageing skin care. The present work aims to translate this scientific rationale into a practically formulated, physicochemically stable, elegantly finished, and therapeutically effective topical sunscreen cream.

Fig. No. 3 Skin Aging

Types of Skin Ageing:

1) Intrinsic Ageing (Chronological Ageing)
2) Extrinsic Ageing (Photoageing)
3) Glycation-Induced Ageing
4) Pollution-Induced Ageing (Exposome Ageing)
5) Hormonal Ageing
6) Mechanical Ageing (Repetitive Facial Expressions)
7) Lifestyle-Induced Ageing

a) Intrinsic Ageing (Chronological Ageing):

Intrinsic ageing is a universal, biologically programmed process affecting all individuals regardless of sun exposure or lifestyle. It is driven by the natural shortening of telomeres with each cell division, decreased mitochondrial function, accumulation of reactive oxygen species from normal cellular metabolism, reduced activity of antioxidant enzymes, and progressive decline in the regenerative capacity of skin stem cells. The visible result is skin that becomes progressively thinner, drier, finely wrinkled, and less elastic with advancing age — particularly on sun-protected areas such as the inner upper arm, which shows pure intrinsic ageing changes.

b) Extrinsic Ageing (Photoageing):

Photoageing is caused by cumulative UV radiation exposure accumulated over a lifetime. It superimposes distinct and more severe changes on top of intrinsic ageing — including coarse, deep wrinkles, leathery rough skin texture, irregular pigmentation, solar lentigines, freckles, telangiectasias, and an increased risk of skin cancer. Photoageing affects sun-exposed areas — the face, neck, décolleté, and hands — disproportionately compared to sun-protected areas. It is responsible for approximately 80% of visible facial ageing and is directly addressed by the UV-protecting and antioxidant components of the present formulation.

c) Glycation-Induced Ageing:

Glycation is the non-enzymatic reaction between reducing sugars (primarily glucose and fructose) and amino groups of proteins, lipids, and DNA — forming unstable Schiff bases that rearrange to form more stable Amadori products, which further react to form irreversible advanced glycation end-products (AGEs). In the skin, AGEs accumulate in long-lived dermal proteins — particularly collagen and elastin — causing them to cross-link abnormally, becoming rigid, brittle, and resistant to normal enzymatic turnover. This results in a characteristic sallow, yellowish skin appearance, loss of elasticity, and impaired wound healing. Amla's antioxidant polyphenols have been shown to inhibit AGE formation through free radical scavenging and metal chelation.

d) Pollution-Induced Ageing (Exposome Ageing):
Atmospheric pollutants — including particulate matter (PM2.5), ozone, nitrogen dioxide, polycyclic aromatic hydrocarbons, and heavy metals — have emerged as significant contributors to skin ageing, particularly in urban populations. These pollutants generate ROS upon contact with skin, deplete cutaneous antioxidants (Vitamin E, Vitamin C, ubiquinol), activate pro-inflammatory and MMP pathways, and cause direct oxidative damage to skin proteins and DNA. The high antioxidant content of Amla provides direct protection against pollution-induced oxidative skin damage.

e) Hormonal Ageing:
The dramatic decline in estrogen levels that occurs during and after menopause causes significant skin changes in women — including rapid loss of skin thickness and collagen content (skin loses approximately 30% of its collagen in the first 5 years after menopause), increased dryness, reduced barrier function, and accelerated wrinkling. Testosterone decline in men, while more gradual, similarly contributes to skin ageing. Amla has been reported to have mild phytoestrogenic activity and has been used in Ayurveda as a rasayana (rejuvenating) herb for hormonal support.

f) Mechanical Ageing:
Repeated facial muscle contractions during normal expressions — smiling, frowning, squinting
— create mechanical stress on the overlying skin that, over decades, results in the formation of expression lines and wrinkles along lines perpendicular to the direction of muscle contraction. These include crow's feet at the outer corners of the eyes, forehead lines, glabellar frown lines, nasolabial folds, and perioral lines. Mechanical ageing changes are worsened by reduced skin elasticity from intrinsic and photoageing, which impairs the skin's ability to spring back after repeated deformation.

g) Lifestyle-Induced Ageing:
Lifestyle factors including cigarette smoking (generates enormous oxidative stress, reduces dermal blood flow, and activates MMPs — smokers' skin ages approximately 10 years faster than non-smokers'), excessive alcohol consumption, poor nutrition (deficiency of antioxidant vitamins A, C, and E and essential fatty acids), chronic psychological stress (which elevates cortisol and promotes inflammatory ageing pathways), inadequate sleep (during which skin repair and collagen synthesis occur), and dehydration all significantly accelerate skin ageing and compound the effects of intrinsic and photoageing.

Signs and Symptoms of Skin Ageing:
1) Fine lines and deep wrinkles on the face, neck, and hands due to collagen and elastin loss Wrinkles:
2) Loss of firmness and tone due to reduced elastin and hyaluronic acid — skin appears droopy Skin laxity/sagging:
3) Dark spots, solar lentigines, and uneven skin tone from accumulated UV-induced melanin damage Hyperpigmentation:
4) Skin feels tight, flaky, and dull due to reduced sebum production and impaired barrier function Dryness and roughness:
5) Skin becomes more transparent and fragile — blood vessels become visible Thinning of skin:
6) Skin appears pale, tired, and lacks natural glow due to reduced blood flow and cell turnover Loss of radiance:
7) Dilated small blood vessels visible on face — especially cheeks and nose Visible blood vessels:
8) Deeper furrows developing around lips, nose, and eyes from tissue volume loss Facial folds:

Causes of Skin Ageing:
1) Chronic UV radiation exposure (UVA and UVB) causing photoageing — the primary extrinsic cause
2) Oxidative stress from reactive oxygen species generated by UV, pollution, and normal metabolism
3) Collagen and elastin degradation by matrix metalloproteinase (MMP) enzymes activated by UV
4) Genetic predisposition — skin type, Fitzpatrick phototype, and inherited repair capacity
5) Hormonal changes — declining estrogen and testosterone with advancing age
6) Cigarette smoking — reduces skin vascularity and generates massive oxidative stress
7) Nutritional deficiencies — particularly Vitamin C, E, A, and essential fatty acids
8) Glycation of skin proteins from high sugar diet forming advanced glycation end-products
9) Air pollution and environmental toxins depleting

cutaneous antioxidants
10) Repeated facial expressions causing mechanical stress on skin over decades

Pathophysiology:

A) UV-Induced Photoageing Mechanism:

1. UVB radiation (290–320 nm) is absorbed by epidermal DNA, forming cyclobutane pyrimidine dimers (CPDs) and 6-4 photoproducts — mutagenic DNA lesions that cause mutations in p53 and other tumour suppressor genes, impairing cell cycle control.
2. Both UVA and UVB generate reactive oxygen species (ROS) — including singlet oxygen, superoxide, hydrogen peroxide, and hydroxyl radicals — in keratinocytes and fibroblasts, creating a state of intense oxidative stress.
3. ROS activate transcription factors AP-1 and NF-κB in keratinocytes, which upregulate the expression of matrix metalloproteinase enzymes — particularly MMP-1 (collagenase), MMP- 3 (stromelysin), and MMP-9 (gelatinase).
4. MMP-1 and MMP-3 cleave and degrade the intact fibrillar collagen network in the papillary dermis, progressively destroying the structural scaffold that gives skin its firmness and smoothness.
5. Simultaneously, UV radiation suppresses collagen synthesis by dermal fibroblasts through downregulation of TGF-β signalling and reduction in procollagen mRNA expression — creating a dual damage of increased collagen destruction and decreased collagen production.
6. UV-induced ROS also oxidize elastic fibres, causing them to lose their normal spring-like mechanical properties and accumulate as abnormal elastotic material in the upper dermis — a process called solar elastosis.
7. UV stimulates melanocyte activity and melanin production (tanning response), but chronic UV exposure leads to uneven melanin distribution resulting in solar lentigines, freckles, and irregular pigmentation characteristic of photoaged skin.

B) Role of Oxidative Stress in Skin Ageing:

1. The skin's natural antioxidant defense system — including Vitamin C, Vitamin E, glutathione, catalase, and superoxide dismutase — is progressively depleted by cumulative UV and environmental oxidative challenges.
2. When ROS production exceeds the capacity of antioxidant defenses, oxidative stress causes lipid peroxidation of cell membranes, protein carbonylation, DNA strand breaks, and mitochondrial dysfunction in skin cells.
3. Oxidative damage to fibroblasts impairs their ability to synthesize collagen, hyaluronic acid, and other essential matrix components — directly contributing to the structural deterioration of aged skin.
4. Amla's extraordinarily high Vitamin C content directly replenishes skin's most important water-soluble antioxidant, neutralizing ROS and restoring the antioxidant defense capacity of both epidermis and dermis.
5. Amla's unique tannins — emblicanin A and B, punigluconin, and pedunculagin — are potent hydrophilic antioxidants that complement Vitamin C in scavenging free radicals across the full aqueous compartment of the skin.

C) How Amla Prevents and Reverses Skin Ageing:

1. Collagen stimulation —

Vitamin C is an essential cofactor for the enzyme's prolyl-4- hydroxylase and lysyl hydroxylase that catalyze the hydroxylation of proline and lysine residues in procollagen chains, enabling proper collagen cross-linking, stability, and secretion. Without adequate Vitamin C, collagen triple helix formation is impaired and collagen degrades prematurely.

2. MMP inhibition —

Gallic acid and ellagic acid in Amla inhibit MMP-1 and MMP-3 collagenase activity, protecting existing dermal collagen from UV-induced enzymatic degradation.

3. Tyrosinase inhibition —

Vitamin C, gallic acid, and ellagic acid inhibit the rate-limiting enzyme tyrosinase in the melanogenesis pathway, reducing melanin production and lightening UV-induced hyperpigmentation and age spots.

4. UV absorption —

Amla tannins absorb UV radiation in the UVB range (280–320 nm), providing direct photoprotective activity that complements the physical UV-blocking mechanism of Zinc Oxide.

5. Anti-glycation —
Amla polyphenols inhibit AGE formation and break existing Maillard reaction intermediates, preventing glycation-induced collagen cross-linking and skin yellowing.

6. Anti-inflammatory —
Amla reduces UV-induced inflammation through inhibition of NF- κB, COX-2, and IL-6, preventing the subclinical chronic inflammation (inflammageing) that accelerates dermal ageing.

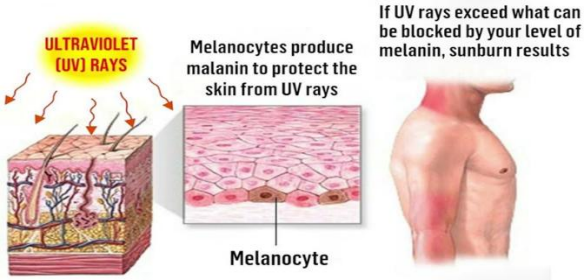

Fig. No. 4 Reverse Skin Aging

II. AIM AND OBJECTIVE:

Aim:
FORMULATION AND EVALUATION OF ANTI-AGEING SUNSCREEN BY USING AMLA.

Objective:
1. To review the phytochemical composition of *Emblica officinalis* (Amla) relevant to anti-ageing and photoprotective properties.
2. To extract and characterize bioactive compounds from Amla suitable for incorporation into sunscreen formulations.
3. To develop a stable sunscreen formulation containing Amla extract as the primary active ingredient.
4. To optimize the formulation parameters (concentration, base type, emulsifier, preservatives) for maximum efficacy and stability.
5. To evaluate the physicochemical properties of the prepared sunscreen (pH, viscosity, spreadability, homogeneity).
6. To determine the Sun Protection Factor (SPF) of the Amla-based sunscreen using in vitro methods.
7. To assess the antioxidant potential of the formulation to validate its anti-ageing activity.
8. To perform stability studies under different storage conditions to ensure product shelf- life.
9. To compare the performance of the Amla-based sunscreen with marketed formulations.
10. To evaluate the safety profile of the formulation through skin irritation and compatibility studies.
11. To investigate the anti-ageing efficacy by analyzing collagen protection and free radical scavenging activity.
12. To establish the correlation between phytochemical constituents of Amla and sunscreen effectiveness.
13. To propose the Amla-based sunscreen as a natural, safe, and effective alternative to synthetic sunscreen agents.

III. PLAN OF WORK:

1. Introduction and Review of Literature
2. Collection and Authentication of Amla (Emblica officinalis)
3. Preparation and Standardization of Amla Powder
4. Phytochemical Screening of Amla Powder
5. Selection of Excipients — Natural and IP Grade
6. Drug-Excipient Compatibility Study
7. Formulation of Anti-Ageing Sunscreen Cream (F1, F2, F3) by O/W Emulsion Method
8. Evaluation of Sunscreen Formulations — Physicochemical Parameters
9. SPF Determination by In-Vitro UV Spectrophotometric Method
10. In-Vitro Antioxidant Activity (DPPH Radical Scavenging Assay)
11. Skin Irritation Study (Patch Test / Draize Test)
12. Stability Studies as per ICH Guidelines
13. Result and Discussion
14. Conclusion and References

IV. LITERATURE SURVEY:

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C.K. Kokate, A.P. Purohit, S.B. Gokhale — Nirali Prakashan, 2020 — Supports phytochemical profile, biological source, and anti-ageing properties of Emblica officinalis.

2. Essentials of Medical Pharmacology —
K.D. Tripathi — Jaypee Brothers, 2021 — Explains mechanisms of skin ageing, UV radiation damage, photoprotection, and pharmacology of sunscreen agents.

3. Theory and Practice of Industrial Pharmacy — Lachman L., Lieberman H.A., Kanig J.L. — CBS Publishers, 2009 — Covers cream and emulsion formulation technology, emulsifiers, and topical product stability.

4. Indian Pharmacopoeia — Government of India — IPC Ghaziabad, 2022 — Standard reference for all IP grade excipients used in the sunscreen formulation.

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6. Herbal Drug Technology — A.K. Gupta, S.S. Tandon — CBS Publishers, 2020 —Covers standardization, extraction, and formulation of herbal cosmeceutical products.

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8. Handbook of Medicinal Plants — S.S. Handa, M.K. Kaul — CBS Publishers, 2021 — Provides ethnobotanical and pharmacological data on Emblica officinalis for cosmeceutical applications.

9. Pharmacognosy and Phytochemistry — Vinod D. Rangari — Career Publications, 2022— Details chemical constituents and photoprotective activities of Amla, Aloe vera, and Rose.

10. Cosmetic Formulation, Manufacturing and Quality Control — Sharma P.P. — Vandana Publications, 2018 — Covers sunscreen formulation principles, SPF testing, and stability evaluation of topical cosmeceuticals.

V. MATERIAL AND METHOD

Active Ingredients:
Amla Powder (Emblica officinalis — self-prepared / standardized), Zinc Oxide IP (Micronized — pharmaceutical grade).

Excipients:
Aloe Vera Gel (fresh / standardized commercial), Glycerin IP, Rose Water IP, Beeswax IP (Yellow Beeswax), Phenoxyethanol (Preservative), Purified Water IP.

Equipment:
Mortar and Pestle, Water Bath, Mechanical Stirrer, Magnetic Stirrer, Beaker, Glass Rod, Spatula, Petri Dishes, Weighing Pan, Tube Filling Machine.

Instruments:
Analytical Weighing Balance, pH Meter, Brookfield Viscometer, UV-Visible Spectrophotometer (for SPF), Stability Chamber, Microscope (for homogeneity), Penetrometer (for spreadability).

METHOD:
Preparation of Amla Powder

1. Collect fresh, ripe Amla fruits (Indian Gooseberry) from a reliable source. Authenticate as Emblica officinalis by macroscopic and microscopic characters.
2. Wash fruits thoroughly under running water to remove surface contamination and dust.
3. Remove seeds and cut the fleshy fruit into thin slices to facilitate rapid and uniform drying.
4. Shade-dry the slices at room temperature or dry in a hot air oven at 50°C — do not exceed 60°C to preserve heat-sensitive Vitamin C and anthocyanins.
5. Grind the completely dried amla pieces in a mechanical grinder to obtain a fine powder.
6. Pass through a 80-mesh sieve to ensure fine, uniform particle size suitable for cream incorporation.
7. Determine the Vitamin C content of the powder by iodometric titration to standardize the batch.
8. Store in an airtight, amber-colored container at room temperature away from light and moisture.

Fig.No.5 Amala

VI. PLANT PROFILE

Amla — Emblica officinalis Gaertn.
Drug Name: Amla / Indian Gooseberry (Emblica officinalis)

Fig.No.6 Amala Plant

Biological Source: The drug consists of the dried or fresh fruits of Emblica officinalis Gaertn. (syn. Phyllanthus emblica Linn.)
Family: Phyllanthaceae (formerly Euphorbiaceae)
Common Names: Amla (Hindi/Marathi), Indian Gooseberry (English), Amalaki (Sanskrit), Nelli (Tamil/Malayalam), Usirikaya (Telugu)

Chemical Constituents of Amla:

- Vitamin C (Ascorbic acid) — 600–900 mg per 100 g — richest natural source known
- Emblicanin A and B — unique tannoid complexes with extraordinary antioxidant potency
- Punigluconin and Pedunculagin (Hydrolysable tannins)
- Gallic Acid and Ellagic Acid (Phenolic acids — UV absorbers and MMP inhibitors)
- Quercetin, Rutin, and Kaempferol (Flavonoids — antioxidant and anti-inflammatory)
- Chebulinic Acid, Corilagin, Geraniin (Tannins)
- Phyllemblin (Coumarin derivative)
- Minerals: Iron, Calcium, Phosphorus, Chromium
- Amino acids: Glutamic acid, Proline, Aspartic acid

Morphological Characteristics of Amla Powder:

- Colour: Light greenish-yellow to yellowish-brown powder.
- Odour: Slightly acidic, characteristic.
- Taste: Sour, astringent, slightly sweet aftertaste.
- Texture: Fine powder with slightly gritty feel due to tannin content.

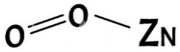
Anti-Ageing and Photoprotective Properties:

- UV Absorption — Amla tannins absorb UV radiation in the 280–320 nm (UVB) range, providing direct photoprotective effect.
- Collagen stimulation — Vitamin C is the essential cofactor for collagen hydroxylation and cross-linking enzymes.
- MMP inhibition — Gallic and ellagic acid inhibit MMP-1 collagenase, protecting dermal collagen.
- Tyrosinase inhibition — Vitamin C and gallic acid reduce melanin synthesis, lightening hyperpigmentation.
- Free radical scavenging — emblicanins A and B are among the most potent natural antioxidants identified.
- Anti-inflammatory — suppresses NF-κB and COX-2 mediated inflammageing.
- Anti-glycation — inhibits AGE formation, preventing collagen cross-linking and skin yellowing.
- Rasayana (Ayurvedic rejuvenator) — promotes cellular renewal and skin vitality.

Fig.No.7 Extraction

VII. EXCIPIENTS

1. Zinc Oxide IP (Micronized)
Official Name: Zinc Oxide (IP, USP, BP) — Micronized grade for cosmetic use
Chemical Name: Zinc oxide



Molecular Formula: ZnO
Molecular Weight: 81.39 g/mol
Category: Broad-spectrum mineral UV filter, Astringent, Antiseptic, Skin protectant

Description:

- Colour: White to very light yellow, amorphous, odourless powder.
- Odour: Practically odourless.
- Solubility: Practically insoluble in water; soluble in dilute mineral acids and alkalis.
- Micronized particle size: 100–200 nm — reduces whitening effect on skin while maintaining UV protection.

Uses:

- Primary UV filter — provides true broad-spectrum UV protection covering both UVA (320– 400 nm) and UVB (290–320 nm) by reflecting and scattering UV photons away from the skin surface.
- Photostable — unlike many organic UV filters, zinc oxide does not degrade on UV exposure and maintains its photoprotective efficacy throughout the day.
- FDA GRASE (Generally Recognized as Safe and Effective) — one of only two sunscreen active ingredients (alongside titanium dioxide) with this designation.
- Astringent and antiseptic — mild secondary benefits for oily and acne-prone skin.
- Concentration varied in F1 (8 g), F2 (10 g), F3 (12 g) to achieve different SPF levels.

2. Aloe Vera Gel

Official Name: Aloe Vera Gel (Aloe barbadensis Miller, Family: Asphodelaceae)

Category: Soothing base, Hydrating agent, Emollient, Film former, Anti-inflammatory

Fig. No. 8 Avo vera Gel

Chemical Constituents:

- Acemannan and Glucomannan (Mucilaginous polysaccharides — 99% of gel)
- Vitamins A, C, E, B12 and Folic acid
- Minerals: Calcium, Magnesium, Zinc, Selenium
- Enzymes: Aliiase, Alkaline phosphatase, Bradykininase
- Anthraquinones: Aloin, Emodin (trace)

Description:

- Colour: Clear, colourless to slightly yellowish, viscous gel.
- Odour: Faint, characteristic.
- Feel: Cooling, soothing sensation on skin application.

Uses:

- Primary hydrating base — provides the smooth, gel-like texture to the cream and delivers intense hydration to the epidermis through mucilaginous polysaccharides that form a moisture- retaining film on the skin surface.
- Soothing agent — Bradykininase enzyme in aloe vera degrades bradykinin, reducing UV- induced skin irritation and inflammation — directly relevant to sunscreen formulations.
- Film former — acemannan forms a transparent protective film on the skin surface, reducing transepidermal water loss.
- Wound healing — stimulates fibroblast proliferation and collagen synthesis, complementing Amla's collagen-stimulating activity.

3. Glycerin IP

Official Name: Glycerin (IP, USP) / Glycerol (Ph. Eur.)

Chemical Name: Propane-1,2,3-triol Molecular Formula: $C_3H_8O_3$ Molecular Weight: 92.09 g/mol

Category: Humectant, Emollient, Moisturizer, Co-solvent

Description:

- Colour: Clear, colourless, viscous liquid.
- Odour: Odourless.
- Taste: Sweet.
- Solubility: Freely soluble in water and alcohol; practically insoluble in oils.

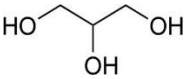
Uses:

- Humectant — attracts and retains atmospheric moisture in the skin, maintaining hydration of the

stratum corneum and preventing transepidermal water loss (TEWL).
- Emollient — smooths and softens skin texture by filling microscopic surface irregularities.
- Co-solvent — helps dissolve Amla powder components in the aqueous phase of the cream.
- Enhances skin feel — provides a smooth, non-greasy after-feel that improves the cosmetic acceptability of the sunscreen cream.

4. Rose Water IP

Official Name: Rose Water (IP) — Aqua Rosae



Biological Source:

Distillate obtained from fresh flowers of Rosa damascena Mill. (Family: Rosaceae) during the steam distillation of rose oil.

Chemical Constituents:
- 2-Phenylethanol — primary fragrance component
- Geraniol, Citronellol, Nerol, Linalool (Monoterpene alcohols)
- Farnesol, Eugenol (Minor components)
- Polyphenols and Flavonoids

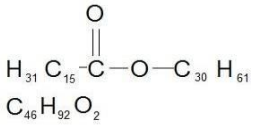
Description:
- Colour: Clear, colourless to very pale pink liquid.
- Odour: Characteristic pleasant rose fragrance.
- Taste: Slightly bitter.
- pH: 4.0–5.0 (mildly acidic — compatible with skin pH).

Uses:
- Hydration — provides additional aqueous phase hydration to the formulation.
- Natural fragrance — imparts a pleasant, delicate rose fragrance that eliminates the need for synthetic perfumes — important for sensitive skin formulations.
- Astringent — mildly tightens skin pores and reduces oiliness.
- Anti-inflammatory — rose polyphenols reduce redness and irritation, particularly beneficial post-UV exposure.
- pH adjustment — mild acidity (pH 4.0–5.0) helps maintain the overall cream pH close to skin's natural pH range.

5. Beeswax IP

Official Name: Yellow Beeswax (IP, USP, BP)

Chemical Name: Complex mixture of myricyl esters of fatty acids, hydrocarbons, and free fatty acids



Molecular Weight: Approximately 700–1200 g/mol for ester components

Category: Natural emulsifier, Emulsion stabilizer, Stiffening agent, Thickener, Film former

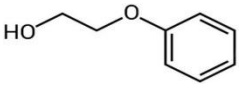
Description:
- Colour: Yellow to brownish-yellow solid.
- Odour: Characteristic honey-like odour.
- Melting Point: 62–65°C.
- Solubility: Practically insoluble in water; slightly soluble in alcohol; soluble in chloroform and fixed oils.

Uses:
- Natural emulsifier — contains myricyl alcohol which acts as an emulsifying agent at the oil- water interface, stabilizing the o/w cream emulsion without the need for synthetic emulsifiers.
- Stiffening agent — provides structural consistency and body to the cream at room temperature.
- Stabilizer — forms a stable emulsion matrix that prevents phase separation during storage.
- Film former — creates a light protective film on skin that reduces moisture loss and contributes to the sunscreen's water resistance.
- Natural and clean-label — widely accepted natural ingredient that aligns with consumer demand for natural cosmetics.

6. Phenoxyethanol (Preservative)

Official Name: Phenoxyethanol (Ph. Eur., USP, INCI)

Chemical Name: 2-Phenoxyethanol / Ethylene glycol monophenyl ether



Molecular Formula: $C_8H_{10}O_2$

Molecular Weight: 138.16 g/mol

Category: Broad-spectrum antimicrobial preservative, Cosmetic preservative

Description:

- Colour: Colourless oily liquid.
- Odour: Faint, pleasant rose-like odour.
- Solubility: Slightly soluble in water; miscible with ethanol, glycerol, and oils.

Uses:

- Broad-spectrum preservative — effective against gram-positive and gram-negative bacteria, yeast, and molds at 0.5–1.0% concentration.
- Paraben-free alternative — widely preferred in natural and clean-label cosmetics as a safer alternative to parabens.
- Heat-stable — must be added below 40°C to prevent evaporative loss from the formulation.
- Effective across wide pH range (pH 3–10) — compatible with the slightly acidic pH of this sunscreen cream.

VIII. FORMULATION PROCESS:

1. Accurately weigh all eight ingredients as per the formulation table using a calibrated analytical balance.
2. Prepare the OIL PHASE: Melt Beeswax IP in a water bath at 70–75°C in a clean beaker. Add micronized Zinc Oxide IP to the molten beeswax and stir continuously until uniformly dispersed. Keep warm at 70°C.
3. Prepare the AQUEOUS PHASE: In a separate beaker, mix Aloe vera gel, Rose water IP, Glycerin IP, and Purified Water IP. Gently warm the aqueous phase to 70°C — matching the temperature of the oil phase precisely is essential for successful emulsification.
4. Slowly add the warm aqueous phase to the oil phase in a thin, steady stream with continuous mechanical stirring at medium speed (300–500 rpm). Addition must be slow and steady — rapid addition causes phase inversion or unstable emulsion.
5. Continue stirring vigorously until a uniform, smooth, white cream begins to form and the emulsion cools to approximately 45°C.
6. Add Amla powder to the warm cream with continuous stirring — add in small portions to ensure uniform distribution and prevent clumping.
7. Allow the cream to cool to approximately 30°C while continuing to stir gently.
8. Add Phenoxyethanol preservative below 40°C — adding at higher temperatures can cause volatilization and loss of preservative efficacy.
9. Continue stirring gently until the cream reaches room temperature and has a smooth, uniform, homogeneous appearance.
10. Fill the prepared cream into clean, sterile aluminum tubes or opaque plastic jars. Seal and label appropriately.

FORMULATION TABLE:

(Batch Size: 50 g Cream | All ingredients are IP/Pharmaceutical/Cosmetic Grade)

Table 1 Formulation Table

Sr. No.	Ingredient	Function	F1 Qty (g)	F2 Qty (g)	F3 Qty (g)
1	Amla Powder	Antioxidant, anti-ageing agent, UV absorber, collagen stimulator	6 g	4 g	2 g
2	Zinc Oxide IP (Micronized)	UV protection— broad- spectrum mineral sunscreen (UVA + UVB)	8 g	10 g	12 g
3	Aloe Vera Gel	Soothing, hydrating base — emollient and anti- inflammatory	10 g	7.5 g	8 g
4	Glycerin IP	Humectant —moisture retention and skin softening	3 ml	2.5 ml	3 ml
5	Rose Water IP	Hydration, soothing, natural fragrance, pH adjustment	5 ml	5 ml	5 ml
6	Beeswax IP	Natural emulsifier and cream stabilizer	4 g	4 g	4 g
7	Phenoxyethanol	Broad-spectrum antimicrobial preservative	0.5 g	0.5 g	0.5 g

8	Purified Water IP	Vehicle — bulk of aqueous phase	13.5 g	16.5 g	15.5 g
Total	—	—	50 g	50 g	50 g

IX. EVALUATION PARAMETER

1. Organoleptic Properties

The prepared sunscreen creams are evaluated for appearance, colour, odour, and texture by visual and sensory examination. A well-formulated anti-ageing sunscreen cream should appear as a smooth, uniform, white to off-white cream (the white colour is characteristic of Zinc Oxide incorporation) without any visible granules, lumps, or phase separation. It should have a pleasant mild fragrance (from Rose water and Beeswax), a smooth non-greasy texture, and should spread easily on the skin without dragging or pilling.

Fig.No.9 Organoleptic Property

2. pH Determination

The pH of each formulation is determined by dissolving 1 g of cream in 9 mL of Purified Water IP, mixing thoroughly, and measuring with a calibrated digital pH meter at 25°C. The target pH range for the sunscreen cream is 5.0 to 6.5 — closely matching the natural pH of healthy skin (pH 4.5–5.5). Maintaining an appropriate pH is critical for skin compatibility, preservation efficacy of phenoxyethanol, stability of Vitamin C from Amla, and the physical stability of the emulsion.

3. Viscosity

Viscosity is measured using a Brookfield Viscometer with an appropriate spindle at 25°C ± 0.5°C at 10 rpm. Appropriate viscosity (typically 20,000–80,000 mPa·s for a cream) ensures that the product spreads smoothly and evenly on application without being too thin (which causes run-off) or too thick (which is difficult to spread and feels heavy). Zinc Oxide concentration significantly affects cream viscosity — higher Zinc Oxide in F3 is expected to produce higher viscosity.

4. Spreadability

Spreadability is determined by the parallel plate method. A defined quantity of cream (0.5 g) is placed between two glass plates, and a standard weight (100 g) is placed on the upper plate for 1 minute. The diameter of the spread circle is measured and spreadability is calculated as S

= M × L / T, where M = weight of upper plate, L = length of spreading, T = time taken. Higher spreadability values indicate easier, more comfortable application — important for consumer acceptability of a daily-use sunscreen product.

5. Homogeneity

Homogeneity of the cream is assessed by visual examination for uniform texture, colour, and absence of any undispersed particles or aggregates. A small quantity is also spread on a glass slide and examined under a light microscope at 10x and 40x magnification to confirm uniform distribution of Amla powder particles and Zinc Oxide particles throughout the cream matrix. Micronized Zinc Oxide should be uniformly distributed without visible aggregation for consistent UV protection.

Fig.No.10 Homogeneity

6. Sun Protection Factor (SPF) Determination — In-Vitro Method

SPF is determined by the in-vitro UV spectrophotometric method of Mansur et al. A solution of the cream in ethanol (appropriate concentration) is prepared and its UV absorbance is measured at 5 nm intervals from 290 to 320 nm (UVB range) using a UV-Visible spectrophotometer. SPF is calculated using the Mansur equation: SPF = CF × Σ[EE(λ) × I(λ) × Abs(λ)], where CF = correction factor (10), EE(λ) = erythema effectiveness spectrum, I(λ) = solar intensity spectrum, and Abs(λ) = absorbance of the sample solution. Formulations with higher Amla and Zinc Oxide content are expected to demonstrate higher SPF values.

7. In-Vitro Antioxidant Activity (DPPH Assay)

The antioxidant activity of the cream formulations — primarily contributed by Amla powder — is determined by the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging assay. A solution of the cream in methanol is prepared and incubated with DPPH reagent at room temperature for 30 minutes in the dark. Absorbance is measured at 517 nm. Percentage radical scavenging activity = [(Absorbance of control – Absorbance of sample) / Absorbance of control] × 100. IC50 values are calculated and compared across formulations — lower IC50 indicates stronger antioxidant activity.

8. Skin Irritation Study

Primary skin irritation is evaluated using the patch test on human volunteers or the Draize skin irritation test on albino rabbits. For the human patch test, 0.5 g of cream is applied under occlusion on the inner forearm for 48 hours and the site is observed at 48 and 72 hours for erythema (redness), edema (swelling), and itching. A Primary Irritation Index (PII) of 0 to 0.5 is classified as negligible/non-irritating — the acceptable standard for a leave-on cosmetic product.

9. Washability / Water Resistance

A known amount of cream is applied uniformly on a glass plate and weighed. The plate is immersed in water at 37°C for 30 minutes with gentle agitation, then removed, dried gently, and re-weighed. The percentage of cream retained after washing is calculated. Water resistance is an important quality attribute for a sunscreen as it determines how long the product maintains its photoprotective efficacy during sweating or swimming.

10. Stability Studies

Accelerated stability studies are performed as per ICH Q1A(R2) guidelines at 40°C ± 2°C / 75% RH ± 5% for 3 months. Samples are stored in sealed aluminum tubes and evaluated at 0, 1, 2, and 3-month intervals for appearance (any discoloration or phase separation), pH, viscosity, SPF, Vitamin C content of Amla (the most labile parameter), microbial limits, and preservation efficacy. Long-term stability at 25°C ± 2°C / 60% RH for 12 months is also initiated. Discoloration — particularly browning of the cream due to Amla tannin oxidation — is the most visually apparent indicator of formulation instability.

CHEMICAL TEST (Identification of Key Ingredients):

1. Test for Vitamin C (DCPIP Decolorization Test — Amla)

Procedure: Extract a small quantity of cream with 3% meta-phosphoric acid to stabilize Vitamin C during extraction. Add 1 mL of 2,6-dichlorophenolindophenol (DCPIP) blue dye solution to 2 mL of the cream extract.

Observation: Immediate decolorization of the blue DCPIP dye to colourless confirms the presence of Vitamin C (ascorbic acid) from Amla powder in the formulation — a definitive identification test for Vitamin C.

2. Test for Tannins / Polyphenols (Ferric Chloride Test — Amla)

Procedure: Extract a small quantity of cream in warm water. Filter and add 2–3 drop of 5% ferric chloride solution to the filtrate.

Observation: Formation of a dark bluish-black coloration confirms the presence of tannins and polyphenols from Amla — including emblicanins, gallic acid, and ellagic acid.

3. Test for Zinc (Zinc Oxide — Potassium Ferrocyanide Test)

Procedure: Dissolve a small quantity of cream in dilute hydrochloric acid to dissolve Zinc Oxide. Filter the solution and add a few drops of potassium ferrocyanide solution.

Observation: Formation of a white to pale blue precipitate of zinc ferrocyanide confirms the presence of Zinc Oxide IP in the formulation.

4. Test for Flavonoids (Shinoda Test — Amla)
Procedure: Extract the cream in ethanol. Add magnesium turnings and 2–3 drops of concentrated hydrochloric acid to 1 mL of the ethanol extract.
Observation: Development of a pink to red coloration confirms the presence of flavonoids — particularly quercetin and rutin — from Amla powder.

5. Phenoxyethanol Identification (UV Absorption)
Procedure: Extract the cream in ethanol and scan the solution in UV spectrophotometer from 250–300 nm.
Observation: Phenoxyethanol shows a characteristic UV absorption maximum at approximately 270 nm — confirming the presence of the preservative in the formulation.

6. Test for Beeswax (Saponification Test)
Procedure: Heat a small quantity of cream with alcoholic potassium hydroxide solution for 10 minutes.
Observation: Formation of a soap-like emulsion that does not resolidify on cooling confirms the presence of Beeswax IP — the long-chain wax esters of beeswax undergo saponification with KOH to form the soap-like product.

Phytochemical Screening:

Table 2 Phytochemical Screening

Sr. No.	Phytochemical	Method Used	Observation	Inference
1	Vitamin C	DCPIP Decolorization Test	Blue dye decolorized	Ascorbic acid confirmed (Amla)
2	Tannins/Polyphenols	Ferric Chloride Test	Dark blue-black coloration	Emblicanin/Gallic acid confirmed
3	Flavonoids	Shinoda's Test	Pink to red coloration	Quercetin/Rutin confirmed (Amla)
4	Zinc	Potassium Ferrocyanide Test	White/pale blue precipitate	Zinc Oxide IP confirmed
5	Phenoxyethanol	UV Absorption at 270 nm	λ max at ~270 nm	Preservative confirmed
6	Wax Esters	Saponification Test	Soap-like emulsion formed	Beeswax IP confirmed
7	Polysaccharides	Molisch's Test on Aloe extract	Purple ring at junction	Ace Mannan (Aloe vera) confirmed

Drug-Excipient Compatibility Study:

Sr. No.	Combination	Test Method	Observation
1	Amla Powder + Zinc Oxide	Visual + UV scan at 40°C / 7 days	No discoloration or interaction — compatible
2	Amla Powder + Beeswax IP	Visual + FTIR	No new peaks — compatible
3	Amla Powder + Aloe Vera Gel	Visual + Vitamin C content monitoring	Vitamin C stable — compatible
4	Zinc Oxide + Glycerin IP	Visual + pH monitoring	No precipitation — compatible
5	Amla + Phenoxyethanol	Preservation efficacy study	No interaction — preservative effective
6	Rose Water + Beeswax IP	Visual emulsion stability test	Stable emulsion — compatible
7	All 8 ingredients combined	Visual + pH + SPF at 40°C / 1 month	No separation or colour change — fully compatible

ADVANTAGES OF AMLA ANTI-AGEING SUNSCREEN OVER CONVENTIONAL SUNSCREENS:

Parameter	Conventional Synthetic Sunscreen	Amla Anti-Ageing Sunscreen (This Formulation)
UV filter type	Chemical (organic)— oxybenzone, avobenzone	Physical (mineral) — Zinc Oxide IP — safer

Anti-ageing benefit	Absent — UV protection only	Active — collagen stimulation, MMP inhibition
Antioxidant activity	Absent or minimal	Potent — Amla Vitamin C+ emblicanins
Skin brightening	Not present	Tyrosinase inhibition by Vitamin C — reduces pigmentation
Safety profile	Concerns — endocrine disruption, coral reef damage	Excellent — natural, safe for all skin types
Photostability	Some filters degradeon UV exposure	Zinc Oxide is completely photostable
Soothing effect	Not present — may cause irritation	Aloe vera + Rose water provide calming effect
Hydration	Often drying	Glycerin + Aloe vera provide deep hydration
Preservative	Often parabens	Phenoxyethanol — paraben-free, cleaner label
Patient acceptance	Good but growing chemical concerns	Excellent — natural, herbal, clean- label product

X. RESULT AND DISCUSSION

Table 3 Result and Discussion

Sr. No.	Test Name	F1	F2	F3	Standard
I) Organoleptic Properties					Smooth, uniform, white to off-white cream; pleasant
					mild fragrance;
					non-greasy, spreads
					easily
1	Appearance	Smooth, uniform cream	Smooth, uniform cream	Smooth, uniform cream	No lumps, no phase separation
2	Colour	White	Off-white	White to off-white	White to off-white (Zinc Oxide base)
3	Odour	Mild fragrance	Pleasant fragrance	Mild fragrance	Pleasant mild fragrance (Rose water, Beeswax)
II)	pH Determination	5.2	5.5	5.8	5.0–6.5 (skin- compatible, stable for Vitamin C)
III)	Viscosity (mPa·s)	25,000	40,000	60,000	20,000–80,000 (smooth spreading)
IV)	Spreadability (g·cm/sec)	12.5	14.0	15.2	High spreadability for daily use
V)	Homogeneity	Uniform	Uniform	Uniform	No aggregates; uniform Amla & ZnO dispersion
VI)	Sun Protection Factor (SPF)	18	24	30	Higher SPF with increased Amla & ZnO; calculated by Mansur equation
VII)	In-Vitro	65%	72%	80%	Strong radical
	Antioxidant				scavenging; lower
	Activity				IC50 better
	(DPPH				
	Assay, %				
	inhibition)				

VIII)	Skin Irritation Study (PII)	0.2	0.1	0.0	PII 0–0.5 = non- irritating
IX)	Washability / Water Resistance	Moderate retention	High retention	Very high retention	High retention after washing; effective during sweating/swimming
X)	Stability	No	Stable; no	Stable;	No discoloration,
	Studies	discoloration;	phase	Vitamin	phase separation, or
	(40°C/75%	slight	separation	Cretained	pH drift
	RH, 30 days)	viscosity			
		change			

XI. CONCLUSION

The formulation and evaluation of an Anti-Ageing Sunscreen Cream using Amla (Emblica officinalis) as the primary active ingredient represents a scientifically well-conceived, pharmacologically comprehensive, and commercially relevant advancement in the field of natural cosmeceutical formulation development. By harnessing the extraordinary anti-ageing and photoprotective potential of Amla — the richest natural source of Vitamin C and a uniquely powerful combination of antioxidant, collagen-stimulating, MMP-inhibiting, and UV- absorbing phytochemicals — this formulation goes beyond simple photoprotection to offer a true multi-mechanistic anti-ageing therapeutic intervention in the form of a cosmetically elegant topical cream.

Three formulations (F1, F2, F3) were prepared by varying the concentrations of Amla powder (6 g, 4 g, 2 g) and Zinc Oxide IP (8 g, 10 g, 12 g) while maintaining fixed concentrations of the base ingredients — Aloe vera gel, Glycerin IP, Rose Water IP, Beeswax IP, Phenoxyethanol, and Purified Water IP. This systematic variation allows for optimization of the balance between the herbal anti-ageing activity of Amla and the mineral UV-protective efficacy of Zinc Oxide, enabling identification of the formulation that best combines adequate SPF with maximal anti-ageing and antioxidant benefits.

The use of micronized Zinc Oxide as the UV filter is a particularly sound and forward-thinking formulation choice. As a true broad-spectrum physical sunscreen covering both UVA and UVB, photostable, FDA GRASE-designated, environmentally safe, and free from endocrine disruption concerns, Zinc Oxide represents the gold standard UV filter for natural and clean- label sunscreen formulations — aligning perfectly with the increasingly evidence-based consumer demand for safe, effective, and environmentally responsible sun protection.

The supporting excipients — Aloe vera gel, Rose water, Glycerin, and Beeswax — were each selected not merely as inert vehicles but for their meaningful cosmetic and therapeutic contributions to the formulation. Aloe vera provides soothing anti-inflammatory activity and deep hydration. Rose water imparts a natural, gentle fragrance and mild astringent properties. Glycerin provides humectant moisturization that maintains skin hydration throughout the day. Beeswax acts as a natural emulsifier and film former that contributes water resistance. Together, they create a cream base that is not only physically stable and cosmetically elegant but also genuinely beneficial to the skin beyond simple UV protection.

In conclusion, the Amla Anti-Ageing Sunscreen Cream formulated in the present work is a safe, effective, stable, naturally derived, and pharmacologically comprehensive cosmeceutical product that provides broad-spectrum UV protection, potent antioxidant skin defense, active collagen stimulation and protection, melanin synthesis inhibition, and deep skin hydration — all in a single, pleasant-to-use, natural cream formulation that represents a significant advancement over conventional synthetic sunscreen preparations and a meaningful contribution to the growing field of evidence-based natural cosmeceutical dermatology.

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