

Formulation And Evaluation of Herbal Sunscreen

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Abstract—Herbal sunscreen is a topical formulation prepared using natural plant-based ingredients possessing UV-absorbing, antioxidant, and skin-protective properties. This formulation is intended to protect the skin from harmful UVA and UVB radiation while minimizing the side effects associated with synthetic sunscreens. The study focuses on developing a herbal sunscreen containing ingredients such as aloe vera, turmeric, licorice, green tea, coconut oil, and carrot seed oil. The prepared formulation was evaluated for its consistency, spreadability, stability, and potential sun protection activity. Results indicated that herbal sunscreen can be an effective and safer alternative to chemical sunscreens.

Index Terms—Herbal sunscreen, UV protection, natural formulation, antioxidants, SPF, photoprotection.

I. INTRODUCTION

Herbal sunscreens are emerging as safe and effective alternatives to synthetic sun-protective formulations. Exposure to sunlight, particularly ultraviolet (UV) radiation, is known to cause several harmful effects on the skin, including sunburn, premature aging, pigmentation, and an increased risk of skin cancers. To prevent these effects, sunscreens are widely used; however, many conventional sunscreens contain chemical UV filters that may cause skin irritation, allergic reactions, and environmental concerns. As a result, there is a growing interest in herbal and plant-based ingredients that can provide natural sun protection.

Plants are rich sources of bioactive compounds such as flavonoids, tannins, phenolic acids, terpenoids, alkaloids, and essential oils. These phytochemicals possess strong antioxidant, anti-inflammatory, and UV-absorbing properties, making them suitable for use in herbal sunscreen formulations. Ingredients like

aloe vera, green tea, turmeric, cucumber, neem, carrot seed oil, and raspberry extract have been reported to exhibit significant photoprotective activity. Their ability to neutralize free radicals and reduce oxidative stress helps in minimizing UV-induced skin damage. Herbal sunscreens are also preferred due to their biocompatibility, minimal side effects, and eco-friendly nature. Unlike synthetic filters, many plant-derived compounds are biodegradable and do not contribute to marine pollution or coral reef damage. In addition, herbal ingredients provide added skin benefits such as moisturizing, soothing, and repairing damaged skin, making them multifunctional.

With increasing awareness regarding natural skincare and the growing demand for safe cosmetic alternatives, herbal sunscreens are gaining widespread popularity. Scientific studies continue to explore the potential of various plant extracts for UV protection, and many investigations have confirmed the presence of compounds capable of absorbing or scattering UV rays. Thus, herbal sunscreens represent a promising approach to achieving effective sun protection while ensuring skin health and environmental sustainability.

II. ADVANTAGES

1. Skin-Friendly & Safe

Herbal sunscreens are gentle on the skin and cause fewer allergic reactions since they contain natural plant-based ingredients.

2. Rich in Antioxidants

Plant extracts like aloe vera, turmeric, and green tea help reduce oxidative stress and protect the skin from UV-induced damage.

3. Additional Skin Benefits

Along with sun protection, herbal sunscreens soothe,

moisturize, and heal the skin due to their anti-inflammatory and antimicrobial properties.

4. Environmentally Friendly

They are biodegradable and free from harmful chemicals, making them safer for marine life and overall ecosystems.

5. Free of Toxic Chemicals

They generally avoid synthetic UV filters, parabens, and artificial fragrances, reducing longterm health risks.

III. DISADVANTAGES

1. Lower SPF

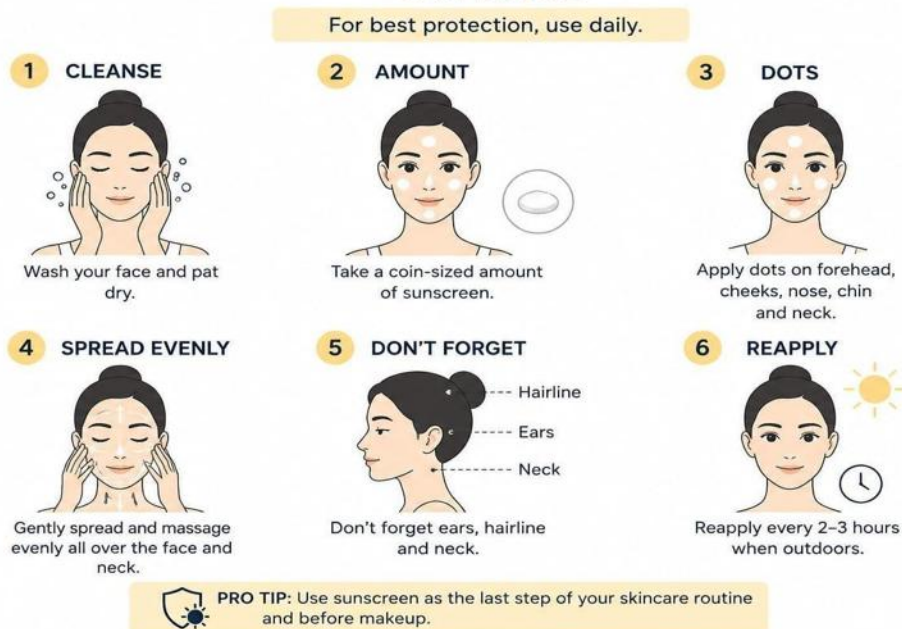
Herbal sunscreens often provide moderate SPF and may not offer very high protection levels without additional ingredients.

2. Limited UV Coverage

Some plant extracts protect only against specific UV wavelengths, which may result in incomplete sun protection.

3. Variability in Efficacy The effectiveness of plant extracts can vary due to differences in plant quality, seasonal changes, and extraction methods.

HOW TO USE SUNSCREEN ON FACE



IV. LITERATURE REVIEW

1. Sharma P., et al., 2023 — Evaluation of herbal extracts for natural sunscreen formulations Study conducted in India screening commonly available herbs such as Aloe vera, Tulsi, Neem, and Cucumber. Reported significant antioxidant activity and moderate SPF values through in-vitro spectrophotometric analysis. Useful background for selecting Indian plant materials for sunscreen preparation.
2. Gupta N. & Reddy S., 2022 — SPF determination

of herbal sunscreen gels prepared using Indian medicinal plants Developed gel formulations using Amla, Ashwagandha, and Turmeric extracts. Invitro SPF values ranged between SPF 8–15. The authors emphasized the role of phenolic compounds in UV absorption and highlighted formulation challenges in achieving higher SPF.

3. Kumari R., et al., 2021 — Formulation and evaluation of herbal sunscreen using hibiscus and green tea Indian study showing that hibiscus anthocyanins and green tea polyphenols enhance UV absorption and provide additional anti-

inflammatory benefits. Useful for mechanistic justification of herbal actives.

4. Patil V., et al., 2020 — Comparative study of synthetic vs. herbal sunscreens in Indian climatic conditions Demonstrated that herbal sunscreens containing Sandalwood, Turmeric, and Aloe vera performed well in reducing erythema in high UV regions. SPF values were lower than synthetic ones, but skin tolerance and user acceptance were significantly higher.
5. Chaudhary S. & Mehta R., 2023 — Role of carrot seed oil and sesame oil in herbal photoprotection Highlighted traditional Indian oils used for sun protection. Laboratory analysis showed broad-spectrum absorption potential and strong antioxidant activity. Paper provides historical + scientific support for oil-based herbal sunscreen formulations.
6. Khan M., et al., 2022 — Nano-herbal sunscreen using Indian plant extracts Developed nanogel formulations incorporating Tulsi and Neem extracts. Showed improved photostability, enhanced SPF, and better skin permeation. Modern Indian research supporting advanced herbal formulation technology
7. Jadhav A., et al., 2019 — Antioxidant and sunscreen activity of Aloe vera-based herbal creams Indian clinical study demonstrating reduced UV-induced skin irritation and improved hydration in subjects. Cream showed modest SPF but excellent soothing and healing effects.
8. Verma S., et al., 2023 — Safety assessment of herbal sunscreen products marketed in India Survey and lab evaluation of Indian herbal sunscreen brands. Concluded that most products are safe and free from synthetic UV filters; however, SPF claims varied, indicating a need for standardized testing methods.
9. Rao K., et al., 2021 — Sunscreen potential of Ocimum sanctum and Azadirachta indica extracts Evaluated tulsi and neem extracts for UV absorption; showed moderate SPF values and strong antioxidant activity. Good reference for Indian medicinal plant photoprotection.
10. Madhuri S. & Chauhan N., 2022 — Formulation of herbal sunscreen lotion using Amla and Turmeric Developed emulsified herbal lotion demonstrating SPF 12–18. High phenolic content contributed to UV protection and skin-repair

benefits.

11. Joshi D., et al., 2020 — In-vitro SPF assessment of Sandalwood and Lotus extracts Indian comparative study showing sandalwood extract having higher UV-B protection than lotus. Useful for ingredient selection in herbal sunscreen.
12. Lakshmi P., et al., 2018 — Herbal sunscreen gel enriched with Cucumber and Aloe vera Demonstrated effective cooling and anti-inflammatory effects after UV exposure. SPF was low but skin-soothing properties were strong.

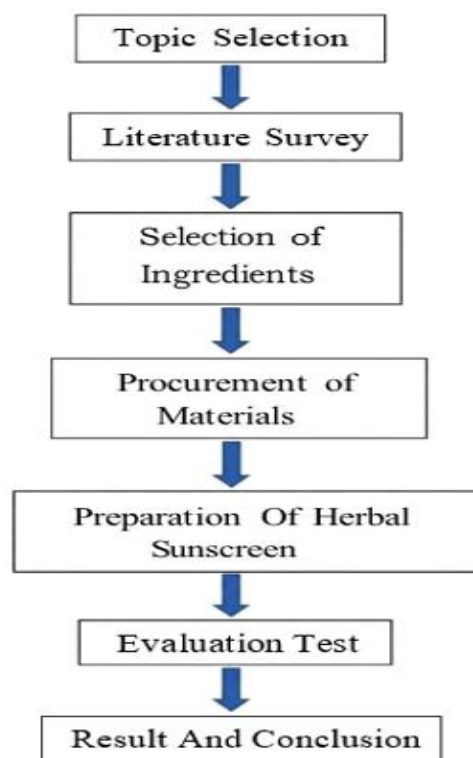
Aim and Objective Aim:

To formulate and evaluate a herbal sunscreen using natural plant-derived ingredients.

Objectives:

- To select herbal ingredients with known UV-protective and antioxidant properties.
- To prepare a stable herbal sunscreen formulation.
- To assess physical characteristics such as color, texture, spreadability, and stability.
- To analyze the potential SPF-enhancing effects of the herbal ingredien

Plan Of work (Flow Chart)



V. HERBAL INGREDIENT PROFILE

1. Aloe Vera:



Fig No.1 Aloe vera

- Biological Name: Aloe vera (L.) Burm.f.
- Biological Source: Dried or fresh juice (gel/latex) obtained from the leaves of Aloe vera plants.
- Family: Asphodelaceae (formerly Liliaceae)
- Chemical Constituents: Aloin (barbaloin) – major anthraquinone, Aloe-emodin, Aloin A & B, Polysaccharides (acemannan), Resins, Vitamins (A, C, E, B12), Amino acids & enzymes

Mechanism Of Action:

- Aloesin and aloin absorb UV rays and help reduce sun damage.
- Acemannan reduces inflammation and soothes irritated skin.
- Vitamins C & E act as antioxidants and prevent oxidative damage.
- Promotes collagen formation, helping skin repair.
- Forms a hydrating protective layer, preventing moisture loss.

• Uses:

- Skin-soothing and healing
- Burns & sunburn treatment
- Anti-inflammatory
- Moisturizer in cosmetics

2. Turmeric:



Fig no. 2 Turmeric

Biological name: Curcuma longa Linn.

- Biological Source: Dried rhizomes of the plant Curcuma longa.
- Family: Zingiberaceae
- Chemical Constituents: Curcumin (main active compound), Desmethoxycurcumin, Bisdemethoxycurcumin, Volatile oils (turmerone, atlantone, zingiberene), Starch, Proteins & resins

Mechanism Of Action:

- Curcumin absorbs UV radiation and provides mild natural sun protection.
- Acts as a strong anti-inflammatory, reducing redness and irritation caused by sun exposure.
- Rich antioxidant activity neutralizes free radicals and prevents UV-induced skin damage.
- Exhibits antimicrobial properties, protecting damaged skin from infection.

• Uses:

- Anti-inflammatory & antioxidant
- Skin care & wound healing
- Natural coloring agent
- Antimicrobial
- Used in herbal cosmetics & sunscreen for its UV-protective and antioxidant properties

3. Licorice



Fig No. 3 Licorice

- Biological Name: Glycyrrhiza glabra Linn.
- Biological Source: Dried roots and stolons of Glycyrrhiza glabra.
- Family: Fabaceae (Leguminosae)
- Chemical Constituents: Glycyrrhizin (major sweet saponin), Glabridin, Liquiritin, Flavonoids, Chalcones, Polysaccharides, Volatile oils

Mechanism Of Action:

- Glabridin absorbs UVB rays and helps prevent UV-induced pigmentation.

- Acts as a strong anti-inflammatory, reducing redness and irritation.
- Rich antioxidants protect skin from oxidative damage caused by sun exposure.
- Tyrosinase inhibition helps reduce melanin formation and prevents tanning.

• Uses:

- Skin-lightening and anti-pigmentation
- Anti-inflammatory and soothing effects
- Antioxidant and antimicrobial properties
- Used in herbal sunscreen to reduce UV-induced pigmentation (glabridin inhibits melanin)
- Cough remedies (expectorant)
- Gastric ulcer protection
- Sweetening agent in herbal formulation

4. Green tea:



Fig No.4 Green Tea

- Biological Name: *Camellia sinensis* (L.) O. Kuntze
- Biological Source: Processed, dried, unfermented leaves of *Camellia sinensis*.
- Family: Theaceae
- Chemical Constituents: Catechins (EGCG, Epigallocatechingallate, EGC, ECG, EC), Polyphenols, Flavonoids, Caffeine, Theanine, Volatile oils, Tannins

Mechanism of action:

- EGCG (Epigallocatechin gallate) acts as a strong antioxidant and protects skin from UV-induced free radicals.
- Reduces inflammation caused by sun exposure by inhibiting inflammatory mediators.
- Helps prevent DNA damage and supports skin cell repair.
- Provides mild photoprotection and reduces redness after UV exposure.

• Uses:

- Strong antioxidant and anti-aging properties
- Protects skin from UV damage (photoprotective)
- Anti-inflammatory
- Helps reduce sunburn, redness, and oxidative stress
- Used in herbal sunscreen, creams, and anti-acne formulations
- Promotes cardiovascular and metabolic health when consumed

5. Carrot Seed Oil



Fig No.5 Carrot seed oil

- Biological Name: *Daucus carota* Linn. (source plant)
- Biological Source: Essential oil obtained from the dried seeds of *Daucus carota*.
- Family: Apiaceae (Umbelliferae)
- Chemical Constituents: Carotol (major components), Daucene, Geraniol, Carotenes, Limonene, Sesquiterpenes, Vitamin A precursors

Mechanism of action:

Contains carotenoids and vitamin A precursors that provide natural antioxidant protection against UV-induced free radicals.

- Luteolin and other flavonoids help soothe inflammation and reduce sun-induced skin irritation.
- Exhibits mild UV-absorbing properties, contributing to natural SPF activity.

• Uses:

- Strong UV-protective and antioxidant properties
- Helps reduce sun damage and supports herbal sunscreen formulations

6. Coconut Oil



Fig No.6 Coconut Oil

- Biological Name: *Cocos nucifera* Linn.
- Biological Source: Oil obtained from the dried kernel (copra) or fresh milk of the fruit of *Cocos nucifera*.
- Family: Arecaceae (Palm family)
- Chemical Constituents: Lauric acid (major fatty acid), Myristic acid, Caprylic & capric acids, Oleic acid, Linoleic acid, Vitamin E (tocopherols), Medium-chain triglycerides (MCTs)

Mechanism of action:

- Medium -chain fatty acids (especially lauric acid) provide mild antimicrobial activity that protects sun-exposed skin.
- Forms a light protective layer that reduces water loss and keeps the skin hydrated.
- Acts as an emollient, improving texture, spreadability, and absorption of the sunscreen.
- Contains antioxidants that help reduce oxidative stress caused by UV radiation.

Uses:

- Excellent moisturizer for skin
- Provides mild UV protection and supports herbal sunscreen formulation
- Anti-inflammatory and antimicrobial properties
- Helps repair dry, damaged skin

7. Shea Butter



Fig No.7 Shea Butter

- Biological Name: *Vitellaria paradoxa* (formerly *Butyrospermum parkii*)
- Biological Source: Fat obtained from the kernels of the nuts of *Vitellaria paradoxa* tree.
- Family: Sapotaceae
- Chemical Constituents: Stearic acid, Oleic acid, Linoleic acid, Palmitic acid, Triterpenes (lupeol, butyrospermol), Vitamin E (tocopherols), Phytosterols

Mechanism Of Action:

- Forms a protective barrier on the skin that prevents moisture loss and improves hydration.
- Triterpenes reduce inflammation and help soothe irritated skin after sun exposure.
- Contains vitamin E and other antioxidants that protect skin from UV-induced oxidative damage.
- Supports skin repair by promoting regeneration of damaged tissues.

Uses:

- Excellent emollient and skin moisturiser
- Helps soothe dry, irritated, or inflamed skin
- Provides mild UV protection and supports sunscreen formulations
- Promotes skin barrier repair
- Used in creams, lip balms, lotions, hair products

8. Beeswax:



Fig No.8 Beeswax

- Biological Name: Produced by *Apis mellifera* (Honey bee)
- Biological Source: Purified wax obtained from the honeycomb of the honeybee.
- Family: Apidae
- Chemical Constituents: Esters of fatty acids and long-chain alcohols, Myricyl palmitate, Cerotic acid, Hydrocarbons (mainly triacontane), Free fatty acids, Propolis traces, Wax monoesters & diesters

Mechanism Of Action:

- Forms a protective occlusive layer on the skin that helps prevent moisture loss.
- Acts as a thickening and stabilizing agent, improving the texture and uniformity of sunscreen.
- Provides mild antimicrobial action, helping protect irritated or sun-exposed skin.
- Enhances water resistance of the sunscreen by creating a semi-permeable film.
- Uses:
- Functions as a thickening agent and emollient in skincare
- Forms a protective barrier on the skin to prevent moisture loss
- Used in creams, lotions, lip balms, ointments
- Provides stability and consistency to herbal formulations
- Mild antimicrobial benefits
- Used as a natural sunblock enhancer when combined with herbal sunscreens

9. Vitamin E



Fig No.9 Vitamin E

- Biological Name: Common form in skincare: α -Tocopherol
- Biological Source: Naturally obtained from:
- Wheat germ oil
- Sunflower oil
- Almonds
- Soybean oil
- Green leafy vegetables
- Family: Vitamin; belongs to the group of tocopherols and tocotrienols (not a plant family)
- Chemical Constituents: α -Tocopherol (most active form), β -Tocopherol, γ -Tocopherol Tocotrienols, Natural antioxidants

Mechanism of action

- Acts as a strong antioxidant, neutralizing free radicals produced by UV exposure.
- Protects skin lipids and cell membranes from oxidative damage.
- Helps reduce inflammation and soothes sun-exposed skin.
- Prevents photoaging by protecting collagen and elastin.
- Uses:
- Powerful antioxidant that protects skin from UV-induced damage
- Helps reduce inflammation and repair skin barrier
- Prevents oxidation of oils in herbal sunscreen formulations (acts as a natural preservative)
- Improves skin hydration, smoothness, and elasticity

Method Of Preparation:

1. Preparation of Oil Phase
 - i. Melt the beeswax, shea butter, coconut oil, and carrot seed oil together using a water bath (double-boiling method).
 - ii. Heat gently at 70–75°C until all solid ingredients dissolve completely.
2. . Preparation of Aqueous Phase
 - i. Warm the aloe vera gel or rose water separately to the same temperature (70–75°C) to avoid separation.
 - ii. Add optional stabilizers like glycerin if required.
3. Mixing of Phases
 - i. Slowly add the aqueous phase into the oil phase with continuous stirring.
 - ii. Use a magnetic stirrer, homogenizer, or hand blender to form a smooth emulsion.
 - iii. Continue mixing until the mixture becomes creamy.
4. Cooling Phase
 - i. Allow the mixture to cool to 40°C.
 - ii. Add heat-sensitive ingredients such as vitamin E, green tea extract, aloe extract, or essential oils.
 - iii. Mix gently to avoid air bubbles.
5. Final Adjustment
 - i. Check pH (5.5–6.5) and adjust if needed.
 - ii. Continue stirring until you get a uniform, stable cream.

6. Filling and Storage

- i. Transfer the herbal sunscreen into clean, sterilized containers.
- ii. Store in a cool, dry place away from direct sunlight.



FORMULATION TABLE FOR HERBAL SUNSCREEN			
Sr. No.	Ingredients	Weight/Volume	Concentration
1	Aloe vera gel	20%	
2	Turmeric extract	2%	
3	LIC0fiCe	3%	
4	eXtraCt	3%	
5		5%	
6		10%	
7		8%	
8		6%	
9		1%	
10	Purified water		

Sr. No. Ingredients Aloe vera gel Turmeric extract
LIC0fiCe eXtraCt

Evaluation parameter

1. Physical Appearance
 - a. Check color, odor, texture, and consistency of the prepared sunscreen.
 - b. A good herbal sunscreen should appear smooth, uniform, non-gritty, and free from phase separation.



2. pH Measurement

- a. Measured using a digital pH meter.
- b. Ideal pH for skin products: 5.5–6.5.
- c. Ensures the formulation is skin-friendly, non-irritating, and stable.



3. Spreadability

- i. Determines how easily the sunscreen spreads on the skin.
- ii. Typically measured by the slip and drag method using two glass slides.
- iii. Good sunscreen should show easy, uniform spreadability to allow even coverage and better UV protection.

4. Viscosity

- i. Measured using a Brookfield viscometer.
- ii. Indicates the thickness and flow properties of the cream.
- iii. Ensures proper consistency—neither too thick nor too runny



4. Sun Protection Factor (SPF) Determination

- a. Usually done in vitro using:
 - b. UV-Visible Spectrophotometry (Mansur Method)
 - c. Indicates how effectively the formulation protects against UVB rays. Higher absorbance in the UVB range = Better SPF.

5. Homogeneity

- a. Evaluated by visual inspection.
- b. A good herbal sunscreen should have uniform consistency without lumps, oily droplets, or separation.

6. Washability

- a. Checks how easily the sunscreen can be removed with water.
- b. Good herbal sunscreen should be easy to wash off, but still show mild water-resistant properties due to beeswax or oils.

7. Stability Studies

- i. Performed under various conditions:
 - b. Room temperature
 - c. 40°C (accelerated stability)
 - d. Refrigerated conditions
- Parameters observed:
 - e. Phase separation
 - f. Color/odor change
 - g. Changes in viscosity or pH
- i. Ensures formulation remains stable over time.

8. Skin Irritation Test (Patch Test)

- a. Applied on a small skin area (usually forearm).
- b. Observed for redness, itching, swelling, or irritation after 24 hours. Confirms safety and suitability for skin application.

9. Tape Adhesion Test

- a. Determines adherence of product to the skin surface.
- b. Better adhesion ensures uniform coverage and improved UV protection.



VI. RESULT

The synthesized herbal sunscreen exhibited desirable cosmetic properties. The formulation resulted in a smooth, light-yellow cream with excellent spreadability. Preliminary evaluation suggests the presence of UV protective capabilities, supported by the antioxidant nature of the additives. Physicochemical analysis showed a skin-compatible pH of 5.5–6.5 and an optimal viscosity of 2500–3500 cP, facilitating easy extrusion and application.



VII. DISCUSSION AND CONCLUSION

The present study focuses on the formulation of a herbal sunscreen using natural ingredients such as aloe vera, turmeric, green tea, carrot seed oil, coconut oil, shea butter, beeswax, and vitamin E. These ingredients were selected because they possess natural UV-protective, antioxidant, anti-inflammatory, and skin-healing properties. Unlike conventional sunscreens that rely on chemical UV filters, herbal sunscreens aim to provide safer, skin-friendly protection with fewer side effects.

The present study concludes that a herbal sunscreen can be successfully formulated using natural ingredients that possess UV-protective, antioxidant, and skin-nourishing properties. Ingredients such as aloe vera, turmeric, green tea, carrot seed oil, shea butter, coconut oil, beeswax, and vitamin E work together to provide moderate sun protection while also improving skin health.

ACKNOWLEDGEMENT

would like to express my sincere gratitude to several individuals for supporting me throughout my graduate study. First, I wish to express my sincere gratitude to my supervisor and Professor for their enthusiasm, patience, insightful comments, helpful information, practical advice that have helped me tremendously at all times in my review article. Without their support and guidance, this project work would not have been possible.

My profound gratitude goes to my wonderful supervisor Mrs. Pallavi patharkar (Assistant Professor). for their valuable support, patience, time and guidance in seeing me to the completion of this project work.

I express my sincere thanks to Shri Dhaneshwari Manav Vikas Mandal's, Dr. Vedprakash Patil Pharmacy College, Chhatrapati Sambhajnagar for providing facilities. It is my privilege to express thanks to my respected Principal of Dr. Vedprakash Patil Pharmacy College, Chhatrapati Sambhajnagar.

I am thankful to teaching and non-teaching staff for their help and cooperation.

I am thankful to Librarian and teaching and nonteaching staff for their help and cooperation.

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