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EMERGING ROLE OF ARGEMONE MEXICANA IN DERMATOLOGICAL DISORDERS: PHYTOCHEMICAL AND PHARMACOGNOSTIC INSIGHTS

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ABSTRACT

Argemone mexicana L. (Papaveraceae), commonly known as Satyanashi, is a medicinal plant widely distributed in tropical and subtropical regions. The plant has been extensively utilized in traditional medicine for the management of various skin-related disorders, including wounds, eczema, scabies, ringworm, itching, and other infectious conditions. The therapeutic potential of *A. mexicana* is attributed to the presence of diverse bioactive constituents such as alkaloids, flavonoids, phenolic compounds, tannins, and terpenoids. Important phytochemicals including sanguinarine, berberine, chelerythrine, and protopine have been reported to exhibit significant antimicrobial, anti-inflammatory, antioxidant, and wound-healing properties. The present review highlights the pharmacognostical characteristics, phytochemical composition, and dermatological applications of *A. mexicana*. Various experimental studies have demonstrated that different extracts of the plant possess notable antibacterial and antifungal activities against several pathogenic microorganisms associated with skin infections. Additionally, the plant has shown potential in reducing inflammation and oxidative stress, which are key factors involved in chronic dermatological conditions such as psoriasis and dermatitis. Pharmacognostical evaluation, including macroscopic and microscopic examination, contributes to the authentication, identification, and standardization of the crude drug, ensuring its quality and purity. Growing interest in herbal therapeutics has encouraged the development of plant-based topical formulations. In this context, *A. mexicana*

represents a promising candidate for incorporation into dermatological preparations such as creams, gels, ointments, and novel nanoformulations. Overall, the available evidence suggests that *Argemone mexicana* possesses considerable potential in dermatological therapy. However, further pharmacological, toxicological, and clinical investigations are required to establish its safety, efficacy, and therapeutic applications in modern medicine.

KEYWORDS: *Argemone mexicana*, Dermatological disorders, Pharmacognosy, Phytochemicals, Antimicrobial activity, Wound healing, Anti-inflammatory activity, Herbal medicine.

INTRODUCTION

Skin is the largest organ of the human body and acts as the first line of defense against physical, chemical, microbial, and environmental challenges. It plays essential roles in thermoregulation, immune protection, sensory perception, and maintenance of body fluid balance. Dermatological disorders such as eczema, psoriasis, acne, fungal infections, wounds, burns, and dermatitis affect millions of people worldwide and often reduce the quality of life. Although conventional therapies are available, their long-term use may be associated with adverse effects, high costs, and drug resistance. Therefore, interest in plant-based therapeutics has increased considerably in recent years.[1]

Medicinal plants are rich sources of bioactive compounds with antimicrobial, antioxidant, anti-inflammatory, and wound-healing properties. Among them, *Argemone mexicana* L. (Mexican poppy), a member of the Papaveraceae family, has gained attention for its traditional use in the treatment of skin diseases and wounds. Different parts of the plant, including leaves, roots, seeds, flowers, and latex, have been used in folk medicine for managing skin infections, itching, eczema, ulcers, and wound healing.[2]

The therapeutic potential of *A. mexicana* is mainly attributed to its diverse phytochemical constituents, including alkaloids, flavonoids, phenolics, tannins, and terpenoids. Bioactive alkaloids such as berberine, sanguinarine, and chelerythrine have demonstrated antimicrobial, antioxidant, and anti-inflammatory activities that are highly relevant to dermatological applications. This review highlights the pharmacognostic characteristics, phytochemical profile, traditional uses, and dermatological potential of *A. mexicana*, with emphasis on its role in wound healing, skin infections, and inflammatory skin disorders.[3]

TAXONOMY AND BOTANICAL DESCRIPTION

Argemone mexicana L. is an important medicinal herb belonging to the family Papaveraceae. The plant is commonly known as Mexican poppy and is widely distributed throughout tropical and subtropical regions of the world. Although considered a troublesome weed in agricultural fields, *A. mexicana* has gained considerable attention due to its medicinal value and extensive use in traditional systems of medicine. Various parts of the plant including leaves, roots, seeds, flowers and latex have been employed for the management of skin diseases, wounds, inflammation, microbial infections and several systemic disorders. The widespread occurrence and adaptability of the plant have contributed to its extensive utilization in ethnomedicine across Asia, Africa and Latin America.[4]

The plant is believed to be native to Mexico and Central America but has become naturalized in many countries including India. In India, *Argemone mexicana* grows abundantly along roadsides, wastelands, railway tracks, open fields and disturbed habitats. The plant exhibits remarkable tolerance to drought and adverse environmental conditions, which explains its successful establishment in diverse geographical regions.[5]

Figure: *Argemone Maxicana.*

Taxonomical Classification

Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Magnoliophyta
Class	Magnoliopsida
Order	Ranunculales
Family	Papaveraceae
Genus	Argemone
Species	*Argemone mexicana* L.

The genus *Argemone* comprises several species distributed worldwide; however, *A. mexicana* is the most extensively investigated species owing to its medicinal significance and rich phytochemical profile.[6]

Ethnobotanical Importance

The botanical characteristics of *Argemone mexicana* have facilitated its widespread use in traditional medicine. Various indigenous communities have employed different plant parts for the treatment of skin infections, eczema, itching, wounds, ulcers, malaria, jaundice and inflammatory disorders. The easy availability of the plant, coupled with its diverse therapeutic applications, has contributed to its continued importance in herbal medicine.[7]

The unique morphological features such as yellow latex, prickly stem, spiny leaves and bright yellow flowers provide reliable identification markers for the species. These taxonomic and botanical characteristics form the foundation for further pharmacognostic and phytochemical investigations aimed at exploring its dermatological potential.[8]

PHARMACOGNOSTIC CHARACTERISTICS OF ARGEMONE MEXICANA

Pharmacognostic evaluation is essential for the identification, authentication, and quality assessment of medicinal plants. It helps distinguish genuine plant material from adulterants and ensures the consistency of herbal formulations. *Argemone mexicana* L., belonging to the family Papaveraceae, possesses several distinctive pharmacognostic features that aid in its accurate identification.[9]

Macroscopically, the plant is an erect, prickly annual herb that grows up to 120 cm in height. A characteristic yellow latex exudes from injured plant parts, serving as an important diagnostic marker. The leaves are sessile, bluish-green, deeply lobed, and marked with prominent white veins and sharp marginal spines. Bright yellow flowers and prickly capsules containing dark brown to black seeds further facilitate identification.[10]

Microscopic examination of the leaf reveals a dorsiventral structure with distinct upper and lower epidermis. Anisocytic stomata are predominantly present on the lower surface, while laticiferous tissues containing yellow latex are distributed throughout the mesophyll region. Calcium oxalate crystals and well-developed vascular bundles are also observed. The stem shows a typical dicotyledonous arrangement with epidermis, cortex, vascular bundles, and a large parenchymatous pith.[11]

Powder microscopy of the dried plant material exhibits diagnostic features such as epidermal fragments, anisocytic stomata, spiral and reticulate vessels, fibers, laticifer fragments, pollen grains, and calcium oxalate crystals. Collectively, these macroscopic and microscopic characteristics provide reliable criteria for authentication and standardization of *A. mexicana*, supporting its quality control and future dermatological applications.[12]

PHYTOCHEMICAL PROFILE OF ARGEMONE MEXICANA

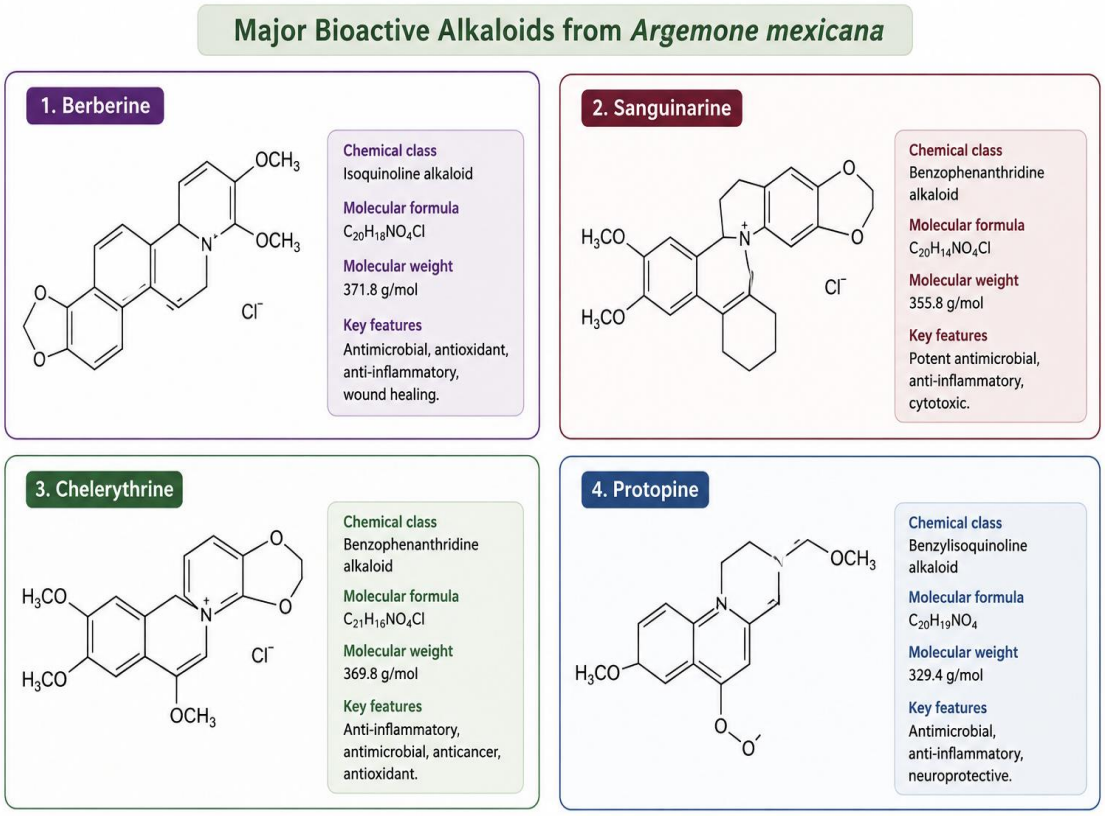

Figure 3. Major bioactive alkaloids reported from *Argemone mexicana.*

The therapeutic potential of *Argemone mexicana* is primarily attributed to its rich phytochemical composition. Studies have identified several bioactive constituents in leaves, roots, flowers, seeds, and latex, including alkaloids, flavonoids, phenolics, tannins, glycosides, terpenoids, saponins, and steroids. These compounds contribute to the plant's antimicrobial, antioxidant, anti-inflammatory, and wound-healing activities.[13–16]

Among these constituents, isoquinoline alkaloids are the most characteristic phytochemicals of *A. mexicana*. Important alkaloids include berberine, sanguinarine, chelerythrine, protopine, allocryptopine, and dihydrosanguinarine, particularly concentrated in seeds and latex. These

alkaloids possess significant antimicrobial, antioxidant, and anti-inflammatory properties.[17,18]

Berberine has demonstrated broad-spectrum antimicrobial activity along with antioxidant and wound-healing potential, whereas sanguinarine serves as a marker compound of the plant and exhibits strong antimicrobial and antioxidant effects. Chelerythrine and protopine further contribute to the anti-inflammatory and antimicrobial activities of the species.[18,21]

Flavonoids and phenolic compounds are widely distributed in aerial parts and are mainly responsible for antioxidant activity by scavenging free radicals and reducing oxidative stress. These effects are particularly relevant in dermatological disorders. Tannins contribute astringent, antimicrobial, and wound-healing properties, while terpenoids, saponins, and steroids provide additional anti-inflammatory, antimicrobial, and supportive pharmacological effects.[19,20,22]

Phytochemical composition varies depending on plant part, geographical origin, and extraction method. Methanolic and hydroethanolic extracts generally contain a broader spectrum of secondary metabolites than non-polar extracts. Recent phytochemical profiling studies have confirmed considerable chemical diversity within the species.[19]

From a dermatological perspective, the synergistic action of alkaloids, flavonoids, phenolics, tannins, and terpenoids may explain the traditional use of *A. mexicana* in wounds, skin infections, eczema, ulcers, and inflammatory skin disorders. These findings support its potential as a source of bioactive compounds for future dermatological and phytopharmaceutical applications.[23]

DERMATOLOGICAL ACTIVITY OF ARGEMONE MEXICANA

Skin disorders such as acne, eczema, dermatitis, fungal infections, wounds, and burns remain major global health concerns. Medicinal plants have gained attention as alternative therapeutic agents due to their rich phytochemical composition and relatively fewer adverse effects. Among them, *Argemone mexicana* has attracted interest because of its traditional use in skin diseases and the presence of bioactive compounds including alkaloids, flavonoids, phenolics, and terpenoids. These constituents contribute to antioxidant, antimicrobial, anti-inflammatory, and wound-healing activities relevant to dermatological therapy.

Traditional Relevance

Traditionally, different parts of *A. mexicana* have been used in India, Mexico, and Africa for the treatment of wounds, ulcers, eczema, itching, and skin infections. Latex, leaf paste, and plant extracts are commonly applied externally, and several modern studies support these traditional applications.[24]

Antioxidant Activity and Skin Protection

Oxidative stress contributes significantly to skin ageing, inflammation, and delayed wound healing. *A. mexicana* contains flavonoids, phenolics, and alkaloids with strong antioxidant properties that help scavenge free radicals and protect skin tissues from oxidative damage. These effects may promote tissue repair and support wound healing.[25]

Anti-inflammatory Activity

Inflammation is a key factor in dermatological disorders such as dermatitis, psoriasis, eczema, and acne. Experimental studies have demonstrated significant anti-inflammatory activity of *A. mexicana*, mainly attributed to flavonoids and alkaloids. These compounds may reduce inflammatory mediators and oxidative stress, thereby helping to alleviate skin inflammation.[26]

Antimicrobial Activity

Microbial infections often complicate skin disorders and delay healing. Various extracts of *A. mexicana* have shown activity against both Gram-positive and Gram-negative bacteria. Alkaloids such as sanguinarine, berberine, and chelerythrine are considered major contributors to its antimicrobial effects, supporting its traditional use in infected wounds and skin infections.[27]

Antifungal Activity

Studies have reported antifungal activity of *A. mexicana* against several fungal pathogens. Bioactive constituents identified through phytochemical investigations may inhibit fungal growth and reduce fungal colonization, indicating potential use in herbal antifungal formulations.[28]

Wound-Healing Activity

Wound healing is one of the most extensively studied dermatological properties of *A. mexicana*. Experimental studies have demonstrated accelerated wound contraction and

improved tissue repair following treatment with plant extracts. These effects are likely due to the combined antioxidant, antimicrobial, and anti-inflammatory activities of the plant.

Proposed Mechanisms of Wound Healing

- Reduction of microbial contamination
- Suppression of excessive inflammation
- Neutralization of reactive oxygen species
- Promotion of fibroblast activity
- Enhancement of collagen deposition

Potential Role in Acne and Other Skin Disorders

Although direct clinical evidence remains limited, the antimicrobial, antioxidant, and anti-inflammatory properties of *A. mexicana* suggest possible benefits in acne, dermatitis, and eczema. Further clinical studies are needed to confirm these effects.[29]

Future Prospects

The growing demand for herbal dermatological products has increased interest in developing creams, gels, ointments, and wound dressings containing *A. mexicana* extracts. However, further research is required to establish safety, efficacy, and standardization before widespread clinical use.

Overall, available evidence suggests that *Argemone mexicana* possesses considerable dermatological potential due to its antioxidant, antimicrobial, anti-inflammatory, antifungal, and wound-healing properties. Nevertheless, well-designed clinical studies are still required to validate its therapeutic effectiveness in human skin disorders.

TOXICITY AND SAFETY CONSIDERATIONS OF ARGEMONE MEXICANA

Despite its significant pharmacological and dermatological potential, *Argemone mexicana* presents important safety concerns due to the presence of toxic alkaloids, particularly in seeds and seed oil. The major toxic constituents, sanguinarine and dihydrosanguinarine, are considered the primary toxicological markers of the plant and have been associated with serious adverse effects, especially epidemic dropsy.

Major Toxic Effects

Sanguinarine can increase capillary permeability, leading to vascular leakage, edema, cardiovascular complications, and ocular abnormalities. Dihydrosanguinarine exhibits similar

toxic effects. High-dose exposure to these alkaloids has been linked to oxidative stress, cellular damage, and systemic toxicity.

Epidemic Dropsy

The most significant toxicological concern associated with *A. mexicana* is epidemic dropsy, which occurs following consumption of edible oils contaminated with argemone seed oil. Clinical manifestations include generalized edema, gastrointestinal disturbances, skin lesions, cardiac complications, and glaucoma. Several outbreaks reported in India have been directly linked to sanguinarine and dihydrosanguinarine contamination.

Dermatological and Other Toxicities

Although traditionally used for skin disorders, crude latex and unstandardized extracts may occasionally cause local irritation, redness, itching, and dermatitis in sensitive individuals. Ingestion of plant material or contaminated seed oil may produce nausea, vomiting, abdominal discomfort, and diarrhea. Experimental studies have also reported hepatotoxic, cytotoxic, and DNA-damaging effects of sanguinarine at higher concentrations. Ocular complications, particularly glaucoma, have been observed in severe cases of systemic toxicity.

Safety Considerations

For dermatological applications, safe utilization of *A. mexicana* requires:

- Avoidance of crude seed oil preparations.
- Standardization of extracts for alkaloid content.
- Skin irritation and sensitization testing.
- Acute and chronic toxicity evaluation.
- Use of purified or standardized fractions.
- Establishment of safe therapeutic dosage ranges.

Risk–Benefit Assessment

Available evidence demonstrates that *A. mexicana* possesses valuable antimicrobial, antioxidant, anti-inflammatory, and wound-healing properties. However, the presence of toxic alkaloids necessitates careful standardization and toxicological evaluation. Future research should focus on maximizing therapeutic benefits while minimizing toxic constituents to ensure safe dermatological use.

Overall, *Argemone mexicana* represents a promising medicinal plant, but its clinical application requires rigorous safety assessment, standardization, and validation before widespread therapeutic use.

FUTURE PERSPECTIVES AND RESEARCH OPPORTUNITIES

The increasing interest in medicinal plants has highlighted *Argemone mexicana* as a promising source of dermatologically active compounds. Studies have demonstrated its antioxidant, antimicrobial, anti-inflammatory, antifungal, and wound-healing properties; however, several research gaps remain before its full therapeutic potential can be realized.

One major limitation is the lack of standardization in extraction methods, plant materials, and experimental conditions. Future studies should focus on developing standardized extraction protocols and establishing validated phytochemical markers such as sanguinarine, berberine, and chelerythrine to ensure quality and reproducibility.

Advanced analytical techniques including LC-MS/MS, HPLC, GC-MS, metabolomics, and molecular profiling may facilitate the identification of novel bioactive compounds with potential dermatological applications. Further phytochemical characterization could expand the therapeutic scope of the plant.

Future research should also emphasize the development of dermatological formulations such as creams, gels, ointments, nanoemulsions, hydrogels, and wound-healing patches. Nanotechnology-based systems including nanoparticles, liposomes, nanogels, and phytosomes may improve bioavailability, skin penetration, and therapeutic efficacy while reducing toxicity.

Although antioxidant, antimicrobial, and anti-inflammatory activities have been widely reported, the underlying molecular mechanisms remain incompletely understood. Future investigations should explore inflammatory signaling pathways, cytokine regulation, oxidative stress markers, collagen synthesis, and growth factor expression to strengthen mechanistic evidence.

A major research gap is the scarcity of well-designed clinical studies. Future clinical trials should evaluate the efficacy and safety of *A. mexicana* in wound healing, diabetic ulcers, acne vulgaris, eczema, dermatitis, fungal infections, and other inflammatory skin disorders.

Such studies would provide essential information regarding dosage, effectiveness, and long-term safety.

Safety optimization remains equally important because toxic alkaloids such as sanguinarine and dihydrosanguinarine may limit therapeutic applications. Selective extraction, fractionation, purification of active constituents, and toxicity-guided formulation strategies may help improve the safety profile of plant-derived products.

Emerging technologies including molecular docking, network pharmacology, bioinformatics, and artificial intelligence offer additional opportunities for identifying novel therapeutic targets and accelerating drug discovery from *A. mexicana*. Furthermore, sustainable cultivation and conservation strategies should be established to ensure consistent phytochemical quality and responsible utilization of plant resources.

Overall, *Argemone mexicana* possesses considerable potential for future dermatological applications. However, successful translation into clinical practice will require standardized phytochemical characterization, advanced formulation development, comprehensive safety evaluation, and robust clinical validation through multidisciplinary research efforts.

CONCLUSION

Argemone mexicana L., traditionally regarded as a common weed, has emerged as a medicinally important plant with significant dermatological potential. Pharmacognostic studies have established reliable diagnostic features for its identification and standardization, while phytochemical investigations have revealed the presence of diverse bioactive constituents including alkaloids, flavonoids, phenolics, tannins, and terpenoids.

Available evidence indicates that *A. mexicana* possesses notable antioxidant, antimicrobial, antifungal, anti-inflammatory, and wound-healing activities, supporting its traditional use in the management of wounds, skin infections, ulcers, and inflammatory skin disorders. Among these activities, wound-healing and antimicrobial effects appear particularly promising for future dermatological applications.

However, the presence of toxic alkaloids such as sanguinarine and dihydrosanguinarine necessitates careful safety evaluation, standardization, and toxicity assessment before clinical utilization. Although preclinical studies provide encouraging results, well-designed clinical trials remain limited and are essential for establishing efficacy and safety in humans.

Future research should focus on phytochemical standardization, mechanism-based studies, toxicity-guided formulation development, and clinical validation. Advances in nanotechnology, metabolomics, and computational drug discovery may further facilitate the development of innovative dermatological formulations based on *A. mexicana*.

Overall, *Argemone mexicana* represents a valuable source of bioactive compounds with considerable potential for dermatological and phytopharmaceutical development. Continued multidisciplinary research may help translate its traditional medicinal uses into evidence-based therapeutic applications.

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