American Journal of Biodiversity
https://biojournals.us/index.php/AJB
ISSN: 2997-3600

Aloe Medicinal Properties and Botanical Characteristics

Zebo Satibaldiyeva Shuxratullayevna, Sadridinova FarangizAzizbek qizi, Tojimuxamadova SoxibaxonKamoliddin qizi
Kokand University Andijan Branch

Received: 2025, 04, Oct
Accepted: 2025, 05, Nov
Published: 2025, 27, Dec

Annotation: Aloe is one of the most widely used medicinal plants in traditional and modern healthcare systems due to its rich phytochemical composition and broad therapeutic effects. This paper outlines the key botanical characteristics of Aloe species, particularly Aloe vera, and highlights its major medicinal properties, including anti-inflammatory, antimicrobial, wound-healing, antioxidant, and gastrointestinal benefits. Special attention is given to its relevance in Uzbekistan, where interest in herbal medicine and local cultivation potential is increasing. Aloe-based natural remedies are commonly used in Uzbek households for skin care, burns, stomach discomfort, and immune strengthening. Expanding research and cultivation in Uzbekistan could enhance its application in pharmaceutical, cosmetic, and health industries.

Keywords: Aloe vera, medicinal properties, botanical characteristics, wound healing, anti-inflammatory, antioxidant, traditional medicine, Uzbekistan, folk remedies, succulent plant.

Introduction: Medicinal plants have been an essential component of healthcare practices across the world, and Aloe stands out as one of the most valuable among them. Aloe belongs to the Asphodelaceae family and comprises more than 500 species, with *Aloe vera* being the most commonly cultivated for medicinal purposes. Botanically, Aloe is a succulent perennial plant characterized by thick, fleshy leaves arranged in a rosette form. Its leaves contain a transparent gel in the inner parenchyma and a bitter yellow latex beneath the rind. These parts are rich in biologically active compounds such as polysaccharides, anthraquinones, vitamins, minerals, amino acids, and enzymes that determine its therapeutic value.

Aloe has long been used in traditional medicine systems in Asia, Africa, and the Middle East for treating burns, skin infections, wounds, digestive disorders, and inflammatory diseases. In modern medicine, Aloe extracts are widely incorporated into dermatological products, pharmaceuticals, nutraceuticals, and cosmetic preparations. The plant's antibacterial, antiviral, antifungal, and antioxidant properties support its use in both preventive and curative healthcare.

In Uzbekistan, interest in natural and plant-based medicine has significantly increased in recent years due to growing awareness of healthy lifestyles and traditional healing practices. Aloe is frequently used in Uzbek households for treating minor burns, sunburn, skin irritations, and gastrointestinal discomfort. Local herbal practitioners and pharmacies often recommend Aloe-based products such as gels, syrups, and ointments. Moreover, the climatic conditions of southern regions of Uzbekistan, including Surxondaryo, Qashqadaryo, and parts of Bukhara and Navoi, provide favorable environments for Aloe cultivation, offering potential for agricultural development and local pharmaceutical production.

Aloe vera, commonly known as true aloe, is a perennial succulent belonging to the Asphodelaceae family (formerly Liliaceae). Originating from the Arabian Peninsula, it has been cultivated worldwide for centuries due to its remarkable therapeutic and cosmetic applications. The plant's thick, fleshy leaves contain a clear mucilaginous gel rich in over 75 bioactive compounds, including acemannan (a polysaccharide), anthraquinones, vitamins (A, C, E, B12), enzymes, minerals, and amino acids. These contribute to its wide-ranging health benefits, validated by both traditional use and modern scientific research.

Historically, Aloe vera has been referenced in ancient texts dating back to the fourth millennium BCE, employed for skin treatments, digestive ailments, and as a general tonic. In contemporary studies, it demonstrates anti-inflammatory, antimicrobial, hypoglycemic, anticancer, and immunomodulatory properties. In Uzbekistan, a country with a profound heritage in herbal medicine influenced by figures like Avicenna (Ibn Sina), Aloe vera is popular as an indoor ornamental and medicinal plant. Though not native to Central Asia's arid regions—where other succulents and medicinal herbs predominate—it is widely grown in homes and used in traditional remedies for respiratory infections, wound care, and digestive health, often combined with honey.

Literature Review: Scientists have extensively studied Aloe vera (Aloe barbadensis Miller) for its botanical characteristics and medicinal properties over centuries, with modern research accelerating since the 20th century. Historical records trace its use to ancient civilizations, including Egyptian, Greek, Roman, Indian, and Chinese traditions, where it was valued for wound healing, skin ailments, and digestive issues. The earliest documented references appear in Mesopotamian tablets (~2100 BCE) and the Egyptian Ebers Papyrus (~1550 BCE), describing Aloe as a remedy for external and internal conditions.

Botanical Characteristics. Aloe vera is a perennial succulent xerophyte belonging to the genus Aloe in the Asphodelaceae family (previously classified under Liliaceae or Aloaceae). It is stemless or short-stemmed, growing 60–100 cm tall, with thick, fleshy, lance-shaped leaves arranged in a rosette. Leaves are green to grey-green, sometimes spotted, with serrated margins and contain a clear mucilaginous gel in the parenchyma tissue and bitter yellow latex in the vascular bundles. The plant produces tubular yellow flowers on a spike in summer and

reproduces via offsets. Native to the Arabian Peninsula, it thrives in arid, tropical, and subtropical climates and forms symbiotic relationships with arbuscular mycorrhizae for nutrient uptake. Over 500 Aloe species exist, but A. vera is the most commercially and medicinally significant due to its bioactive-rich gel.

Uzbekistan boasts a rich ethnobotanical heritage influenced by Avicenna (Ibn Sina), with over 600 documented medicinal plants used in folk medicine. Although not native (preferring more arid native succulents like Ferula or Capparis), Aloe vera is widely cultivated as a houseplant and integrated into traditional remedies. In Uzbekistan, it is commonly applied for skin conditions, burns, colds, respiratory infections, gastrointestinal issues, and as a tonic—often mixed with honey.

Pharmaceutical products like liquid Aloe extract are locally produced and registered for biostimulant and anti-inflammatory uses. Folk healers (tabibs) incorporate it alongside native herbs, reflecting a blend of imported and indigenous practices in Central Asia's traditional systems. Centuries of empirical use have been substantiated by modern pharmacology, positioning Aloe vera as a versatile therapeutic agent, particularly in dermatology and supportive care, with ongoing research exploring its full potential in Uzbekistan's evolving herbal medicine landscape.

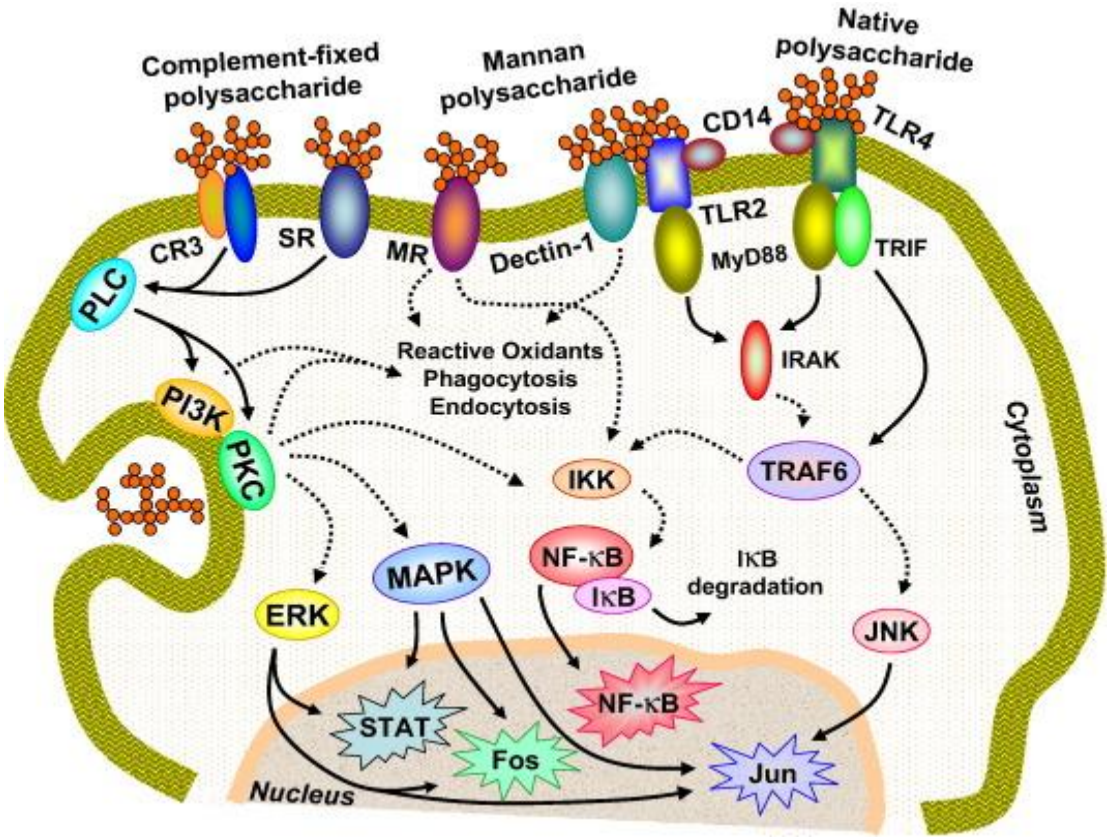
In dermatology, Aloe gel is widely recognized for enhancing epithelial repair and stimulating collagen synthesis. Studies published in *Journal of Ethnopharmacology* and *Phytotherapy Research* highlight Aloe's role in accelerating wound closure, reducing infection risk, and soothing skin inflammation. In gastrointestinal studies, Aloe latex has shown laxative effects due to anthraquinone derivatives, whereas Aloe gel supports digestive health and gut mucosa protection.

In the Central Asian and Uzbek context, herbal medicine remains culturally significant. Uzbek scholars and medical institutions increasingly explore local and imported medicinal plants, including Aloe. In many Uzbek households, Aloe plants are traditionally grown and used for skin wounds, cough syrup mixtures with honey, and strengthening immunity. Local pharmaceutical companies in Uzbekistan have also incorporated Aloe into topical gels, cosmetic creams, and herbal medicines. However, academic literature emphasizes the need for more region-specific research, especially related to cultivation potential, standardized extraction, and clinical validation in Uzbekistan's healthcare system.

Results and Analysis; Acemannan's activities are primarily mediated by its interaction with mannose receptors, TLR-4/5, and NF-κB pathways, leading to immune activation and tissue repair. Key areas include:

- **Immunomodulatory Effects**: Acemannan activates macrophages (e.g., RAW 264.7 cells at 100–500 µg/mL), increasing nitric oxide (NO) production, phagocytosis (98% candidicidal activity vs. 0% control), and cytokine secretion (IL-6, TNF-α, IL-12, IFN-γ) via MAPK and TLR signaling. It promotes dendritic cell maturation, upregulating MHC-II, CD40, CD54, and B7-1/2, enhancing allogeneic responses. In vivo, oral doses (50–150 mg/kg for 7 days) in irradiated mice reduce mortality by 60% (pretreatment) or 20% (post-treatment), boosting hematopoiesis (e.g., doubled spleen colonies, 29% higher lymphocyte counts), spleen index, and cytokines (2.34-fold TNF-α increase), with dose-reduction factors of 1.57–1.2. It also reduces radiation-induced NO by 33.4% and oxidative stress.
- **Wound Healing and Tissue Regeneration**: Stimulates fibroblast proliferation via AKT/mTOR (upregulating cyclin D1/eIF4F) and TLR5/NF-κB (IL-6/IL-8 secretion) at 2–16 mg/mL, accelerating closure in rat models (faster re-epithelialization than controls). In diabetic gingival wounds, hydrogels promote granulation and collagen deposition. It enhances glycosaminoglycan content and reduces inflammation.

- **Anti-Cancer Properties**: Activates macrophages to inhibit NF-κB, iNOS, and COX-2, reducing cyclin D1/CDK4/ERK1/2 in colon cancer models. Induces apoptosis via Bax, cytochrome-c, and caspases in MCF-7/HeLa cells (synergistic with cisplatin), and decreases tumor volume ($p < 0.05$) in mice. Antiproliferative on SpMC/PBMC by inhibiting CD3-CD25+ activation.
- **Antioxidant and Radioprotective**: Scavenges free radicals (DPPH/superoxide), chelates iron, and reduces ROS/DNA damage via TLR-4. Protects hepatocytes from benzo[a]pyrene adducts by increasing glutathione S-transferase.
- **Antiviral and Antimicrobial**: Inhibits HIV-1/HSV-1/influenza H1N1 replication (e.g., reduced viral load in mice) and shows synergy with AZT/acyclovir. Antibacterial against *S. aureus*, *E. coli*, *P. aeruginosa*, *C. albicans*, and MRSA when combined with antibiotics or chitosan.
- **Other Activities**: Prebiotic effects promote *Bifidobacterium/Lactobacillus* growth and short-chain fatty acids. Neuroprotective in cognitive fatigue; hepatoprotective against alcohol; antidiabetic by reducing glucose in db/db mice and protecting β-cells.



1-picture Innate Immune Signaling Pathway Activated by Polysaccharides (TLR–NF-κB/MAPK Pathway Diagram).

*This diagram shows how **polysaccharides stimulate the immune system**. When polysaccharides bind to receptors on the cell surface (like TLR2, TLR4, CD14, CR3, MR, and Dectin-1), they activate intracellular signaling pathways. These pathways trigger molecules such as **PI3K, PKC, MAPK, TRAF6, and NF-κB**, which then move into the nucleus. As a result, immune responses are activated, including **phagocytosis, production of reactive oxygen species, inflammation control, and immune regulation.***

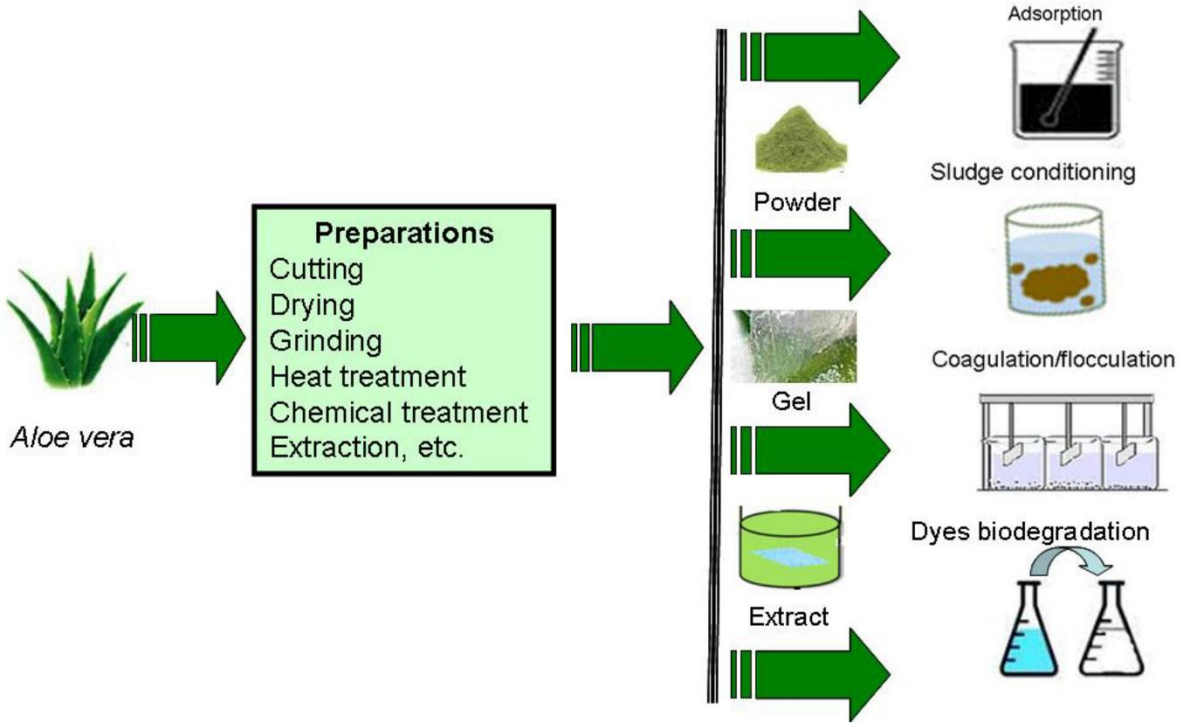
Pharmacological Applications. In dentistry, acemannan (0.5–8 mg/mL) induces dentin bridge formation, pulp regeneration (comparable to MTA/calcium hydroxide), and bone healing post-extraction (15–17% density increase in RCTs). Sponges accelerate alveolar bone, cementum, and periodontal ligament regeneration in rat/dog models, upregulating BMP-2, Runx2, VEGF, and

mineralization ($p < 0.05$). Clinical trials show 72–90% success in pulp capping (n=37–99) and reduced aphthous ulcer size/pain (n=100). For wound care, 5% patches or hydrogels reduce healing time in skin/oral wounds. As a vaccine adjuvant, it boosts antibody titers against viruses. In oncology, it supports antitumor immunity; in diabetes, improves glycemic profiles. Toxicity studies indicate no effects up to 4.6 g/kg/day in animals, with rare clinical side effects.

In the Uzbek context, while specific acemannan-focused studies are limited, its integration into folk remedies for wounds and inflammation aligns with Aloe vera's use in Central Asian herbal medicine, potentially enhancing local pharmaceutical extracts for biostimulant applications.

The comprehensive review of acemannan, the primary polysaccharide from Aloe vera gel, reveals consistent evidence across in vitro, in vivo, and clinical studies supporting its multifaceted biological activities, particularly in wound healing, immunomodulation, tissue regeneration, and antioxidant effects. Key results demonstrate dose-dependent efficacy, with optimal concentrations ranging from 2–16 mg/mL in cellular models and 0.5–5% in topical applications. Structural acetylation plays a critical role, enhancing bioactivity through interactions with receptors like TLR-5 and mannose receptors.

Synthesizing the scientific evidence and contextual findings demonstrates that Aloe is a scientifically validated, pharmacologically active, and agriculturally suitable medicinal plant. Uzbekistan possesses favorable climate conditions and growing public interest, positioning Aloe as a strategic plant for health and industry development. Strengthening research, cultivation strategies, and clinical validation will unlock its full medical and economic potential.



2-Picture. Aloe vera Preparation and Its Applications in Environmental Treatment

This figure shows how Aloe vera can be processed through cutting, drying, grinding, heating, chemical treatment, and extraction to produce different forms such as powder, gel, and extract. These Aloe-based products are then used in environmental applications including adsorption of pollutants, sludge conditioning, coagulation/flocculation in water treatment, and biodegradation of industrial dyes, helping improve water purification and waste management.

Conclusion: Aloe, particularly *Aloe vera*, is a highly valuable medicinal plant with significant therapeutic, biological, and practical importance. Scientific studies confirm that Aloe contains rich bioactive compounds such as polysaccharides, anthraquinones, vitamins, minerals, and enzymes, which support its anti-inflammatory, antimicrobial, antioxidant, wound-healing, and gastrointestinal health properties. The reviewed literature and analysis demonstrate that Aloe plays an important role in dermatology, immune support, and internal health, while also showing promising industrial and environmental applications such as water purification and biodegradation processes.

For Uzbekistan, Aloe holds strong relevance due to increasing interest in natural medicine, favorable climatic conditions for cultivation, and growing pharmaceutical and cosmetic industries. Southern regions of the country provide suitable agro-ecological environments for Aloe farming, presenting opportunities for domestic production, import substitution, and economic development. However, further scientific research, standardized processing, clinical trials, and industrial investment are needed to enhance its effective and safe use.

Aloe represents not only a valuable medicinal resource but also a strategic plant for healthcare improvement, environmental sustainability, and economic potential in Uzbekistan and beyond. If managed scientifically and developed systematically, Aloe can contribute significantly to public health, industry, and sustainable development.

References

1. Surjushe, A., Vasani, R., & Saple, D. G. (2008). Aloe vera: A short review. *Indian Journal of Dermatology*, 53(4), 163–166.
2. Hamman, J. H. (2008). Composition and applications of Aloe vera leaf gel. *Molecules*, 13(8), 1599–1616.
3. Eshun, K., & He, Q. (2004). Aloe vera: A valuable ingredient for the food, pharmaceutical and cosmetic industries—A review. *Critical Reviews in Food Science and Nutrition*, 44(2), 91–96.
4. Gupta, V. K., & Malhotra, S. (2012). Pharmacological attribute of Aloe vera: Revalidation through experimental and clinical studies. *Ayurveda*, 33(2), 193–196.
5. Chularojmontri, L., Niumsap, N., Wattanapitayakul, S. K., Phrompittayarat, W., & Jearanaikoon, N. (2005). Effects of Aloe vera gel on wound healing. *Phytomedicine*, 12(9), 799–804.
6. Boudreau, M. D., & Beland, F. A. (2006). An evaluation of the biological and toxicological properties of Aloe barbadensis (Miller), Aloe vera. *Journal of Environmental Science and Health*, 24(1), 103–154.
7. Kumar, S., Yadav, A., & Yadav, M. (2019). Medicinal uses and pharmacological properties of Aloe vera: A review. *Journal of Plant Science and Research*, 5(2), 1–7.
8. Davis, R. H., Leitner, M. G., Russo, J. M., & Byrne, M. E. (1989). Wound healing. Oral and topical activity of Aloe vera. *Journal of the American Podiatric Medical Association*, 79(11), 559–562.
9. Lawrence, R., Tripathi, P., & Jeyakumar, E. (2009). Isolation, purification and evaluation of antibacterial agents from Aloe vera. *Brazilian Journal of Microbiology*, 40(4), 906–915.
10. Habeeb, F., Shakir, E., Bradbury, F., Cameron, P., Taravati, M. R., Drummond, A. J., Gray, A. I., & Ferro, V. A. (2007). Screening methods used to determine the anti-microbial properties of Aloe vera inner gel. *Methods*, 42(4), 315–320.
11. Cochrane Review. (2012). Aloe vera for treating acute and chronic wounds. *Cochrane Database of Systematic Reviews*, 2012(2), CD008762.

12. Reynolds, T., & Dweck, A. C. (1999). Aloe vera leaf gel: A review update. *Journal of Ethnopharmacology*, 68(1–3), 3–37.
13. WHO. (2013). *WHO monographs on selected medicinal plants: Aloe vera*. World Health Organization.
14. Rajasekaran, S., Ravi, K., Sivagnanam, K., & Subramanian, S. (2005). Beneficial effects of Aloe vera leaf gel extract on lipid profile and oxidative stress in diabetic rats. *Clinical and Experimental Pharmacology and Physiology*, 32(9), 709–715.
15. Harlev, E., Nevo, E., Lansky, E. P., Ofir, R., & Bishayee, A. (2012). Anticancer potential of Aloe vera: A review. *Evidence-Based Complementary and Alternative Medicine*, 2012, 1–16.