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Review Article

Aloe Vera: A Wonder Plant with Multiple Activities

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A B S T R A C T

The medicinal properties of aloe vera, a drought-resistant succulent perennial, are widely recognized. Aloe vera has a multitude of well-documented health benefits, including immunomodulatory, hypoglycemic, anticancer, gastro-protective, antifungal, and anti-inflammatory qualities. It also aids in wound and burn healing. Aloe vera's advantageous therapeutic qualities have been used in a variety of commercial applications. In addition to providing an overview of its use in foods and cosmetics, the current study surveys the literature on its composition, rheology, processing, and pharmacological applications. Furthermore, a summary of the risks related to Aloe vera use is provided, along with pertinent safety measures. Scientific advancements in analytical chemistry are advancing the chemical characterization of Aloe vera.

KEYWORDS: Aloe vera, Aloe barbadensis, Acemannan, Immunomodulatory, Hypoglycemic, Anticancer, anti-inflammatory

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INTRODUCTION:

Botany: Aloe vera, Aloe barbadensis, Arborescens, A. ferox, Aloe vera (Cape aloe), Aloe vulgaris, Aloe arborescens, Aloe perryi (Socotrine or Zanzibar aloe). There are more than 300 species of aloe, the majority of which are indigenous to Madagascar, South Africa, and Arabia. The amounts of active compounds vary slightly across the different species.

Plant Description: Aloe barbadensis miller is the botanical name for aloe vera. This plant belongs to the Asphodelaceae (Liliaceae) family and is a perennial, xerophytic, succulent, shrubby, or arborescent species with a pea-green hue. Aloe plants have long, thick, triangular leaves that can get up to 20 inches long and 5 inches wide. The margins of the leaves are prickly.[1]

The plant aloe vera may grow to be 60–100 cm (24–39 in) tall with offsets, or it may have very small stems. There are certain assortments that appear as white bits on the upper and lower stem surfaces of the thick, plump, green to grey-green clears away. The margin of a leaf with tiny white teeth and serrations. The blossoms have shown in the summer on spikes that can reach heights of up to 90 cm (35 in). The pendulous bloom features a 2-3 centimeter yellow tubular flower.

History:

Many countries throughout the world love aloe vera as a herb. Beginning in the fourth century B.C., the aloe vera plant and its derivatives have been used in medicine and healthcare. This plant spread throughout the world due to migration and trade with humans. There are several benefits that may be obtained from aloe vera, which is the most effective natural plant when used both orally and externally. The benefits of aloe vera for health have been widely shared worldwide. Among the 250 kinds that exist, aloe vera is most well-known for its therapeutic qualities. It is applied to treat many illnesses. To satisfy the high demand for Aloe Vera gel, juice, and latex, which have a variety of uses in the food, cosmetic, and alternative medicine industries, Aloe Vera is now commercially grown around the world.

Taxonomical Classification:

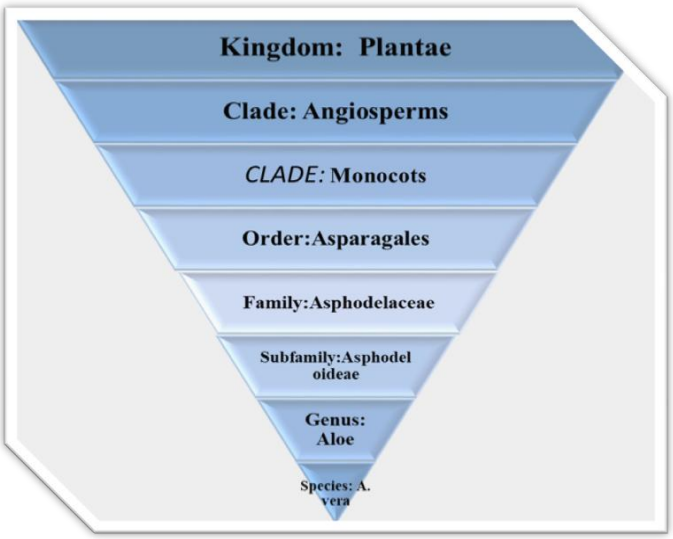


Figure 01: Taxonomical Classification of Aloe -Vera

Cultivation and Collection

Around 250 different species of adult aloe are known to exist worldwide. Whichever the case, only two species are currently cultivated commercially: Aloe barbadensis Miller and Aloe aborescens.Grown in warm tropical regions, aloe vera cannot withstand temperatures that are too cold to harden. Growing slowly to reach 0.8 m by 1 m, it is an evergreen perennial. The plants like light (sandy) to medium (loamy) soil, and they can grow in generally impoverished soil if it is in good condition. Corrosive, impartial, and necessary (basic) soil is what the plant prefers. Under shadows, it cannot grow. It can withstand dry spells and does best in clammy or dry dirt. Their type of plant is xerophytic. Through seed, it can multiply. In a warm green house, seeds are sowed in the spring. Usually, the seed takes 1-6 months to sprout at 16°C. We switch the seedlings to pots with significantly reduced soil. For the first two winters at least, they are allowed to grow in a sunny area. Most of the time in the spring, the counterbalance will be available. Unrestrained in their production of balance, the plants can be isolated at any time of year when the temperature rises sufficiently to encourage new growth and allow for plant regeneration. Following the swirling season, young equalization are planted in the ground in lines arranged at a 60-meter separation.[27]

Chemical Composition:

Table I

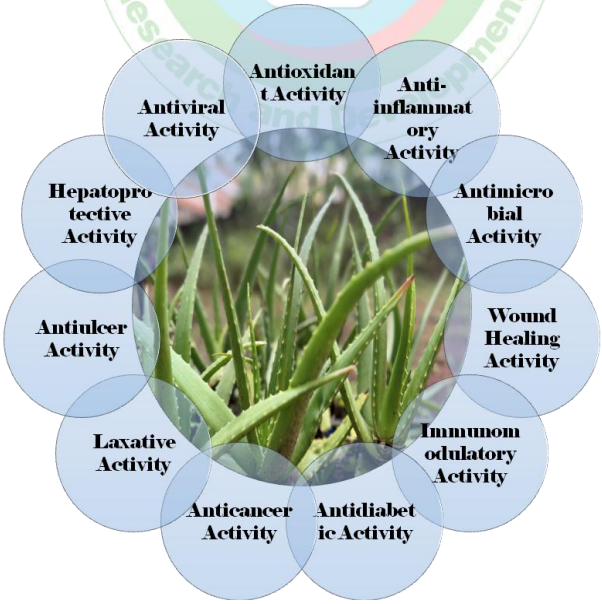
Component	*Type*
Acemannan[2]	Polysaccharide
Aloin[3]	Anthraquinone
Emodin[3]	Anthraquinone
Polysaccharides [4]	Polysaccharide
Saponins[5]	Glycoside
Vitamins (A, C, E)[6]	Vitamins
Methionine, phenylalanine, isoleucine,	Amino Acids
Enzymes (e.g., amylase)[8]	Enzyme
Salicylic Acid[9]	Phenolic Compound
Lignin[10]	Phenolic Compound

Pharmacological Activities:

Table II

Pharmacological activity	*Description*	*Mechanism of action*
1.Antioxidant activity.[11]	Aloe vera exhibits strong antioxidant properties, neutralizing free radicals and reducing oxidative stress.	Contains bioactive compounds like vitamins (a, c, e), polyphenols, and flavonoids that scavenge free radicals.
2. Anti-inflammatory activity[12]	Aloe vera hasbeen known to decrease inflammation in different conditions such as arthritis, skin disorders, and the process of wound healing. It works by inhibiting cyclooxygenase and decreasing the production of prostaglandins and inflammatory cytokines.	Inhibits cyclooxygenase and reduces the synthesis of prostaglandins and inflammatory cytokines.

3. Antimicrobial activity[13]	Aloe vera displays antimicrobial effects against bacteria, viruses, and fungi, making it useful in treating infections.	The presence of substances such as anthraquinones, saponins, and enzymes results in the disruption of microbial cell walls and the inhibition of replication.
4. Wound healing[14]	Aloe vera accelerates wound healing and reduces scar formation.	Enhances collagen synthesis and fibroblast activity while promoting angiogenesis.
5.Immunomodulatory activity[15]	Aloe vera modulates the immune system, enhancing or suppressing immune responses depending on the context.	Modulates the activity of macrophages, t cells, and natural killer cells.
6. Antidiabetic activity[16]	Aloe vera has shown potential in lowering blood glucose levels and improving insulin sensitivity.	Stimulates insulin secretion and enhances glucose uptake by cells.
7. Anticancer activity[18]	Aloe vera shows cytotoxic effects on different cancer cell types, suggesting its potential as a cancer-fighting agent.	Induces apoptosis, inhibits cell proliferation, and interferes with cell signaling pathways.
8. Laxative activity[19]	Aloe vera is used as a laxative (natural) to treat constipation.	The presence of anthraquinones such as aloin results in higher intestinal water content and induces bowel movements.
9. Skin hydration and moisturization[20]	Aloe vera is widely used in cosmetics for its ability to hydrate and moisturize the skin, making it soft and supple.	Penetrates the epidermis and binds moisture, preventing trans-epidermal water loss.
10. Anti-aging activity[21]	Aloe vera slows down the signs of aging, such as wrinkles and fine lines, due to its antioxidant properties and ability to stimulate collagen production.	Reduces oxidative stress and promotes collagen synthesis, improving skin elasticity.
11. Anti-ulcer activity[22]	Aloe vera has been used to prevent and treat ulcers, especially peptic ulcers.	Enhances the production of protective gastric mucus and reduces gastric acid secretion.
12. Hepatoprotective activity[23]	Aloe vera protects the liver from various toxins and improves liver function.	Inhibits lipid peroxidation and enhances the activity of antioxidant enzymes in the liver.
13. Antiviral activity[24]	Aloe vera has shown activity against viruses such as herpes simplex and influenza, making it a potential antiviral agent.	Inhibits viral replication and modulates immune response to enhance antiviral defense.
14.Analgesic[25]	Provides pain relief.	Inhibits pain mediators like bradykinin and histamine.



1. Anti-oxidant Activity:

The process by which damaged tissue responds to mend itself and regains its structural integrity is known as wound healing. While some studies claimed no impact in wound healing, others demonstrated that aloe gel could promote wound healing following topical and systemic administration. The stability of the active components may account for inconsistent outcomes, since it has been demonstrated that treatment timing following harvesting plays a significant role in determining activity. Aloe gel's ability to improve wound healing has been explained by a number of processes, including increased migration of epithelial cells, faster collagen maturation, decreased inflammation, and wound moisturization[11]

2. Anti-inflammatory Activity:

A plant hormone present in aloe vera called gibberellin has been identified in recent studies as a possible powerful anti-inflammatory component. Polymorphonuclear leukocytes, often known as PMNs, are an essential part of the inflammatory process. Inflammation is a complicated biological reaction to damage. Tissue damage and symptoms are caused by these cells migrating to inflammatory areas.

In one carefully monitored investigation, a 2% gelatin model was used to assess Aloe vera's effects on inflammation. The PMN infiltration, a marker of inflammation, significantly increased in response to this model. Because diabetes can worsen inflammation, the study looked at how Aloe vera affected the inflammatory response in these animals. With aloe vera treatment, the results showed a dose-dependent decrease in PMN infiltration.[13]

3. Anti- Microbial activity:

The disc diffusion method was used to examine the antibacterial efficacy of several Aloe vera gel formulations against various food-borne diseases. After 48 hours of incubation at 37°/25°C, it was discovered that the fresh gel, preserved gel, cooling gel, and acne cream showed the maximum zone of inhibition against Bacillus subtilis, Bacillus subtilis, Staphylococcus aureus, and Staphylococcus aureus (24.70, 34.5, 30.3, and 26.3 mm), respectively, and the minimum zone of inhibition was demonstrated by Aspergillusficuum by all four preparations of Aloe vera gel, 9.5, 10.5, 10.5, and 9.5 mm, respectively. This indicates that the antimicrobial susceptibility testing of Aloe vera gel shows the greatest inhibitory effect on the Staphylococcus aureus (18.0 mm).[14]

4. Wound Healing Activity:

Aloe vera's impact on the properties and content of collagen in a wound that is healing. Aloe vera improved the granulation tissue's degree of crosslinking and collagen content, as evidenced by a decrease in acid solubility and an increase in aldehyde content. Treatment groups had higher quantities of type III collagen as seen by their lower type I/type III collagen ratios compared to the untreated controls. Rats were given Aloe vera topically or orally to treat wounds, and it was discovered that the two methods had comparable results.[15]

5. Immunomodulatory activity:

It seems that the host defensive mechanisms are activated by aloe polysaccharides, rather than directly causing cytotoxicity to tumor cells, which would explain its immunomodulatory effect. Cellular and molecular cooperation among lymphocytes sets up a cascade that leads to the immune response. Professional antigen-presenting cells like dendritic cells and macrophages are required to ensnare antigens in order to trigger an immune response (DCs). Following processing, helper T cells are exposed to the captured antigens. Specific interactions between primed B cells and activated helper T cells occur. The growth and development of cytotoxic T cells are similarly stimulated by activated helper T cells. Direct contact between cells as well as soluble mediators (cytokines) generated by immune cells are crucial for this cell-to-cell cooperation.[16]

6. Antidiabetic Activity:

The effects of a health product containing aloe vera gel were investigated in relation to plasma glucose levels in diabetic rats generated by alloxan, as well as stomach mucosal lesions caused by oral administration of 70% v/v ethanol (2 mL/kg) or cold-restraint. Oral pretreatment with the preparation did not prevent the establishment of lesions. Given twice daily for three days, there was no improvement in the repair of stomach mucosal injury caused by ethanol. Rats given 120 mg/kg, s.c. of alloxan had plasma glucose levels that were roughly twice as high as those of the controls. It increased even more after taking the preparation orally once. Plasma glucose levels increased over the course of a 10-day, twice-daily course of treatment with the preparation.[17]

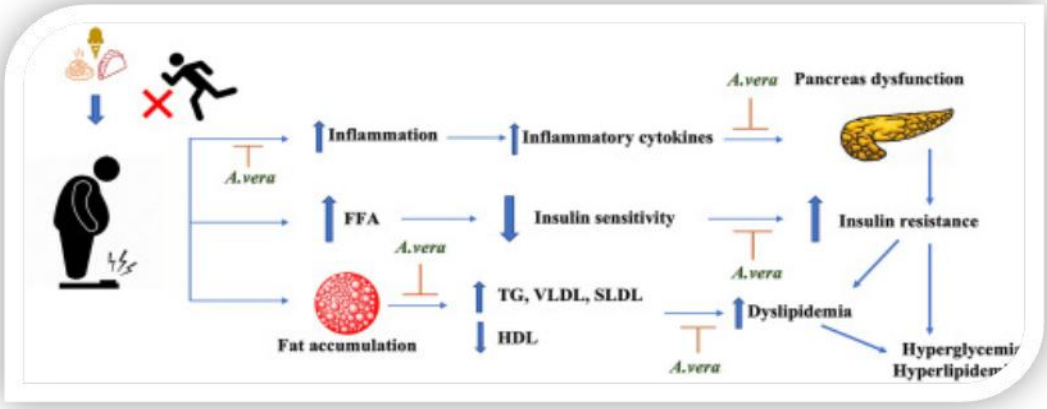


Figure 3: Antidiabetic Activity of Aloe vera

7. Anticancer Activity:

The cytotoxic activity of plant extracts of Aloe pseudorubroviolacea and Aloe castellorum was assessed against the HCT-116 human colon cancer cell line. Individually, the methanol extracts of Aloe pseudorubroviolacea and Aloe castellorums exhibit 98.26%

and 89.09% of cell viability at 20 µg/mL, respectively. Tables 3, 5, and 4 provide a summary of the values. Methanol extracts' impact on apoptotic morphological alterations in the HCT 116 cell line was demonstrated in. Methanol extracts' effects on the HCT 116 cell line's mitochondrial membrane potential were displayed in. The impact of methanol extracts on HCT 116 cell ROS generation was demonstrated in. How methanolic extracts affect HCT[18]

8. Laxative Property:

Aloe vera has powerful laxative properties due to its anthraquinones. It raises intestinal peristalsis, stimulates mucus secretion, and increases intestinal water content.[19]

MOA:

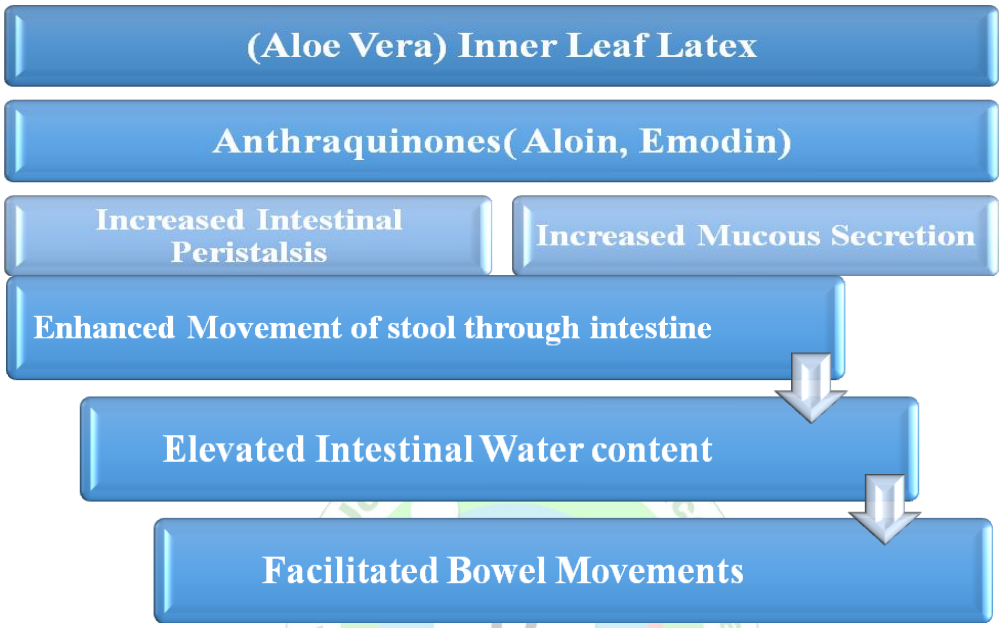


Figure 04: Laxative Property of Aloe-Vera

9. Skin Hydration and Moisturization property:

Over 95% of products that are helpful for dermatology are currently made using aloe vera. Its improbable moisturizing qualities are the reason for this. It helps to reverse the aging process of the skin by increasing the skin's capacity to retain moisture and assisting in the elimination of dead skin cells that produce collagen and elastin fibers. This makes the skin less wrinkly and more elastic. By acting cohesively on the surface's flaking epidermal cells and through the action of amino acids, it softens the skin.[20]

10. Anti-ageing Activity:

Aloe helps to generate collagen and elastin fibers, which make the skin more elastic and less wrinkled. This is how aloe's anti-aging effect works. Their cohesive function softens the skin by adhering the surface peeling epidermal cells together. Zinc functions as an astringent to constrict the pores, while amino acids help soften the tough skin cells.[21]

11. Antiulcer Activity:

In the Ayurvedic tradition. America has found success using leaves as a topical therapy for persistent ulcers. within combining aloe vera powder with gum acacia, the rats were given a 200 mg/kg oral dose of the mixture to treat indomethacin-induced stomach ulcers. The rats experienced a reduction in pain initially, and the ulcers healed within a few weeks. Significant antiulcer activity was demonstrated by the extract, matching that of the control [22]

12. Hepatoprotective Activity:

Aloe vera'shepatoprotective properties might be connected to glutathione-mediated detoxification.

As an enzyme cofactor, glutathione (also known as g-glutamylcysteinyl glycine, or GSH) is a sulfhydryl (SH) antioxidant and antitoxin. Glutathione is mostly present in the cytosol of cells and other watery phases of living organisms.

Many physiologically active substances can be found in aloe vera leaves, however the most well researched ones are lectins, acetylated mannans, polymannans, anthraquinone C-glycosides, anthrones, and anthraquinones.

Aloe vera'sacemannan and other polysaccharides raise reduced glutathione levels, which lower oxidative damage.[23]

13. Antiviral activity:

Acemannan inhibited herpes simplex infection in two target cell lines that were grown. Fractions of Aloe vera gel called lectins directly prevented the cytomegalovirus from proliferating in cell culture, possibly by obstructing the creation of proteins. A pure form of aloe emodin was able to neutralize every virus, including varicella-zoster, influenza, and pseudorabies viruses, as well as the infectivity of herpes simplex virus Types I and II. The herpes simplex virus treated with anthropoquinone showed evidence of partial envelope disruption by electron microscopy analysis. These findings suggest that extracts of anthraquinones from a range

of plants have a direct virucidal effect on enveloped viruses. The immune system's activation may have had an indirect effect on these behaviors.[24]

14. Analgesic activity:

Dentistry Procedures:

Pain Reduction: To reduce pain during dental operations, aloe vera gel is frequently used. Because of its inherent analgesic qualities, it helps to calm the mouth's delicate tissues and lessen discomfort from dental procedures. Mouth Ulcers, Blisters, and Lesions: The gel works well to treat oral lesions, blisters, and mouth ulcers. The gel offers instant pain relief and accelerates healing when applied immediately to the damaged areas. The anti-inflammatory and therapeutic properties of aloe vera lessen inflammation and hasten healing.

Dental Surgery:

Aloe vera gel provides immediate analgesic relief after oral surgery such gum disease treatments or tooth extractions.

Oral Surgery:

Quick Analgesic Pain Relief: Aloe vera gel provides quick pain relief after oral surgery such gum disease treatments or tooth extractions. It facilitates a more comfortable recovery period by lowering inflammation and calming the treated area, which helps reduce post-surgical discomfort.

Gallstones with Hemorrhoids:

Pain Relief: Hemorrhoids and piles can also be treated with aloe vera gel to reduce pain. In these cases, its analgesic and anti-inflammatory qualities aid in lowering pain, swelling, and itching. The gel's cooling impact reduces pain and speeds up the healing process in the injured area.[25]

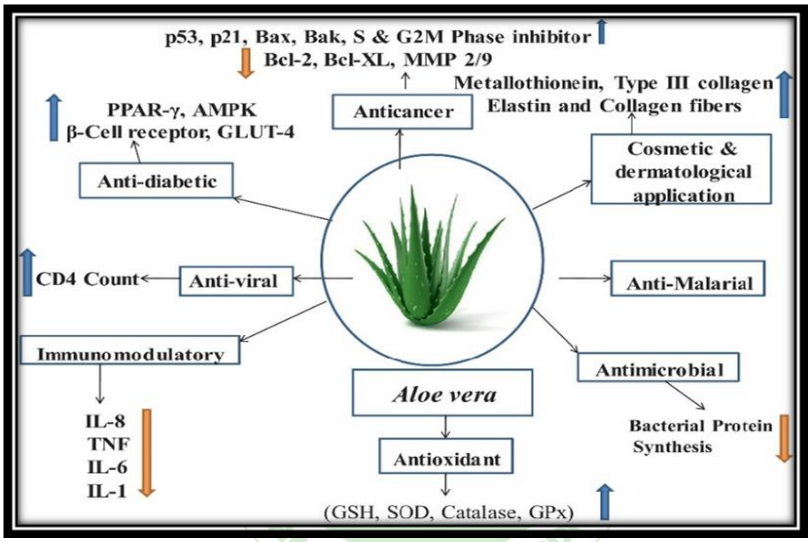


Figure 5: Schematic outlining the biological properties of aloe Vera

CONCLUSION:

Aloe vera, a versatile and widely recognized medicinal plant, offers a broad spectrum of health benefits due to its diverse pharmacological activities . Its well documentated properties include antioxidant, anti-inflammtory, antimicrobial, immunomodulatory, antidiabetic, anticancer and wound-healing effects, making it valuable in both traditional and modern medicine. Aloe vera's applications extend to cosmetics ,food, and alternative medicines, where it is prized for its numerous benefits, the usage of aloe vera should be approached with caution, considering the potential risks and side effects associated with its use. Ongoing advancements in analytical chemistry continue to enhance our understanding of Aloe vera's chemical composition, supporting its safe and effective application in various therapeutic contexts.

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