

Phytochemistry of *Aloe Vera* and its Therapeutic Benefits: An Overview

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Abstract

Aloe vera belongs to the family Liliaceae commonly known as Ghrith Kumari and popular for its medicinal properties. The name *Aloe vera* derives from the Arabic word “Alloeh” meaning shining bitter substance. Phytochemistry of *Aloe Vera* gel has revealed the presence of more than 200 bioactive chemical constituents: vitamins, enzymes, minerals, sugars, lignin, saponins, salicylic acids and amino acids, which are responsible for the multifunctional activity of Aloe. The *Aloe vera* leaf gel contains about 98% water. The total solid content of *Aloe vera* gel is 0.66% and soluble solids are 0.56% with some seasonal fluctuation. On dry matter basis *aloe* gel consists of polysaccharides (53%), sugars (17%), minerals (16%), proteins (7%), lipids (5%) and phenolic compounds (2%). *Aloe vera* is used for vigor, wellness and medicinal purposes since Rigvedic times. *Aloe vera* plants are mostly used in medicinal practices that are quite different in their chemical composition and their therapeutic properties, such as wound healing, psoriasis, genital herpes, intestinal problems, heal gastric ulcers, increasing high density lipoprotein (HDL), reducing low density lipoprotein (LDL), reducing blood sugar in diabetics, cancer, fighting against acquired immunodeficiency syndrome (AIDS), allergies and improving immune system. *Aloe vera* possesses several pharmacological properties such as promoting and healing wound and burn, frost-bite healing, with addition to having anti-inflammatory, antifungal, hypoglycemic and gastroprotective properties. This review explored the phytochemical and pharmacological knowledge as well as several promising aspects for research on *aloe*.

Keywords: *Aloe vera*, Kumari, Ghrithakumari, phytochemical, therapeutic.

Introduction:

Aloe vera, a versatile succulent plant belonging to the genus Aloe, has garnered widespread attention for its remarkable medicinal properties and therapeutic benefits. Revered for centuries in various traditional medicine systems, including Ayurveda, Traditional Chinese Medicine and indigenous healing practices, *Aloe vera* has earned a well-deserved reputation as a healing plant. Its unique phytochemical composition, comprising a diverse array of bioactive compounds, contributes to its multifaceted therapeutic effects. In recent years, scientific research has delved deeper into unraveling the intricate phytochemistry of *Aloe vera* and elucidating its therapeutic potential across various health domains.

This comprehensive analysis aims to explore the phytochemistry of *Aloe vera* in depth, shedding light on its rich composition of bioactive constituents and their respective roles in promoting health and well-being. From polysaccharides and anthraquinones to enzymes, vitamins, minerals, and beyond, *Aloe vera* harbors a treasure trove of phytochemicals that exert diverse pharmacological effects. By synthesizing the latest scientific evidence alongside traditional wisdom, this analysis seeks to provide a holistic understanding of *Aloe vera*'s therapeutic benefits and its applications in modern healthcare practices.

Throughout this analysis, we will delve into the mechanisms of action underlying *Aloe vera*'s medicinal properties, examining its efficacy in skin health, digestive disorders, immune support, antioxidant activity, anti-inflammatory effects, oral health, diabetes management, and more. By elucidating the pharmacological actions of key phytochemicals present in *Aloe vera*, we aim to offer insights into its potential therapeutic applications and provide guidance for harnessing its benefits in clinical practice and everyday wellness routines.

As scientific interest in herbal medicine and natural remedies continues to grow, Aloe vera stands out as a botanical powerhouse with immense therapeutic potential. Through rigorous scientific inquiry and empirical evidence, we endeavor to unravel the mysteries of Aloe vera's phytochemistry and unlock its full healing potential for the betterment of human health and quality of life

ACTIVE COMPONENTS WITH ITS PROPERTIES:

Aloe vera contains 75 potentially active constituents:

Vitamins: It contains vitamins A (beta-carotene), C and E, which are antioxidants. It also contains vitamin B12, folic acid, and choline. Antioxidant neutralizes free radicals.

Enzymes: It contains 8 enzymes: aliiase, alkaline phosphatase, amylase, bradykinase, carboxypeptidase, catalase, cellulase, lipase, and peroxidase. Bradykinase helps to reduce excessive inflammation when applied to the skin topically, while others help in the breakdown of sugars and fats.

Minerals: It provides calcium, chromium, copper, selenium, magnesium, manganese, potassium, sodium and zinc. They are essential for the proper functioning of various enzyme systems in different metabolic pathways and few are antioxidants.

Sugars: It provides monosaccharides (glucose and fructose) and polysaccharides: (glucomannans/polymannose). These are derived from the mucilage layer of the plant and are known as mucopolysaccharides. The most prominent monosaccharide is mannose-6-phosphate, and the most common polysaccharides are called glucomannans [beta-(1,4)-acetylated mannan]. Acemannan, a prominent glucomannan has also been found. Recently, a glycoprotein with antiallergic properties, called alprogen and novel anti-inflammatory compound, C-glucosyl chromone, has been isolated from Aloe vera gel.

Anthraquinones: It provides 12 anthraquinones, which are phenolic compounds traditionally known as laxatives. Aloin and emodin act as analgesics, antibacterials and antivirals.

Fatty acids: It provides 4 plant steroids; cholesterol, campesterol, β -sisosterol and lupeol. All these have anti-inflammatory action and lupeol also possesses antiseptic and analgesic properties.

Hormones: Auxins and gibberellins that help in wound healing and have anti-inflammatory action.

Others: It provides 20 of the 22 human required *amino acids* and 7 of the 8 essential amino acids. It also contains salicylic acid that possesses anti-inflammatory and antibacterial properties. Lignin, an inert substance, when included in topical preparations, enhances penetrative effect of the other ingredients into the skin. Saponins that are the soapy substances form about 3% of the gel and have cleansing and antiseptic properties.

THERAPEUTIC USES:

Healing properties: Glucomannan, a mannose-rich polysaccharide, and gibberellin, a growth hormone, interacts with growth factor receptors on the fibroblast, thereby stimulating its activity and proliferation, which in turn significantly increases collagen synthesis after topical and oral Aloe vera. Aloe gel not only increased collagen content of the wound but also changed collagen composition (more type III) and increased the degree of collagen cross linking. Due to this, it accelerated wound contraction and increased the breaking strength of resulting scar tissue. An increased synthesis of hyaluronic acid and dermatan sulfate in the granulation tissue of a healing wound following oral or topical treatment has been reported.

Effects on skin exposure to UV and gamma radiation: Aloe vera gel has been reported to have a protective effect against radiation damage to the skin. Exact role is not known, but following the administration of aloe vera gel, an antioxidant protein, metallothionein, is generated in the skin, which scavenges hydroxyl radicals and prevents suppression of superoxide dismutase and glutathione peroxidase in the skin. It reduces the production and release of skin keratinocyte-derived immunosuppressive cytokines such as interleukin-10 (IL-10) and hence prevents UV-induced suppression of delayed type hypersensitivity.

Anti-inflammatory action: Aloe vera inhibits the cyclooxygenase pathway and reduces prostaglandin E2 production from arachidonic acid. Recently, the novel anti-inflammatory compound called C-glucosyl chromone was isolated from gel extracts.⁸

Effects on the immune system: Alprogen inhibit calcium influx into mast cells, thereby inhibiting the antigen-antibody-mediated release of histamine and leukotriene from mast cells. In a study on mice that had previously been implanted with murine sarcoma cells, acemannan stimulates the synthesis and release of interleukin-1 (IL-1) and tumor necrosis factor from macrophages in mice, which in turn initiated an immune

attack that resulted in necrosis and regression of the cancerous cells. Several low-molecular-weight compounds are also capable of inhibiting the release of reactive oxygen free radicals from activated human neutrophils.

Laxative effects: Anthraquinones present in latex are a potent laxative. It increases intestinal water content, stimulates mucus secretion and increases intestinal peristalsis.

Antiviral and antitumor activity: These actions may be due to indirect or direct effects. Indirect effect is due to stimulation of the immune system and direct effect is due to anthraquinones. The anthraquinone aloin inactivates various enveloped viruses such as herpes simplex, varicella zoster and influenza. In recent studies, a polysaccharide fraction has shown to inhibit the binding of benzopyrene to primary rat hepatocytes, thereby preventing the formation of potentially cancer-initiating benzopyrene-DNA adducts. An induction of glutathione S-transferase and an inhibition of the tumor-promoting effects of phorbol myristic acetate has also been reported which suggest a possible benefit of using aloe gel in cancer chemoprevention.

Moisturizing and anti-aging effect: Mucopolysaccharides help in binding moisture into the skin. Aloe stimulates fibroblast which produces the collagen and elastin fibers making the skin more elastic and less wrinkled. It also has cohesive effects on the superficial flaking epidermal cells by sticking them together, which softens the skin. The amino acids also soften hardened skin cells and zinc acts as an astringent to tighten pores. Its moisturizing effects has also been studied in treatment of dry skin associated with occupational exposure where aloe vera gel gloves improved the skin integrity, decreases appearance of fine wrinkle and decreases erythema. It also has anti-acne effect.

Antiseptic effect: Aloe vera contains 6 antiseptic agents: Lupeol, salicylic acid, urea nitrogen, cinnamonic acid, phenols and sulfur. They all have inhibitory action on fungi, bacteria and viruses.

Chemical Component	Medicinal Properties
Polysaccharides	Complex carbohydrates with immunomodulatory, anti-inflammatory, and wound-healing properties.
Anthraquinones	Organic compounds with laxative effects, including aloin, emodin, and barbaloin.
Enzymes	Various enzymes such as amylase, lipase, and bradykinase with anti-inflammatory and digestive benefits.
Vitamins	Essential nutrients including vitamins A, C, E, and B complex, contributing to overall health and immunity.
Minerals	Trace elements like calcium, magnesium, zinc, and selenium, vital for metabolic functions and cellular health.
Amino Acids	Building blocks of proteins, with roles in tissue repair, muscle growth, and neurotransmitter synthesis.
Salicylic Acid	Beta hydroxy acid with exfoliating and anti-inflammatory properties, beneficial for skin health.
Saponins	Glycosides with detergent-like properties, exhibiting antimicrobial and anti-inflammatory effects.
Flavonoids	Antioxidant compounds that scavenge free radicals, reducing oxidative stress and inflammation.
Sterols	Plant-derived compounds with cholesterol-lowering and anti-inflammatory properties.
Lignin	Insoluble fiber with humectant properties, aiding in moisture retention and skin hydration.
Phenolic Compounds	Polyphenols with antioxidant, anti-inflammatory, and

	anticancer activities.
Glycoproteins	Protein-carbohydrate complexes with immunomodulatory and wound-healing effects.
Acemannan	A type of polysaccharide with immunostimulatory and antiviral properties.
Aloin	Laxative, anti-inflammatory
Aloesin	Antioxidant, anti-inflammatory
Gibberellins	Anti-inflammatory, wound healing, skin repair
Flavonoids	Antioxidant, anti-inflammatory, cardiovascular support

Table containing active components found in Aloe vera and their Medicinal Properties

SIDE EFFECTS:

Topical: It may cause redness, burning, stinging sensation and rarely generalized dermatitis in sensitive individuals. Allergic reactions are mostly due to anthraquinones, such as aloin and barbaloin. It is best to apply it to a small area first to test for possible allergic reaction.

Oral: Abdominal cramps, diarrhea, red urine, hepatitis, dependency or worsening of constipation. Prolonged use has been reported to increase the risk of colorectal cancer. Laxative effect may cause electrolyte imbalances (low potassium levels).

Contraindication: Contraindicated in cases of known allergy to plants in the Liliaceae family.

Pregnancy and breastfeeding: Oral aloe is not recommended during pregnancy due to theoretical stimulation of uterine contractions, and in breastfeeding mothers, it may sometime causes gastrointestinal distress in the nursing infant.

Interactions: Application of aloe to skin may increase the absorption of steroid creams such as hydrocortisone. It reduces the effectiveness and may increase the adverse effects of digoxin and digitoxin, due to its potassium lowering effect. Combined use of Aloe vera and furosemide may increase the risk of potassium depletion. It decreases the blood sugar levels and thus may interact with oral hypoglycemic drugs and insulin.

Thus, though Aloe vera has wide spectrum of the properties and uses, some of them could be myths and some of them could be real magic. In future, controlled studies are required to prove the effectiveness of Aloe vera under various conditions.

CONCLUSION:

Hence there is no wonder in considering *Aloe vera* as the 'Wonder plant'. It's uses as multiple from like an antiseptic, anti-inflammatory agent, a curing agent for heart problems, helps in relieving the symptoms of severe illnesses like cancer and diabetes, being a beauty enhancer and improves health. This Ancient Indian herb has been known from centuries for its unique medicinal properties, but now it has been rediscovered and recognized as beneficial for the human beings. The active ingredients hidden in its succulent leaves have the power to smooth human life and health in a myriad ways. So, more and better trial data are needed to define the clinical effectiveness of this popular herbal remedy precisely. *Aloe vera* is undoubtedly, the nature's gift to humanity and it remains for us to introduce it to ourselves and thank the nature for its never-ending gift.

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