

## BIOLOGICAL AND PHARMACOLOGICAL APPLICATIONS OF ALOE VERA

Aloe vera has been used in folk medicine for over 2,000 years and remains an integral element of the traditional medicine of numerous contemporary cultures, including China, India, the West Indies, and Japan. Extensive research has been conducted on the therapeutic properties of *A. vera*, and its gel is used in a variety of industries, including cosmetics, pharmaceuticals, and food. In addition, *A. vera* is renowned for its ability to thrive in arid conditions, and its succulent leaves enable it to survive in severe environments. *Aloe vera* is highly esteemed for its medicinal properties and has been used for centuries to treat a variety of conditions. Its bioactive constituents, such as vitamins, minerals, and antioxidants, account for its therapeutic properties. Moreover, aloe vera gel has shown promise for promoting wound healing, reducing inflammation, and soothing skin irritations (McMullen, 2023).

The plant *Aloe vera* is a succulent. The large water storage tissue that distinguishes succulents, which are xerophytes that have evolved to survive in low-water environments, the primary characteristic of the *A. vera* plant is its high water content, which ranges between 99.5% and 99.5% (Saxena et al, 2006). According to reports, the remaining 0.5–1% solid material contains over 75 potentially active compounds, including water- and fat-soluble vitamins, minerals, enzymes, simple and complex polysaccharides, phenolic compounds, and organic acids. Compositional analyses of the structural components of *A. vera* plant leaf portions revealed that the cuticle accounts for 20–30% and the pith for 70–80% of the leaf's total weight. On a dry weight basis, the proportions of lipids (2.7% and 4.2%) and proteins (6.3% and 7.3%) in the rind and pith represented a negligible amount. No starch polysaccharides and lignin, however, comprised the majority of each leaf fraction, comprising 62.3% and 57.6% of the dried weight of the epidermis and pulp, respectively (Hamman, 2008).

Aloe vera is renowned for its significant medicinal properties. This plant is one of the most abundant natural sources of human health. The plant's chemistry has revealed the presence of over 200 distinct biologically active compounds. The inner substance of the leaves contributes to a number of the biological characteristics of aloe species (Radha et al, 2014). The majority of research has focused on the biological activities of the diverse aloe species, including the antibacterial and antimicrobial activities of the non-volatile constituents of the leaf gel. Aloe species are widespread across the African and eastern European continents, as well as the rest of the globe. There are more than 400 species in the genus *Aloe*, but only a few, including *A. vera*, *Aloe ferox*, and *Aloe arborescens*, are globally traded. The medicinal properties of *A. vera* include antitumor, antiarthritic, antirheumatoid, anticancer, and antidiabetic properties. In addition, *A. vera* has also been promoted for constipation, gastrointestinal disorders, and immune system deficiencies. *A. vera* gel polysaccharides are linear chains of glucose and mannose molecules, with mannose being more concentrated than glucose; consequently, these molecules are known as polymannans. The length of these linear chains ranges from a few to several thousand molecules.

Aloe was available in tablet, ointment, jelly, aerosol, and drink forms, among others. Important applications of aloe vera include wound healing, treating burns, anti-inflammatory,

anti-diabetic, anti-cancer, anti-ulcer, protection against skin damage from x-rays, lung cancer, intestinal problems, increasing HDL, reducing LDL, lowering blood glucose in diabetics, combating acquired immune deficiency syndrome (AIDS), allergies, and so on (Sánchez et al, 2020). Additionally, antimicrobial properties have been identified in aloe vera, making it effective against a variety of infections. Due to its cathartic properties, aloe vera may also improve digestion and alleviate constipation, according to studies.

This article concentrates on the biological composition of aloe vera and its various phytochemicals, which have various biological properties that aid in improving health and preventing disease. The latex and gel comprise components with biological activity. The majority of aloe vera's health advantages are attributable to polysaccharides found in the gel of the leaf.

## I. PHYTOCHEMICALS IN ALOE VERA

- 1. Active Components of Aloe Vera:** The leaf gel of aloe vera contains approximately 98% water. The total solid content of aloe vera gel is 0.66 percent, and the soluble solid content is 0.56 percent, with seasonal variations. Aloe gel is composed of polysaccharides (53%), carbohydrates (17%), minerals (16%), proteins (7%), lipids (5%), and phenolic compounds (2%) (Figure 2). 200 potentially active constituents, including vitamins, enzymes, minerals, carbohydrates, lignin, saponins, salicylic acids, and amino acids, are responsible for aloe's multifunctional activity. These active components contribute to the diverse health benefits of aloe vera, including its anti-inflammatory, antioxidant, and immune-stimulating properties. Additionally, aloe vera has been used in traditional medicine for centuries due to its comforting and restorative impacts on the epidermis (Shalash, 2022).
- 2. Vitamins:** Aloe vera contains the antioxidant vitamins A (beta-carotene), C, and E. Additionally, it contains B12, folic acid, and choline. Antioxidants are substances that neutralise free radicals. Free radicals are unstable molecules that can cause cellular injury and contribute to the onset of chronic diseases. Antioxidants protect the body from oxidative stress and promote overall health by neutralising free radicals. The high antioxidant content of aloe vera, which includes vitamins A, C, and E, makes it a valuable addition to a healthy diet or hygiene regimen (Bista et al., 2020).
- 3. Enzymes:** Aloe vera contains eight different enzymes: amylase, alkaline phosphatase, bradykinase, carboxypeptidase, catalase, cellulase, and lipase. Bradykinase reduces excessive inflammation when applied topically to the epidermis, whereas other enzymes aid in the breakdown of carbohydrates and lipids. Enzymes present in aloe vera contribute to its anti-inflammatory properties and aid digestion. Additionally, aloe vera's enzymes can improve nutrient absorption and promote a healthy microbiome in the intestines (Shekar, 2019).
- 4. Minerals:** Calcium, chromium, copper, selenium, magnesium, manganese, potassium, sodium, and zinc are among the minerals present in aloe vera. A few of them are antioxidants, and they are essential for the effective functioning of diverse enzyme systems in various metabolic pathways. In addition, these minerals are essential for maintaining bone health, regulating blood sugar levels, and boosting the immune system.

The high mineral content of aloe vera ensures that the body receives the necessary nutrients to maintain optimal health and physiological functions (Castellari et al., 2019).

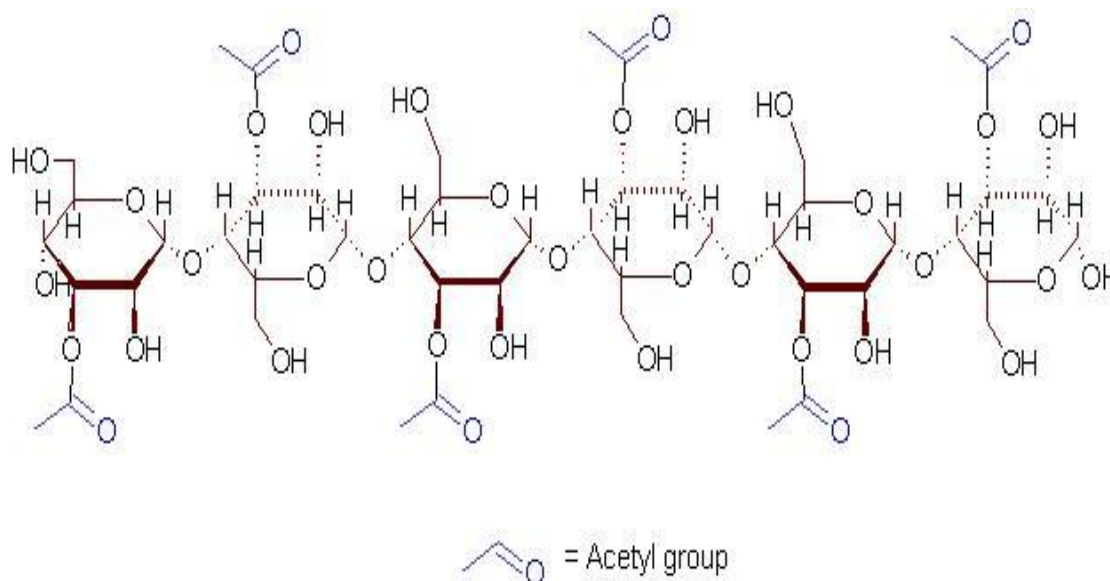
5. **Sugars:** Aloe vera provides monosaccharides (glucose and fructose) and polysaccharides (glucomannans and polymannose). These are derived from the mucilage layer of the plant and are known as mucopolysaccharides. Aloe vera has recently been used to find a glycoprotein called alprogen that helps fight allergies and a new compound called C-glucosyl chromone that helps fight inflammation. These compounds have shown potential for reducing allergic reactions and inflammation in the body (Sunil Mishra et al., 2023). Additionally, aloe vera also contains vitamins, minerals, and antioxidants that contribute to its overall health benefits.
6. **Anthraquinones:** It provides 12 anthraquinones, which are phenolic compounds traditionally known as laxatives. Aloin and emodin act as analgesics, antibacterials, and antivirals. These anthraquinones have been found to have potential benefits for promoting digestive health and relieving constipation. Furthermore, aloe vera's analgesic, antibacterial, and antiviral properties make it a promising natural remedy for various skin conditions and infections (Sunil Mishra et al., 2023).
7. **Fatty Acids:** It contains four plant steroids, including cholesterol, campesterol, sisosterol, and lupeol. Each of these contains carbohydrates in the form of monosaccharides (glucose and fructose) and polysaccharides (glucomannans and polymannose). Mucopolysaccharides are derived from the mucilage layer of plants. Aloe vera has recently been used to find a glycoprotein called alprogen that helps fight allergies and a new anti-inflammatory compound called C-glucosyl chromone that helps fight inflammation. These substances have shown the ability to decrease allergic reactions and inflammation in the body (Langmead et al., 2004). In addition to its overall health benefits, aloe vera contains antioxidants, vitamins, and minerals. anti-inflammatory properties, in addition to antiseptic and analgesic properties. In addition to its health benefits, aloe vera contains fatty acids. Cholesterol, campesterol, sisosterol, and lupeol are examples of these fatty acids. In addition to possessing anti-inflammatory properties, lupeol also possesses antiseptic and analgesic properties. These properties increase the potential of aloe vera as a natural remedy for various ailments.
8. **Hormones:** Auxins and gibberellins are hormones that promote wound healing and have anti-inflammatory properties. In addition to hormones, aloe vera contains polysaccharides that promote immune health and reduce inflammation. These polysaccharides stimulate the production of white blood cells, thereby improving the body's ability to combat infections and cure lesions (Hosseini Yazdi, 2019). The combination of hormones and polysaccharides found in aloe vera makes it a potent natural remedy with multiple therapeutic benefits.

## II. IN VITRO PHARMACOLOGICAL STUDIES FOR ALOE VERA

1. **Acemannan:** Acemannan is an aloe vera (*Barbadensis milleri*)-derived (1,4)-acetylated mannan-based polysaccharides. Acemannan (AC) is a naturally occurring polysaccharide derived from aloe vera that is biodegradable and biocompatible. It has numerous

biomedical applications due to its immunomodulatory, antiviral, antitumor, and tissue regeneration properties (Minjares-Fuentes et al., 2017).

The osteogenic, anti-inflammatory, and antibacterial properties of acemannan speed up lesion healing. In addition, acemannan is known to possess antiviral and antitumor properties *in vivo* by stimulating immune responses (Escobedo-Lozano et al., 2015). In addition, it has been discovered that acemannan promotes collagen synthesis and improves wound healing by stimulating fibroblast proliferation. In addition, research has demonstrated that acemannan effectively reduces the inflammation and discomfort associated with a variety of inflammatory conditions, making it a prospective therapeutic agent for the treatment of inflammatory diseases.



**Figure 1:** Chemical structure of Acemannan

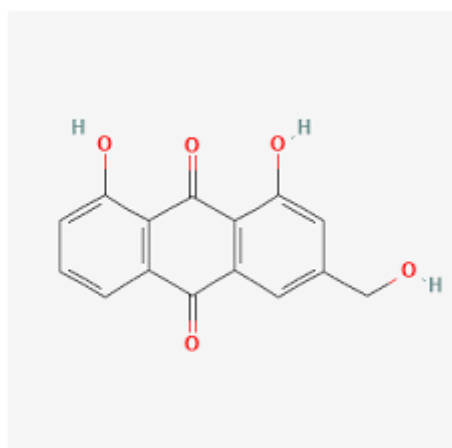
Acemannan is a water-soluble, polydispersed beta-mannan polymer derived from Aloe vera plant material. It is labelled for the treatment of sarcomas in canines and cats. For the treatment of fibrosarcoma, a combination of the intralesional and intraperitoneal administration routes is recommended.

The osteogenic, anti-inflammatory, and antibacterial properties of acemannan speed up lesion healing. In addition, acemannan is known to possess antiviral and antitumor properties *in vivo* by stimulating immune responses. It was determined that aloe vera has enormous therapeutic potential (Bai et al., 2023).

The principal polysaccharide, acemannan, is composed of one or more polymers with varying chain lengths and molecular weights between 30 kDa and 40 kDa or greater. It is composed of glucose and mannose units repeated at a ratio of 1:3. Aloe vera gel contains a highly complex polysaccharide called acemannan. It has been investigated for its potential health benefits, such as immune support and wound healing properties. It is believed that the 1:3 ratio of glucose to mannose in acemannan contributes to its biological activity. The unique structure of acemannan enables it to interact with immune cells and stimulate their activity, thereby enhancing the immune response. Additionally,

acemannan has been demonstrated to stimulate the production of wound-healing growth factors and collagen.

- Aloe emodin:** Emodin is a naturally occurring anthraquinone compound with medicinal properties. It is a potent inhibitor of numerous cellular signalling pathways. It has been demonstrated that emodin inhibits neoplastic processes at the proliferation, invasion, and angiogenesis stages. In addition to treating cholelithiasis and hepatitis, emodin is also used to treat bacterial and viral infections. Emodin's high therapeutic potential derives from its ability to interact with numerous inflammatory and cancer-related molecular targets (Goyal et al., 2023). In addition, emodin, in combination with other biologically active substances such as baicalin or liquiritin, has been demonstrated to be an anti-inflammatory agent. Moreover, emodin has the potential to treat ulcerative colitis, keratitis, cardiac fibrosis, and arthritis. Recent research indicates that emodin isolated from *Artemisia annua* has antimalarial properties. An *in vivo* investigation demonstrated that emodin has analgesic properties. In addition, emodin has demonstrated promising results in inhibiting the proliferation of certain cancer cells, making it a potential cancer treatment candidate. In addition, research indicates that emodin possesses antioxidant properties, which may contribute to its therapeutic effects in a variety of diseases (Saunders et al., 2017).

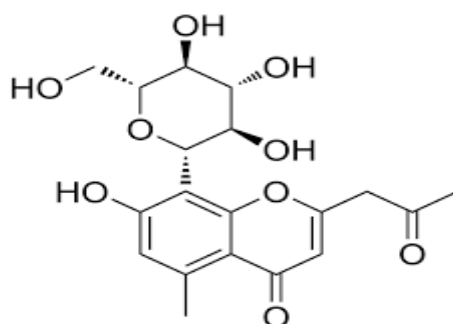


**Figure 2:** Chemical structure of Aloe Emodin

The activity of emodin and its derivatives is related to their influence on inflammatory processes and immunomodulatory activity. Due to the uncertainty surrounding the safety of emodin's use in pharmacotherapy, *in vivo* studies on mice have been conducted to determine its safe dosage. Emodin stops the growth of many different types of cancer by controlling the expression of genes that are involved in carcinogenesis, apoptosis, proliferation, invasion, and metastasis of cancer cells. Dumit et al. determined the effects of emodin on the redox state of cells and mitochondrial homeostasis. They discovered that cells with an effective respiratory metabolism are less susceptible to emodin, while cells with a glycolytic metabolism are more susceptible. In addition, they demonstrated that emodin induces oxidative stress, which is particularly disruptive to cancer cells.

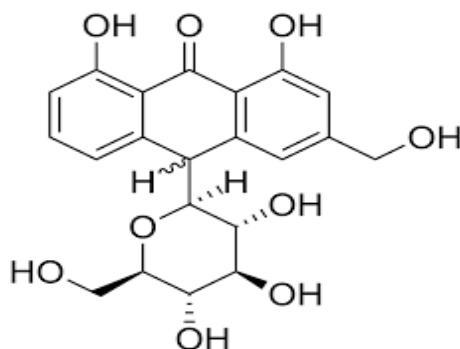
3. **Aloesin:** Aloesin is a C-glycosylated chromone derived from the Aloe vera plant. As a competitive tyrosinase inhibitor, it is known to diminish skin pigmentation by delaying both the conversion of tyrosine to dihydroxyphenylalanine and the conversion of dihydroxyphenylalanine to dopachinone (Choi S. et al., 2002).

Aloe vera stimulates fibroblasts, which produce collagen and elastin filaments, resulting in more elastic and wrinkle-free skin. It also has cohesive effects on the superficial, disintegrating epidermal cells, which soften the skin by adhering them together. This botanical extract promotes the skin's natural regenerative capacity and is used to treat pigmentation irregularities. This glycoprotein also has skin-soothing properties and provides UV-ray protection.



**Figure 3:** Chemical structure of Aloesin

4. **Aloin or barbaloin:** Aloin is an active ingredient present in the leaves of Aloe-genus medicinal plants. The anti-inflammatory, anti-cancer, antimicrobial, and antioxidant properties of aloe vera have attracted considerable interest. Barbaloin, or aloe B, is the substance that gives aloe fluid its high concentration. These elements are anthraquinones with a variety of applications (Jensen et al., 2015). They are potent antibiotics with antibacterial and antiviral properties, as well as analgesic properties. When consumed internally, pure aloe vera is a potent laxative; when combined with the rest of the plant, it merely functions as a digestive tonic. It has extraordinary pain-relieving and tissue-regenerating properties as well. When combined with a lubricant and applied to the epidermis, it produces an effective UV filter.

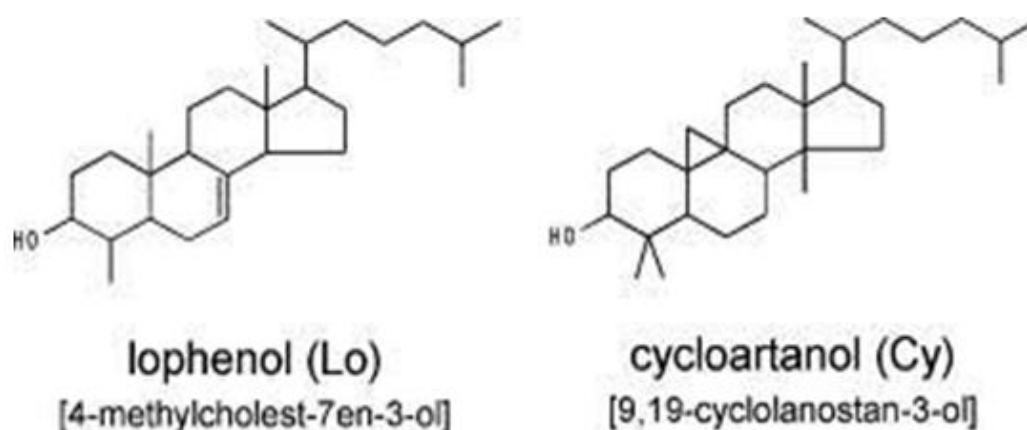


**Figure 4:** Chemical structure of Aloin

- 5. Aloe sterols:** Two categories of compounds make up aloe sterol: the lophenol and cycloartane groups. Lophenol, 24-methyl-lophenol, and 24-ethyl-lophenol comprise the lophenol group. Cycloartane is a group that contains cycloartanol and 24-methylene-cycloartanol. It has been discovered that these compounds have numerous health benefits, including anti-inflammatory and immune-modulating properties (Tanaka *et al.*, 2016). Additionally, aloe sterols have demonstrated the potential to promote wound healing and reduce the risk of UV-induced skin injury.

Aloe sterol consumption contributes to the maintenance of a healthy epidermis. In addition, aloe sterols have been found to have anti-inflammatory properties, which can help reduce erythema and irritation on the skin. In addition, research has demonstrated that regular consumption of aloe sterols can support the body's natural collagen production, resulting in enhanced skin elasticity and a more youthful appearance (Kaminaka *et al.*, 2020).

The aloe sterol group had higher levels of skin moisture, skin elasticity, and collagen scores than the placebo group. In addition, ultrasound echogenicity revealed that aloe sterol supplementation increased dermal collagen content.



**Figure 5:** Chemical structure of Aloe Sterol

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