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Medicinal Properties of Aloe Vera: A Review

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Abstract
Aloe vera, a succulent plant species of the genus Aloe, has been utilized for centuries in traditional medicine for its wide range of health benefits. This review explores the structural and chemical composition of Aloe vera, highlighting its biological activities, including anti-inflammatory, anti-oxidant, anti-cancer, anti-diabetic,wound healing, anti-microbial, immunomodulatory, gastroprotective, hepatoprotective and antiviral effects, are examined in detail. This paper aims to provide a thorough understanding of Aloe vera's medicinal properties and its applications in modern healthcare system.

Keywords: Aloe vera, Compositions, Medicinal properties

Introduction:

Aloe vera is a popular plant that has been used for many years due to its wide range of health benefits. Aloe vera is found in different countries around the world. The plant is undoubtedly detectable by its thick, juicy leaves which accommodate a clean gel like material. This gel is important to Aloe vera's healing properties, which is used for their capability treat skin diseases like burns,cuts, and wounds, additionally to assist good health. For many years, Aloe vera has been used not only for skin disease but also used for internal health development and well-being. People used it to treat gastrointestinal diseases on the stomach and intestines. It’snot benefited only to skin or digestion, Aloe vera is also known for its anti-inflammatory and anti-oxidant properties. The juicy gel of Aloe vera holds vitamins, minerals and other compounds that work simultaneously to promote good health. Aloe vera plays an important role in treating some major health concerns. Many Studies indicates that it could be helpful in maintaining diabetes by controlling sugar levels in blood. This plant is also known for its anti-cancer properties. Some experiments have found that some certain compounds in the plant could be helpful in fighting with cancer cells. It may have ability to boostup the immune system and protection against infections made it a more valuable herbal plant in modern healthcare. On the other side Aloe vera is also known for its immunomodulatory activity which can balance the immune system by improving its ability to fight with infections while it avoids overactive immune responses that can guide to autoimmune diseases like Rheumatoid Arthritis [RA]. Aloe vera has shown pledge in managing conditions like irritable bowel syndrome. Aloe vera is also known for its hepatoprotective qualities which means it could be helpful in protecting the liver from damage caused by toxic substance and other dangerous materials. It makes a valuable unorthodox medicine for improving liver health

This review focuses to explain the different medicinal properties of Aloe vera, and the wide range of health benefits. Aloe vera is an important plant in traditional and modern medicine with in-progress research revealing the different uses of this amazing plant.

Structural Composition of Aloe Vera:

Aloe vera is a succulent plant renowned for its medicinal properties, primarily due to its unique structural composition. The plant's leaves are thick and fleshy, containing a clear gel rich in various bioactive compounds. This gel contains polysaccharides, especially acemannan, which gives to its therapeutic effects. Additionally, Aloe vera contains anthraquinones, like emodin and aloin, known for their laxative properties and potential therapeutic benefits [1,2]. The plant also contains vitamins, minerals, amino acids, enzymes, fatty acids and several organic compounds, allprovides to its health-promoting qualities.

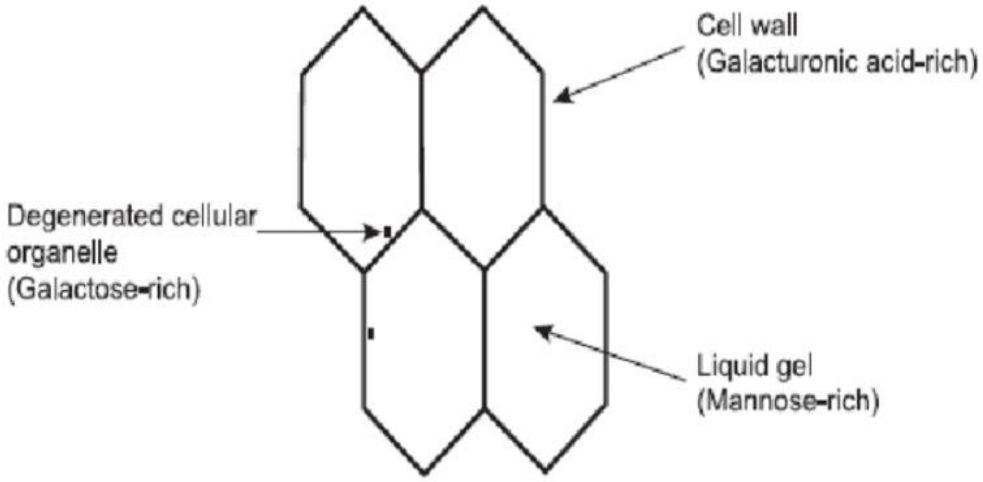

Figure 1. Schematic representation of aloe vera leaf pulp structure and its components [17]

Chemical composition and their structures:

Aloe verais renowned for its variety of chemical composition, which contributes to its various medicinal and cosmetic uses. Below is an overview of its key chemical constituents and their structures.

Table 1: Chemical composition of Aloe vera

S.No	Compounds	Types of compounds
1	**Polysaccharide**	Acemannan, Polymannose,Glucomannans
2	**Anthraquinone**	Aloin, Emodin, Isobarbaloin
3	**Vitamins**	Retinol, Ascorbic acid, folic acid, α-tocopherol, B-complex
4	**Minerals**	Potassium, Calcium, Magnesium, Selenium, Zinc, Iron
5	**Enzymes**	Amylase, Lipase,Cellulase, Phosphatase,
6	**Fatty acids**	Palmitic acid, Linoleic acid,
7	**Organic compounds**	triglycerides,lignin, Arachidonic acid, potassium sorbate, linolenic acid, triterpenoid, gibberellins

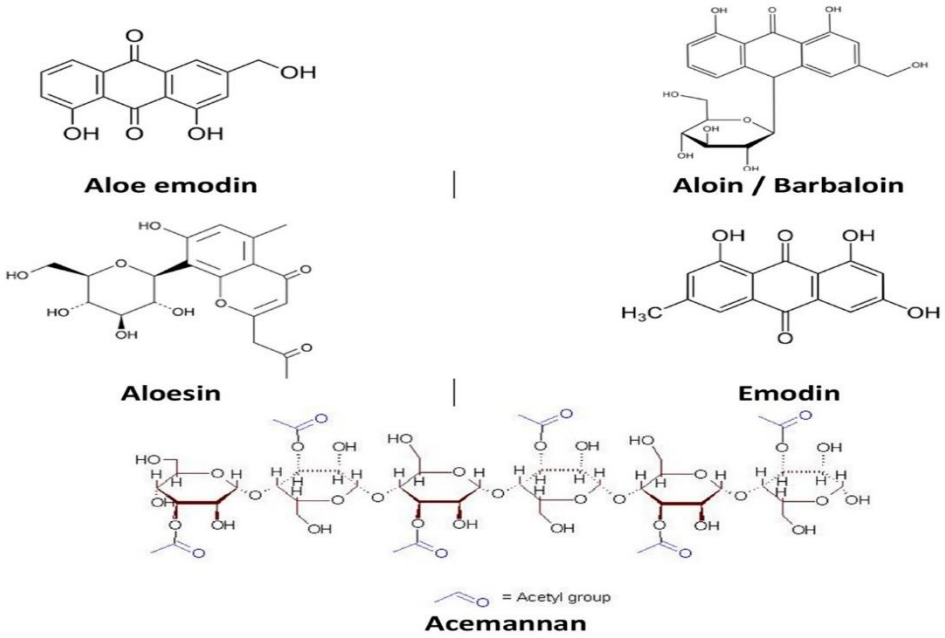

Figure 2. Chemical structure of compounds of *Aloe vera* [3]

Review of literature:

Antidiabetic Properties:

Alethia Muñiz-Ramirezet al [4] conducted a researchupon antidiabetic activity of aloe vera leaves to evaluate the potential of using methanol leaf extract of aloe vera to prevent the the formation ofAGEs by means of the BSA/glucose assay and concluded that methanol leaf extract efficiently blocked the glycation reaction of protein in the BSA/glucose system which may due to oxidative degradation of fructosamine. Shevy KaruniaCahyaningtias& I Gusti Made Sanjaya [9] conducted a research to know the potential effect of Aloin B Compound and its Derivatives to treat Type-2 diabetes using the Quantitative Structure-Activity Relationship (QSAR) and Molecular Bonding method and the results showed that the ID S22 compound with the IUPAC name (S)-10-amino-1,2,8-trihydroxy-6-(hydroxymethyl) -10- ((2R,3R,4S,5S,6R) -2,3, 4,5-tetrahydroxy–6(hydroxymethyl) tetrahydro-2H-piran-2-yl) anthracene-9(10H)- one is the more potent compound which is the derivative of Aloin B as a type-2 antidiabetic agent.

Wound healing Properties:

Oryan et al. [13] investigated the effect of Aloe vera on wound healing. He found that its local application greatly boost the recovery process. The study focused that Aloe vera improves fibroblast activity, boosts collagen production, and accelerates tissue regeneration, leading to faster wound healing. Similarly, Teplicki et al. [14] examined how Aloe vera determines wound healing at the cellular level. Their conclusion shows that it promotes the proliferation and migration of keratinocytes and fibroblasts, both are important for tissue repair. The study concluded that the plant's bioactive compounds attributes to wound healing effectively by speedup cell growth and improving tissue regeneration.

Anti-cancer activity:

Aloevera plant contain many bio active compounds such as aloe-emodin (1,8- dihydroxy-3-(hydrxymethyl)anthraquinone) which is present in leaf, aloin found within the Aloe vera gel extricate, apart from thataloesin, umbeliferone, crysophanol, aloe-saponarin I & II, acemannan, esculetinhave the ability to fight against cancer reported by Abhirup Mitra et al [10].

Anti-microbial Properties:

MALIK A et al.[8] studied the antibacterial and antifungal activity of aloe vera plant extract against different strain of bacteria and pathogenic fungal strain such as Bacillus cereus, Bacillus subtitis, Bacillus megaterium, Streptococcus pyogenes, Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Acinetobacter baumannii and obtained the result that the ethanol exrtract of aloe vera is able to effective against Gram-negative pathogen, Gram-positive pathogens and some fungal pathogens. So we can use Aloe Vera as antimicrobial agent in new drugs for treatment of infectious disease in human. Ka Hee Kwon et al. [11] studied the Antimicrobial and immunomodulatory effects of Aloe vera peel extract in distilled water against Staphylococcus aureus, Bacillus spp., Enterococcus spp., Escherichia coli, Salmonella typhimurium, Pseudomonas aeruginosa, and Vibrio spp. and found that the extract is strong against E. coli and Vibrio spp. ($P<0.001$)

Anti-inflammatory activity:

Subhashis Paul et al. [5] investigated that the anti-inflammatory action of Aloe vera gel using both laboratory experiments as well as with animal models. They focused on the gel's capability to protect cell membranes, prevent protein denaturation, and regulate inflammation-related gene expression (TNF-α and Cox-2) in arthritic rats. The results showed that Aloe vera gel effectively stable RBC membranes, reduce protein breakdown, and decrease TNF-α and Cox-2 expression in a dose-dependent manner. The study concluded that Aloe vera gel can effectively prevent tissue damage and balance immune responses, indicating its usefulness in managing conditions like inflammatory arthritis.

Anti-oxidant properties:

Khanam, N., and Sharma, G. K. [6] suggested that the antioxidant properties of Aloe vera and its effect benefits for health. The plant is rich in compounds likephenols, flavonoids, and vitamins, which act as antioxidants. These compounds help to neutral the free radicals, reduces oxidative stress and prevents cellular damage. The study suggested that Aloe vera may play a vital role as anti-oxidant for human health

Immunomodulatory properties:

Chandu et al. [15] studied the immunomodulatory properties of Aloe vera and got that its chemical constituents, like polysaccharides, may boost the immune system. Their study stated that Aloe vera could promote macrophage activation, which leads to improved immune responses and better defence against foreign pathogens Inamdar et al. [16] studied the effects of Aloe vera gel on the immune system in mice. Their research shows that by stimulating the cytokines aloe vera could regulate the immune system, thereby improving immune function and can protect against infections.

Hepatoprotective and antiviral effects:

Handayani et al. [7] reported that the possibilities of Aloe vera gel has an ability to protect the liver. The gel contains natural compounds like polysaccharides, phenolics, and flavonoids, which may help to prevent liver damage. The study shows how these compounds work, mainly by reducing inflammation and preventing damage caused by oxidative stress. The review accumulates information from various types of studies and research including computer-based, lab experiments, and animal research. They suggested that Aloe vera gel could be a good liver protector, but more research and clinical trials are needed to confirm its efficacy for human health. Keivan Zandi et al. [12] conducted an in vitro study upon the antiviral activity of Aloe vera against herpes simplex virus type 2 and the result obtained that the crude hot glycerine extract of Aloe vera gel has antiviral activity against herpes simplex virus type 2.

Discussion:

The anti-oxidant, immunomodulatory, anti-microbial, anti-diabetic, anti-inflammatory, gastroprotective, hepatoprotective, and antiviral effects of Aloe vera have been extensively studied, and the evidence suggests that it may be a useful auxiliary therapy in modern healthcare. The diverse medicinal property and presence of many chemical compounds like polysaccharides, glycoproteins, phenolic, vitamins, enzymes, minerals, and Anthraquinone make it different.

Future Perspective:

In this modern era the use of herbal product gaining popularity due to high therapeutic and low side effect. So we should drive more clinical studies to confirm the efficacy, synergic effect and safety therapeutic application of the aloe vera extract. It also may provide conventional medication as well complementary therapy. The development of Aloe vera-based pharmaceuticals and cosmetics may also offer new opportunities for the prevention and treatment of various diseases.

Conclusion:

In conclusion, Aloe vera is a versatile plant species which have wide range of medicinal properties, enhancing its utility in traditional medicine as well as modern medicine system. This review emphasizes the structural and chemical composition of Aloe vera and its various medicinal properties, including anti-inflammatory, anti-oxidant, immunomodulatory,anti-diabetic, wound healing, anti-cancer, anti-microbial, gastroprotective, hepatoprotective, and antiviral effects. As research continues to illuminate the therapeutic potential of Aloe vera, it is likely to become an increasingly important component of modern healthcare.

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