**ALOE VERA AS TRADITIONAL MEDICINAL PLANT: A REVIEW ON ITS ACTIVE CONSTITUENTS, BIOLOGICAL AND THERAPEUTIC EFFECTS**

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**ABSTRACT**

*Aloe vera* is a traditional herbal plant that is frequently used in the field of medicine and cosmetics. In many part of the world this medicinal herb is used both internally and externally. Internally it is used to combat most digestive problems, including constipation, colitis, poor appetite, irritable bowel syndrome, asthma, diabetes, immune system enhancement, peptic ulcers and periodontal diseases where as externally it is used to cure sunburns, burns, minor cuts, skin cancer, cures acne and for glowing skin. Phytochemical constituents like anthraquinones, sugars, sterols, hormones, minerals, enzymes, saponins, lignin, amino acids and vitamins have been isolated. This review presents a detail survey of the literature on various phytochemical constituents and medicinal importance of Aloe vera plant.

**KEY WORDS:** Aloe vera, medicinal use, cosmetic use, phytoconstituents.

**INTRODUCTION**

The *Aloe vera* plant has been known and used for centuries for its health, beauty, medicinal and skin care properties. The name *Aloe vera* derives from the Arabic word “Alloeh” meaning “shining bitter substance,” while “vera” in Latin means “true.” 2000 years ago, the Greek scientists regarded *Aloe vera* as the universal panacea. The peoples of Egyptians used to call Aloe as “the plant of immortality.” Today, the *Aloe vera* plant has been used for various purposes in medicine as well as cosmetics.1] The extract of *Aloe vera* is useful for both humans and animals. In many part of the world *Aloe vera* is used both internally and
externally.\(^2\) Internally it is used to cure most digestive problems, including constipation, colitis, poor appetite, irritable bowel syndrome, asthma, diabetes, immune system enhancement, peptic ulcers and periodontal diseases where as externally it is used to cure sunburns, burns, minor cuts, skin cancer, cures acne and for glowing skin.\(^3\)

**Synonyms of Aloe vera**

The common vernacular names of Aloe vera in India; Sanskrit (Kumarirasasambhava, Sahasara), Assamese (Musabbar, Machambar), Bengali (Ghritakalmi), English (Indian Aloe), Nepali (Gheeukumari), Gujrati (Eliyo, Eariyo), Hindi (Musabhar, Elva), Kannada (Karibola, Lolesara satva, Lovalsara, Lolesara), Kashmiri (Musabbar, Siber), Malayalam (Chenninayakam), Marathi (Korphad), Oriya (Musabara), Punjabi (Kalasohaga, Mussabar, Alua), Tamil (Kattazhi, Satthukkathazhai), Telugu (Musambaram), Urdu (Musabbar, Ailiva, Siber).\(^4\)

**Table 1: Taxonomical classification of Aloe vera**

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Plante – plants</th>
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<tbody>
<tr>
<td>Sub-kingdom</td>
<td>Tracheobionta – Vascular plants</td>
</tr>
<tr>
<td>Super-division</td>
<td>Spermatophyta – Seed plants</td>
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<tr>
<td>Division</td>
<td>Magnoliophyta – Flowering plant</td>
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<tr>
<td>Class</td>
<td>Liliopsida – Monocotyledons</td>
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<tr>
<td>Subclass</td>
<td>Liliidae</td>
</tr>
<tr>
<td>Order</td>
<td>Liliales</td>
</tr>
<tr>
<td>Family</td>
<td>Aloaceae/ Liliaceae – Aloe family</td>
</tr>
<tr>
<td>Genus</td>
<td>Aloe Linn.</td>
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**DISTRIBUTION**

*Aloe vera* is native to the Mediterranean region of southern Europe and North Africa and to the Canary Islands. It is commonly grown in Asia (India, Nepal, Bangladesh, Bhutan, Pakistan) southern Europe, southern USA, Mexico, Aruba, Bonaire, Bermuda, the Bahamas, West Indies, Central and South America.\(^5\)
DESCRIPTION

*Aloe vera* plant has triangular, fleshy leaves with serrated edges, yellow tubular flowers and fruits containing numerous seeds. Leaf is mainly composed of three layers. An inner layer is a clear gel, which contains 99% water and rest is made of glucomannans, amino acids, sterols lipids, and vitamins. The middle layer contains latex which is the bitter yellow sap and contains anthraquinones glycosides and other phytoconstituents. Rind is the outer most thick layer of Aloe vera leaves and which is having protective function and also synthesizes carbohydrates and proteins vascular bundles are present inside the rind which are responsible for transportation of substances such as water (xylem) and starch (phloem).\[^6\]

![Figure 2: Aloe vera leaf structure](image)

**Chemical Constituents**

*Aloe vera* contains more than 75 potentially active constituents such as anthraquinone glycosides, vitamins, enzymes, minerals, sugars, lignin, saponins, salicylic acids and amino acids.\[^7-9\]

**a. Anthraquinones**

*Aloe vera* contains 12 anthraquinones, which are phenolic compound. These anthraquinones acts as laxatives. Aloin and emodin act as analgesics, antibacterials and antivirals. *Aloe vera* also contains aloetic acid, mucopolysaccharides, glucosamines, saponins, choline and chrysamminic acid.

**b. Vitamins**

*Aloe vera* contains vitamin A (beta-carotene), vitamin C and vitamin E, which are having antioxidant property. It also contains vitamin B12, folic acid and choline. Antioxidant neutralizes free radicals.
c. **Enzymes**

*Aloe vera* contains eight enzymes: aliase, alkaline phosphatase, amylase, bradykinase, carboxypeptidase, catalase, cellulase, lipase, and peroxidase. Bradykinase helps to reduce excessive inflammation when applied topically, while others help in the breakdown of sugars and fats.

d. **Sugars**

*Aloe vera* plant contains mono-saccharides (glucose and fructose) and polysaccharides (glucomannans/poly-mannose). These are derived from the mucilage layer of the plant and are known as mucopolysaccharides. The most common monosaccharide is mannose-6-phosphate, and the most prominent 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.\[^{10, 11}\]

e. **Minerals**

*Aloe vera* contains several minerals such as calcium, chromium, copper, selenium, magnesium, manganese, potassium, sodium and zinc. These minerals are essential for the proper functioning of various enzyme systems in different metabolic pathways and few are antioxidants.

f. **Fatty acids**

This plant contains 4 plant steroids; cholesterol, campesterol, β-sisosterol and lupeol. All of these steroids have anti-inflammatory action and lupeol also possesses antiseptic and analgesic properties.
g. **Hormones**

It contains Auxins and gibberellins that help in wound healing and have anti-inflammatory action.

h. **Others**

It contains 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.\(^7\)\(^-\)\(^9\)

**Medicinal uses**

*Aloe vera* is the most efficacious natural plant used both externally and internally and there are numerous health benefits that are derived from this wonderful plant.

[Figure 1: Representing the medicinal utilities of *Aloe vera*]

**External Uses of *Aloe vera***

*Aloe Vera* contains a majority of the amino acids and vitamins, which are beneficial for our skin. The *Aloe vera* gel itself forms glue-like substance on skin which acts as a natural “band aide”, sealing in the nutrients and allowing them to begin working immediately and keeping out any bacteria or agents that could shows healing to slow or cease healing completely. The *Aloe vera* gel is also high in water content which is essential for the body to heal. Although *Aloe vera* is effective when taken orally, it is also beneficial when included in topical formulations like ointment, cream or lotion. It mainly protects the wounds due to its moisturizing properties.\(^{12}\)
i. **Skin care**

*Aloe vera* is used widely in skin care products, as it acts as an astringent, moisturizer, humidifier and cleanser. *Aloe vera* is beneficial to skin, as it softens the skin, diminishes wrinkles and cures acne, herpes, red spots, psoriasis, eczema, mycosis, fever blisters, skin irritation and provides protection to the skin against pollution. It is also ideal for sunburns, fragile skin, and for removal and repair of dead skin and cells.

ii. **Aloe vera cures gum disease**

The *Aloe vera* actually heals gums, so now days it is widely used in periodontal formulations in order to eliminates gum disease, mucositis, lip fissure and mouth herpes lesions.

iii. **Relieves itching aids healing**

*Aloe vera* Juice relieves itching that occurs due to allergies and insect bites and aids healing.

iv. **Aloe Vera relieves joint and muscle pain**

Pain in the joints and muscle pain occurred due to arthritis is reduced by the application of *Aloe vera* sprays or gels.

**Internal Uses of Aloe vera**

Numerous scientific studies on *Aloe Vera* are demonstrating its analgesic, anti-inflammatory, wound healing, immune modulating and anti-tumor activities as well as antiviral, antibacterial, and antifungal properties. Aloe’s medicinal properties can be attributed to the synergistic effect of the combined nutritional elements producing a more powerful effect than the individual components. The nutrients together make a powerful combination that can be used in many different therapies to aid in the treatment of different aliments.\(^{[12]}\)

i. **Provides relief in liver infections**

*Aloe vera* Juice improves the liver function and is an excellent antidote in case of excessive ingestion of alcohol. In addition to this, it also prevents scarring of the liver.

ii. **Acts as an anti-inflammatory agent**

*Aloe vera* juice contains 12 essential nutrients that showed anti-inflammatory action and also have rare incidence of side effects. Also, the juice of *Aloe vera* improves joint and muscle mobility.

iii. **Cures stomach and intestinal problems**

*Aloe vera* Juice prevents stomach ulcers, facilitates digestion and intestinal transit.
iv. **Aloe vera stabilizes blood sugar and reduces cholesterol in diabetics**
Laboratory studies show that *Aloe vera* can stimulate insulin release from the pancreas and can lower blood glucose levels in mice.

v. **Cholesterol and triglyceride levels can be lowered naturally with Aloe vera**
High cholesterol is a risk factor that may often lead to heart disease and strokes. According to medical studies that were conducted, the benefits of the *Aloe vera* gel when taken internally were proven. The results confirmed that when the *Aloe vera* gel was administered to patients with heart disease and high cholesterol, these conditions were reduced to a lowered risk.

vi. **Antiviral and anti-tumor activity**
*Aloe vera* facilitates the stimulation of immune system that in turn protects the body against viral and tumor related disorders.

**Side Effects of Aloe vera**

a) **Topical**
*Aloe vera* may cause redness, burning, stinging sensation and rarely generalized dermatitis in aloe sensitive individuals. Allergic reactions are mostly due to presence of anthraquinones, such as aloin and barbaloin. It is best to apply it to a small area first to test (patch test) for possible allergic reaction.\(^{12}\)

b) **Oral**
Abdominal cramps, diarrhea, red urine, dependency or worsening of constipation and hepatitis has been reported in some individual, Prolong use of Aloe vera has been reported to increase the risk of colorectal cancer. Laxative effect may cause electrolyte imbalances in the individual (low potassium levels).\(^{12}\)

**Contraindication of Aloe vera**
*Aloe vera* is contraindicated in cases of known allergy to plants in the Liliaceae family.\(^{12}\)

**Pregnancy and breastfeeding**
During pregnancy oral aloe is not recommended due theoretical stimulation of uterine contractions, and also in breastfeeding mothers as it may sometime causes gastrointestinal distress in the nursing infant.\(^{12}\)
Pharmacological Activities

Anti-ulcer activity
This study was performed to determine the effects of *Aloe vera* on indomethacin induced ulcers in albino rats. *Aloe vera* extract showed statistically significant anti-ulcer activity comparable to standard drug Omeprazole. The mean ulcer indexes of two drugs are formed to be statistically significant. Therefore, the results were suggestive of anti-ulcerogenic activity of *Aloe vera*. However, the cellular mechanisms for anti-ulcerogenic actions remain to be established.[13]

Antitumor activity
Antitumor property of 50% ethanol extract (100 mg/kg) of *Aloe vera* was evaluated against Ehrlich ascites carcinoma (EAC) tumor in mice. The effect of *Aloe vera* on the growth of transplantable ascites tumor, body weight of EAC bearing hosts and simultaneous alterations in the hematological profile, serum proteins (ALT, AST, LDH, ALP and glucose) and liver biochemical parameters (lipid per oxidation, GSH and antioxidant enzymes) were estimated. The 50% ethanol extract of *Aloe vera* exhibited antitumor effect by modulating lipid per oxidation and augmenting antioxidant defense system in EAC bearing mice.[14]

Antiviral activity
Antiviral activities of the crude hot glycerine extract of *Aloe vera* gel which was grown in Bushehr (Southwest of Iran) against HSV-2 replication in Vero cell line has been studies. The extract showed antiviral activity against HSV-2 not only before attachment and entry of virus to the Vero cells but also on post attachment stages of virus replication. Therefore, compounds of *Aloe vera* from Bushehr could be a good candidate for antiviral activity.[15]

Anxiolytic activity
*Aloe vera* was evaluated for its CNS activities in mice and different behavioral activities for anxiety and depression were tested on exploratory activity, open field test, Swimming-induced depression test, stationary rod test, cage crossing and inclined plane test. *Aloe vera* was administered orally in both sexes of mice (male and female) and was found to cause significant depression in general as well as exploratory behavioral profiles. The results showed that *Aloe vera* extract caused reduction of exploratory and loco-motor activities along with the significant decrease in traction in an inclined plane test. The results suggest that *Aloe vera* may have anxiolytic potential with sedative action.[16]
Aloe vera was also evaluated for CNS activities in mice and different behavioral activities for anxiety and depression. Aloe vera administered orally was found to cause significant depression in general as well as exploratory behavioral profiles. The results suggest that Aloe vera may have anxiolytic potential with sedative action.\cite{17}

**Antidepressant activity**

The antidepressant effects of Aloe vera hydro-alcoholic extract at different concentrations were compared with the fluoxetine-treated and the control groups of mice using forced-swimming, FST and open box, OFT tests. Based on the results of the OFT and FST tests, Aloe vera extract at different doses, has favorable antidepressant effects on mice as compared to the fluoxetine treated and the control groups and the better effects were seen by increasing the dose and duration of drug use.\cite{18}

**Hypolipidaemic effect**

The potential antihyperlipidaemic efficacy of the ethanolic extract from Aloe vera leaf gel in streptozotocin (STZ)-induced diabetic rats showed a significant reduction in fasting blood glucose, hepatic transaminases (aspartate aminotransferase and alanine aminotransferase), plasma and tissue (liver and kidney) cholesterol, triglycerides, free fatty acids and phospholipids and a significant improvement in plasma insulin. In addition, the decreased plasma levels of HDL–cholesterol and increased plasma levels of LDH and VDLP–cholesterol in diabetic rats were restored to near normal levels following treatment with the extract.\cite{3}

**Hypoglycaemic effect:** The study aimed to evaluate the antidiabetic activity of Aloe vera ethanolic extract in induced hyperglycemic and normal rats. The results in the hyperglycemic experiment showed highly significant decrease ($P< 0.01$) in plasma glucose level in the group received 500 mg/kg body weight of Aloe vera ethanolic extract. However, the reduction in plasma glucose level at a dose of 100 mg/kg body weight Aloe vera extract and glibenclamide was found to be similar.\cite{19}

**Hypoglycemic and anti atherogenic effect**

Oral administration of Aloe vera leaf extract for 21 days in alloxan induced diabetic rabbits produced a significant reduction in fasting blood glucose levels and Hb$_1$Ac in study. Also there was significant decrease in serum levels of triglycerides, total cholesterol, LDL and a concomitant increase in HDL in Aloe vera treated diabetic rabbit indicates the potential of
Aloe vera as anti diabetic drug. The significant decrease in ‘Atherogenic index’ in Aloe vera treated group shows its protection against cardiovascular diseases.[20]

Study of Aloe vera water extract in normal and alloxan induced diabetic rats, blood glucose level of treated groups of rats showed significant reduction after 30 days of treatment with Aloe vera. By statistical analysis of results it was found that Aloe vera water extract has anti-diabetic effect in normal and alloxan induced diabetic rats.[21]

Antifungal and antioxidant activity
The antifungal activity was determined by the agar-well diffusion method against plant and human fungal pathogens. The methanol and ethanol portions of the extracts studied were more bioactive than ethyl acetate portion. It was also observed that the activity was more pronounced on plant pathogen than human pathogen except Candida albicans. This is an indication that the extract has the potential to treat plant fungal infections. The Aloe extract showed the significant antioxidant activity by the DPPH radical scavenging method. Therefore, the Aloe extract provided as natural antioxidant has been used in health foods for medical and preservative purposes.[22]

Aloe vera gel extracted from the Aloe vera leaves was evaluated for their antifungal activity at 0.15%, 0.25% and 0.35% concentration against five plants pathogenic fungi viz., Aspergillus niger, Aspergillus flavus, Alternaria alternata, Drechslera hawaiensis and Penicillium digitatum 0.35% concentration Aloe vera gel completely inhibited the growth of Drechslera hawaiensis and Alternaria alternate.[2]

Wound healing
The study was undertaken on experimental evaluation of Aloe vera leaves pulp on wound healing activity through topical route on excision wound model. The activity was compared with standard drug Povidone-Iodine ointment (5% w/w). Aloe vera leaves pulp was found to have better and faster wound healing effect than standard drug Povidone Iodine ointment on excision wound model.[23]

Immunohistochemical study
This study was carried out to detect whether Aloe leaf gel and pulp extracts affect pancreatic β-cells. Using type-II diabetic rats, the immunoreactivity of β-cells of the islets of Langerhans did not differ among treatments of control, glibenclamide-, Aloe vera leaf pulp- and gel
extract-treated rats. These results suggest that treatment of diabetic rats with *Aloe vera* gel or pulp or glibenclamide has no beneficial influence on the pancreatic β- cells in type II diabetes.[24]

**Immunostimulant activity**

Oral administration of saline extracts of leaves of *Aloe vera* on the albino mice had been shown immunostimulant effect which could be attributed to the alkaloids content.[25]

**Antibacterial activity**

This study was to evaluate the antibacterial activity of *Aloe barbadensis* Miller (*Aloe Vera*) by using agar diffusion assay and gel filtration chromatography. The bacterial strains used in this research work were *Escherichia coli*, *Bacillus subtilius*, *Salmonella typhi*, *Pseudomonas*, *Klebsiella pneumoniae*, *Staphylococcus epidermidis*. *Aloe vera* plant leaves and gel were macerated in different organic solvents including ethanol, methanol and distilled water. Then, by using agar diffusion assay antibacterial activity was estimated. The *Aloe Vera* extract of Methanol showed the maximum antibacterial activity as compared to other solvent extracts.26 The *in-vitro* studies of aqueous and methanolic extracts of the roots of *Aloe vera* shows antimicrobial activity against *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aerugenosa* and *Enterobacter aerogens* using the agar diffusion method. Preliminary phytochemical analyses showed that the extracts contain flavonoids, terpenoids, tannins, saponins, reducing sugars and anthraquinones.[27]

*Aloe Vera* plant leaves and gel were macerated in different organic solvents including ethanol, methanol and distilled water. Then, by using agar diffusion assay antibacterial activity was estimated. The zones of inhibition were measured by scaling and represented by tables and graphs. The *Aloe Vera* extract of methanol showed the maximum antibacterial activity as compared to other solvent extracts.[28]

**Antioxidant property**

The purpose of this study was to evaluate the ability of aqueous extract of *Aloe vera* on oxidative damage and Anion Exchanger 1 (AE1, also known as Band 3) expression in human erythrocytes exposed to the water soluble free radical initiator 2,2’-azobis-2-amidinopropano dihydrochloride (AAPH). In addition, total phenolic compounds in the extracts were determined as catechin equivalent and the various antioxidant activities were compared to natural and synthetic standard antioxidants such as BHA and ascorbic acid. Since *Aloe vera*
extract did not cause a consumption of the cytosolic antioxidant, glutathione (GSH) when it was direct incubated with GSH in basic aerated aqueous solution, this indicates that *Aloe vera* extract does not proceed auto oxidation at this experimental condition.[29]

*In-vivo* *Aloe vera* leaf gel shown significant antioxidant capacity due to the presence of the antioxidant polyphenols, indoles, and alkaloids which is confirmed by ORAC and FRAP analyses.[30]

**Nephroprotective Activity**

In the present study, single oral 100–200 mg/kg/day of the leaf aqueous extract of *Aloe barbadensis* were studied for their protective effects in gentamicin and cisplatin-induced nephrotoxic wistar rats for 7 days and 5days respectively. In the gentamicin nephrotoxic rats, 100–200 mg/kg/day significantly attenuated elevations in the serum creatinine, total protein and blood urea nitrogen levels in dose related fashion and no treatment related effect on uric acid and ions, as well as, attenuation of gentamicin-induced tubulonephrosis. Similar effects were also recorded in the cisplatin model of acute renal injury. Results suggest that the nephroprotective effect of *Aloe barbadensis* could be due to the inherent antioxidant and free-radical-scavanging principle(s) contained in the extract.[31]

**The Genotoxic and Antigenotoxic Effects**

The genotoxic and antigenotoxic effects of *Aloe vera* leaf extract were investigated using the chromosome aberrations test for the bone marrow cells of rats, sister chromatid exchanges and micronucleus and CAs tests for human lymphocytes, and the Ames Salmonella/microsome test system. In the bone marrow cells of rats, *Aloe vera* extract significantly induced structural and total CAs at all concentrations and in all treatment periods. In human peripheral lymphocytes, *Aloe vera* did not increase the mean SCE; however, it significantly induced the MN frequency and structural CAs. In addition, Aloe vera showed a cytotoxic effect by decreasing the replication index (RI), mitotic index (MI), and nuclear division index in human lymphocytes and by decreasing the MI in the bone marrow cells of rats. *Aloe vera* did not decrease the genotoxicity or cytotoxicity of urethane in the bone marrow cells of rats or in the mitomycin-C in human lymphocytes.[32]

**Anti-inflammatory Activity**

Studies on aqueous extract of whole leaf of *Aloe vera* at various concentrations had shown significant anti-inflammatory and analgesic activities in albino wistar rats model.[33]
Entomology activity (larvicidal activity)
The bio-efficacy of Aloe vera leaf extract, were assessed against the first to fourth instar larvae of Culex salinarius, under the laboratory conditions. The larvicidal activities of Aloe vera extract were penetrated of larvae body through the oral route and larval membrane by a woody substance as like Lignin. The results revealed that the different concentrations of crude extract of Aloe Vera resulted in considerable mortality for 1st to 4th instar larvae at 0.1 and 0.2mg/ml.[34]

Mutagenic and Anti-mutagenic Activity
Mutagenic and anti-mutagenic activity of Aloe vera in Allium cepa test and micronucleus test in human bi-nucleated lymphocytes result was observed that at the usual dose, the solution of Aloe vera was not mutagenic for the plant test system and not for humans. At a dose ten times more concentrated caused a cytotoxic and mutagenic effect in Allium cepa. In plant cells the solution was anti-mutagenic only when placed after paracetamol, while in human cells, this action was manifested when the solution was used at the same time with paracetamol.[35]

CONCLUSION
Aloe vera is a traditional medicinal herb, which is safely and effectively used in the treatment numbers of internal and external diseases. Phytochemical constituents present in this herb are beneficial for most digestive problems, including constipation, colitis, poor appetite, irritable bowel syndrome, asthma, diabetes, immune system enhancement, peptic ulcers and periodontal diseases Here we have tried to compile all the information from both traditional and published scientific literatures regarding the chemical constituents and the medicinal uses of Aloe vera. It will helpful for the future researchers to get the information. This will provide tremendous opportunities for planning and conduct research related to various aspects of this medicinal plant.

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REFERENCES

