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REVIEW ARTICLE

Chemical Characteristics and Therapeutic Potentials of *Aloe vera*

Shakila Riaz[1], Shabbir Hussain[1,*], Shahzada Khurram Syed[2], Rubi Anwar[3]

[1]Department of Chemistry, Lahore Garrison University, Lahore, Pakistan.
[2]Department of Basic Medical Sciences, University of Management and Technology, Lahore, Pakistan.
[3]Department of Chemistry, University of Management and Technology, Lahore, Pakistan.

ABSTRACT

Background: *Aloe vera* belongs to the family Liliaceae and genus Aloe with a survival rate of up to 50 years under satisfactory conditions. It has been used since >5000 years to cure many kinds of human diseases. This plant is also used for ornamental purposes as an indoor potted plant. *Aloe vera* finds various applications in allopathic and homeopathic medicine.

Objectives: Current review was generated to evaluate the chemical characteristics and therapeutic potential of *Aloe vera*.

Methodology: Relevant literature from last 10 years has been focused to evaluate ingredients and potential medicinal applications of *Aloe vera* published in Science Direct, Scopus, Web of Science, Google Scholar, Medline, Pub Med, and Research Gate.

Results: The plant contains important constituents including enzymes, saponins, minerals, sugars, anthraquinones, vitamins, lignin, fatty acids and amino acids. Its leaves are rich in vitamins, enzymes, natural sugars, fatty acids, amino acid, minerals and other bioactive compounds. *Aloe vera* pulp consists of vitamins, enzymes, inorganic compounds, organic compounds, amino acids, proteins, lipids and other carbohydrates. The plant demonstrates an excellent therapeutic potential due to its laxative, anti-aging, anti-diabetic, anti-inflammatory, anti-oxidant, antitumor, antiseptic, anti-ulcer, hepatoprotective, antiviral, analgesics, anti-bacterial and antifungal potential. Moreover, it holds noticeable potential as a medicinal plant to cure many diseases.

Conclusion: The plant is rich in biologically active constituents and can be used in the potential treatment of numerous diseases.

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INTRODUCTION

Currently, a large number of investigations are focused upon phytochemistry, nutritional and medicinal value of plants[1-3]. Medicinal plants are considered as the best sources of a wide range of drugs, according to the WHO[4]. The *Aloe vera* plant has been used from many years for beauty, medicinal, health and skin care treatments. The word *Aleo vera* has been originated from Arabic word "Alloeh" which means "shining bitter substances while, "vera" has been originated from Latin which means "true". About 2000 years ago Greek named *Aleo vera* as the universal panacea, while the Egyptian named it "the plant of immortality". Now days it's excessively used in dermatology for various purposes[5, 6]. It has been used since >5000 years to cure many kinds of human diseases[7]. This plant is also used for ornamental purposes as an indoor potted plant[8].

Aloe vera is also used to produce a colorless gel from the parenchymatous cells of its fresh leaves[9]. The latex (Aloin, a bitter tasting purgative) is obtained from specialized cells (pericyclic tubules) which occur just

under the epidermis or peel of the leaves. This plant is commercially cultivated in South Africa, India, Haiti, Bonaire, The United State of America and The Bolivarian Republic of Venezuela. The best quality of *Aloe vera* is grown in the desert of Southern California. Interestingly, it can withstand the hot temperatures of 104ºF and can also survive below freezing temperature until its roots are not damaged[10].

Keeping in view the larger use of *Aloe vera* from thousands of years for the treatment of a range of human diseases, current review was conducted to overview its chemical characteristics and therapeutic potentials.

Chemical Characteristics of *Aloe vera*

The *Aloe vera* contains 75 chemically dynamic constituents including anthraquinones, vitamins, lignin, enzymes, saponins, minerals, sugars, fatty acids and amino acids[11].

Anthraquinones

Aloe vera sap is comprised of 12 anthraquinones which are aloin, anthracene, risistannol, ethereal oil, aloetic acid, emodin, anthranol, isobarnaloin and barbaloin etc. They all act as natural purgatives. Aloin alone and Aloe-emodin act as anti-viral, anti-bacterial, and as analgesics[12].

Vitamins

Aloe vera consists of vitamin E, A and C which are anti-oxidants. It also contains folic acid, choline, vitamin B-12 and anti-oxidants that have the property to neutralize free radicals[13].

Lignin

Lignin is an inert substance which is present in the gel of *Aloe vera*. It supplements the penetrating effect of other ingredients into the human skin[14].

Enzymes

Aloe vera contains numerous enzymes which include alkaline phosphatases, amylases, bradykinases, alliinases, carboxypeptidases, peroxidases, lipases, catalases and cellulases. Bradykinase helps to soothe inflammation while others help in the breakdown of fats and sugars[15, 16].

Saponins

They are soapy substances which have antiseptic and cleansing applications[17]. Being a component of *Aloe vera* plant, they demonstrate anti-ulcer, anti-inflammatory, hepatoprotective, and antimicrobial potential[18]. Saponins are powerful surface-active agents and produce foam when mixed with water[19]. They may also find applications as a tooth paste ingredient[18]. These have been used in detergents and as foaming agents[20].

Minerals

Aloe vera contains calcium, magnesium, manganese, chromium, sodium, copper, potassium, zinc and iron which are helpful in proper bone and teeth compactness, proper functioning of insulin, for activation of other enzymes, maintenance of body pH and to help iron to work as oxygen carrier. In cardiovascular system , they contribute in electrical impulses and carbohydrates metabolism[21]. Table **1** demonstrates the percentage of minerals present in the leaves of *Aloe vera*[11].

Table 1. Percentage of Minerals found in the Leaves of *Aloe vera*.

S. No.	Minerals	*Aloe vera* (Whole Leave)	Reference
1.	Calcium	3.58 %	11, 48
2.	Magnesium	1.22 %	11, 48
3.	Sodium	3.66 %	11, 48
4.	Potassium	4.06 %	11, 48
5.	Phosphorus	0.02 %	11, 48
6.	Zinc	0.02 %	11, 48
7.	Copper	0.06 %	11, 48
8.	Iron	0.1 %	11, 48

Table 2. Amount of Amino acids found in *Aloe vera* Gel.

Amino acid	*Aloe vera* (Whole Leave) (nM/mg dry mass)	Amino acid	*Aloe vera* (Whole Leave) (nM/mg dry mass)	Reference
Asparagine	3.29	**Leucine**	0.09	11, 48
Serine	1.27	**Phenyl alanine**	0.08	11, 48
Aspartic acid	1.75	**Isoleucine**	0.07	11, 48
Glutamic acid	4.7	**Tyrosine**	0.06	11, 48
Alanine	0.91	**Cystine**	0.04	11, 48
Lysine	0.18	**Histidine**	0.03	11, 48
Valine	0.36	**Methionine**	0.02	11, 48
Arginine	0.12	**Proline**	0.25	11, 48
Threonine	0.33	**Glycine**	0.95	11, 48
Glutamine	0.83	**Total Concentration**	15.33	11, 48

Sugars

Aloe vera contains numerous polysaccharides and monosaccharaides (fructose and glucose) amongst which polysaccharides promote the strengthening of bones, improve liver functions, maintain cholesterol level and also help in proper digestion[11].

Fatty acids

Aloe vera gives 4 plant steroids which include beta-sitosterol, campesterol, cholesterol and lupeol. They all, possess the pain killer and anti-inflammatory properties[22].

Amino acids

Cumulatively, 20-22 amino acids are obtained from *Aloe vera* out of which 7-8 are vital ones[23]. Some amino acids[11] are given in Table **2**.

Hormones

Gibberellins and auxins both help in the healing of wound because they have anti-inflammatory characteristics[24].

Active Ingredients in Layers of Leaf

Aloe vera leaf consists of three layers (outer, middle and inner) which are described below:

(i) The outer layer is acrimonious yellow latex that contains glycoside aloin A and B from 15%-40% and the derivatives of hydroxyanthraxcene. The outer layer also consists of aloe-emodin-anthrone 10-C glycoside, hydroxyanthracene and chrones[25].

(ii) Middle layer consists of liquid like material (juice) which is originated from the leaf parenchyma and the pericycle cells. This juice flows involuntarily from a leaf cut and is then dried either in the presence or absence of heat and is finally solidified; it should not be confused with the gel of *Aloe vera* which is colorless and sticky and is obtained from the parenchymatous leaf cell[10]. The pulp consists of vitamins, enzymes, inorganic compounds, organic compounds, amino acids, proteins, lipids and other carbohydrates[26].

(iii) The last and most inner layer contains up to 99% water along with lipids, sterols, amino acids, vitamins and glucomannas[13]. The other dynamic constituents contain minerals, enzymes, sugars, saponins, lignin, amino acids and salicylic acid[27]. It has various mono / polysaccharides, several active inorganic ingredients and vitamins B1, B2, B6 and vitamin C[28].

Therapeutic Potentials of *Aloe vera*

Aloe vera is very useful in treatment of many diseases. Some of therapeutic effects include:

a. Antitumor Activity

It has been reported that *Aloe vera* gel possesses chemoprevention potential[29]. The *Aloe vera* extract demonstrates anti-hepatocarcinogenic effect, at least in part, through modulation of apoptosis[30].

b. Laxative Effects

Aleo vera contains 12 anthraquinones, which are phenolic compounds in nature and act as a natural laxatives, means they increase bowel movement and also loose stools.[10, 12] Also these potential laxatives are helpful in enhancing intestinal peristalsis and water content by simply stimulating the intestinal mucous secretion[10]. Aloin A and B can be hydrolyzed in the colon by intestinal bacteria and finally they undergo reduction into active metabolites. Aloe-emodin anthrone is the main active metabolite[10, 31]; it may act as an irritant and stimulant to the gastrointestinal tract[10, 32].

c. Anti-Inflammatory Action

The anti-inflammatory action of the gel of *Aloe vera* has reported in many *in vivo* and *in vitro* studies through the activity of bradykinase[33]. The bradykinase and C-glucosyl chromone are the anti-inflammatory compounds which are separated from *Aloe vera* and its gel extracts, respectively[34-35]. Many sterols are considered to play an important role in the anti-inflammatory action of *Aloe vera* gel and act as natural analgesic and help in the reduction of pain[10, 35].

d. Anti-Aging Property

Aloe vera gel is helpful for binding moisture into the skin due to the presence of muco-polysaccharides. This gel displays no adverse reactions and gives the cooling effect and improves the skin integrity, lowers erythema and decreases appearance of fine wrinkling[36].

e. Antiseptic Property

Aloe vera gel consists of 6 antiseptic agents including salicylic acid, lupeol, cinnamic acid, phenol, sulfur, nitrogen and urea. They have inhibitory effects on fungi, viruses and bacteria[37].

f. Anti-Diabetic Property

Aloe vera contains five phytosterols which demonstrated anti-diabetic effect in Type-2 diabetic mice[38]. Its gel contains polysaccharides which show hypoglycemic activity and increase insulin level[39].

g. Antibacterial Activity

Different microorganisms like *Streptoccocus pyogenes* and *Streptoccocus faecalis* are inhibited by the use of its gel[40].

h. Anticancer Properties

The growth of malignant cancer can be inhibited in the presence of anthraquinone and emodin contents present in *Aloe vera*[41]. Prophylactic use of an *Aloe vera*-based cream found to be useful in delaying radiation dermatitis in head and neck cancer[42].

i. Other Uses

Due to their fewer side effects and affordability, use of natural products for the prevention of diseases is increasing worldwide, especially in the developing countries[43]. The concentrated extract of *Aloe vera* leaves is used for the treatment of hemorrhoid. *Aloe vera* gel also helps in the stimulation of immune system of human body[44]. It is highly effective in the treatment of gum diseases including periodontitis and gingivitis[43, 45]. The plant is also used for the treatment of piles, jaundice, cough, dyspnea and asthma[46]. Significant decrease of plaque and gingivitis has been reported by the use of mouth wash containing *Aloe vera* products[43, 47]. However, there is an urgent need of more detailed studies on the mechanism of action, safety and therapeutic potential of *Aloe vera* in the management of diseases[48].

CONCLUSION

Aloe vera contains powerful constituents. The leaves are rich in catalysts, regular sugars, unsaturated fats, amino corrosive, minerals and other bioactive mixtures. *Aloe vera* mesh comprises of nutrients, chemicals, inorganic mixtures, natural mixtures, amino acids, proteins, lipids and different carbs. The plant exhibits a great restorative potential because of its laxative, anti-aging, anti-diabetic, anti-inflammatory, anti-oxidant, antitumor, antiseptic, anti-ulcer, hepatoprotective, antimicrobial, and analgesic potential. *Aloe vera* additionally discovers applications in the therapy of hemorrhoid, cutaneous injuries, cuts, skin malignancy, burns from the sun and surprisingly harmed skin, jaundice, dyspnea, asthma and dental sicknesses.

The polysaccharides in *Aloe vera* makes bones stronger, improve liver activity, keep up with cholesterol level and furthermore help in digestion.

CONFLICTS OF INTEREST

None.

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None.

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LIST OF ABBREVIATIONS

nM	Nano Molar
WHO	World Health Organization

REFERENCES

1. Rehman A, Hussain S, Javed M, Ali Z, Rehman H, Shahzady TG, *et al*. Chemical composition and remedial perspectives of *Hippophae rhamnoides linn*. Post Biol Kom. 2018; 45(3):199-209.
2. Naseer S, Hussain S, Naeem N, Pervaiz M, Rahman M. The phytochemistry and medicinal value of *Psidium guajava* (guava). Clin Phytosci. 2018; 4(1):1-8.
3. Naseer S, Afzal M, Nisa A, Hussain S, Ahmad M, Parveen S, *et al*. Extraction of brown dye from Eucalyptus bark and its applications in food storage. Qual Assur Saf Crop Foods. 2019;11(8):769-80.
4. Organization WH, Zdrowia ŚO. WHO guidelines on good agricultural and collection practices [GACP] for medicinal plants. World Health Organization: 2003.
5. Surjushe A, Vasani R, Saple DG. *Aloe vera*: A short review. Indian J Derma. 2008; 53(4):163-9.
6. Benhamou A, Fazouane F. Ethnobotanical study, phytochemical characterization and healing effect of *Carthamus coeruleus* L. Rhizomes. Int J Med Arom Plants. 2013; 3(1):61-8.
7. Yagi A, Kabash A, Mizuno K, Moustafa S, Khalifa T, Tsuji H. Radical scavenging glycoprotein inhibiting cyclooxygenase-2 and thromboxane A2 synthase from *Aloe vera* gel. Planta Medica. 2003; 69(03):269-71.
8. Mulu T, Teshale F, Gemeda S, Sahu O. Medicated evaluation of *Aloe vera*: Overview on characteristics and application. World J Nutr Health. 2015; 3(1):1-7.
9. Terefe T, Neges T. Review on therapeutic and medicinal use of *Aloe vera*. Cancer Biol. 2017; 7(4):29-38.
10. Shadu P. Therapeutic and medicnal effect of *Aloe vera*. Pharm Biol. 2013; 4(602):599-610.
11. Sahu PK, Giri DD, Singh R, Pandey P, Gupta S, Shrivastava AK, *et al*. Therapeutic and medicinal uses of *Aloe vera*: A review. Pharmacol Pharm. 2013; 4(08):599-610.
12. Mahor G, Ali SA. Recent update on the medicinal properties and use of *Aloe vera* in the treatment of various ailments. Biosci Biotechnol Res Commun. 2016; 9(2):273-88.
13. Kar SK, Bera TK. Phytochemical constituents of *Aloe vera* and their multifunctional properties: A comprehensive review. Int J Pharm Sci Res. 2018; 9(4):1416-23.
14. Chen S, Jiang H, Wu X, Fang J. Therapeutic effects of quercetin on inflammation, obesity, and type 2 diabetes. Med Inflamm. 2016; 1-6.
15. Alpana S, Singh AK. Optimization of processing variables for the preparation of herb bread using *Aloe vera* gel. J Food Sci Tech Mys. 2009; 46(4):335-8.
16. Hashemi SA, Madani SA, Abediankenari S. The review on properties of *Aloe vera* in healing of cutaneous wounds. Biomed Res Int. 2015; 714216-9.
17. Amin K, Ozgen S, Selamoglu Z. *Aloe vera*: A miracle plant with its wide-ranging applications. Pharm Pharmacol Int J. 2018; 6(1):00144-9.
18. Sharrif M, Verma SK. *Aloe vera* their chemicals composition and applications: A review. Int J Biol Med Res. 2011; 2(1):466-71.
19. Berniyanti T, Mahmiyah E. Microbiological studies on the production of antimicrobial agent by Saponin *Aloe vera* Linn against *Streptococcus sanguinis*. Res J Microbiol. 2015; 10(10):486-93.
20. Arunkumar S, Muthuselvam M. Analysis of phytochemical constituents and antimicrobial activities of *Aloe vera* L. against clinical pathogens. World J Agric Res. 2009; 5(5): 572-6.
21. Chen YF, Yang CH, Chang MS, Ciou YP, Huang YC. Foam properties and detergent abilities of the

saponins from *Camellia oleifera*. Int J Mol Sci. 2010; 11(11):4417-25.

22. Lanka S. A review on *Aloe vera*-the wonder medicinal plant. J Drug Del Therap. 2018; 8(5-s):94-99
23. Mikołajczak N. Potential health benefits of *Aloe vera*. J Educ Health Sport. 2018; 8(9):1420-35.
24. Gupta A, Rawat S. Clinical importance of *Aloe vera.* Res J Top Cosm Sci. 2017; 8(1):30-39.
25. Terefe T, Neges T. Review on therapeutic and medicinal use of *Aloe vera*. Cancer Biol. 2017: 7(4):29-38.
26. Joshi S. Chemical constituents and biological activity of Aloe barbadensis- A review. J Med Aromat Plant Sci. 1998; 20:768-73.
27. Sánchez-Machado DI, López-Cervantes J, Sendón R, Sanches-Silva A. *Aloe vera*: Ancient knowledge with new frontiers. Trends Food Sci Technol. 2017; 61:94-102.
28. Sajjad A, Subhani S. *Aloe vera*: An ancient herb for modern dentistry-A literature review. J Dent Surg. 2014; 2014:210463.
29. Kim HS, Kacew S, Lee BM. Genetic and epigenetic cancer chemoprevention on molecular targets during multistage carcinogenesis. Arch Toxicol. 2016; 90(10):2389-404.
30. Shalabi M, Khilo K, Zakaria MM, Elsebaei MG, Abdo W, Awadin W. Anticancer activity of *Aloe vera* and *Calligonum comosum* extracts separetely on hepatocellular carcinoma cells. Asian Pac J Trop Biomed. 2015; 5(5):375-81.
31. Che QM, Akao T, Hattori M, Kobashi K, Namba T. Isolation of a human intestinal bacterium capable of transforming barbaloin to aloe-emodin anthrone. Planta Med. 1991; 57(01):15-19.
32. Quintino MS, Angnes L. Bia-amperometric quantification of salbutamol in pharmaceutical products. Talanta. 2004; 62(2): 231-6.
33. Calixto J. Efficacy, safety, quality control, marketing and regulatory guidelines for herbal medicines (phytotherapeutic agents). Braz J Med Biol Res. 2000; 33(2):179-89.
34. Ito S, Teradaira R, Beppu H, Obata M, Nagatsu T, Fujita K. Properties and pharmacological activity of carboxypeptidase in *Aloe arborescens* Mill var. natalensis Berger. Phytother Res. 1976 ; 7(7):26-29.
35. Haller JS. A drug for all seasons. Medical and pharmacological history of Aloe. Bull N Y Acad Med. 1990; 66(6):647-659.
36. West DP, Zhu YF. Evaluation of *Aloe vera* gel gloves in the treatment of dry skin associated with occupational exposure. Am J Infect Control. 2003; 31(1):40-2.
37. El Zawahry M, Hegazy MR, Helal M. Use of Aloe in treating leg ulcers and dermatoses. Int J Dermatol. 1973; 12(1):68-73.
38. Tanaka M, Misawa E, Ito Y, Habara N, Nomaguchi K, Yamada M *et al*. Identification of five phytosterols from *Aloe vera* gel as anti-diabetic compounds. Biol Pharm Bull. 2006; 29(7):1418-22.
39. Noor A, Gunasekaran S, Manickam AS, Vijayalakshmi M. Antidiabetic activity of *Aloe vera* and histology of organs in streptozotocin-induced diabetic rats. Curr Sci. 2008; 94(8):1070-6.
40. Bhat G, Kudva P, Dodwad V. *Aloe vera*: Nature's soothing healer to periodontal disease. J Indian Soc Periodont. 2011; 15(3):205-8.
41. Carstensen JT, Rhodes C. Drug stability, revised, and expanded: Principles and practices. CRC Press: 2000.
42. Rao S, Hegde SK, Baliga-Rao MP, Palatty PL, George T, Baliga MS. An *Aloe vera*-based cosmeceutical cream delays and mitigates ionizing radiation-induced dermatitis in head and neck cancer patients undergoing curative radiotherapy: A clinical study. Med. 2017; 4(3):44.
43. Rahmani AH, Aldebasi YH, Srikar S, Khan AA, Aly SM. *Aloe vera*: Potential candidate in health management via modulation of biological activities. Pharmacog Rev. 2015; 9(18):120-6.
44. Sahu PK, Giri DD, Singh R, Pandey P, Gupta S, Shrivastava AK, *et al*. Therapeutic and medicinal uses of *Aloe vera*: A review. Pharmacol Pharm. 2013; 4(08):599-605.
45. Grindlay D, Reynolds T. The *Aloe vera* phenomenon: A review of the properties and modern uses of the leaf parenchyma gel. J Ethnopharmacol. 1986; 16(2-3):117-51.
46. Joseph B, Raj SJ. Pharmacognostic and phytochemical properties of *Aloe vera* linn an overview. Int J Pharm Sci Rev Res. 2010; 4(2):106-10.

47. Chandrahas B, Jayakumar A, Naveen A, Butchibabu K, Reddy PK, Muralikrishna T. A randomized, double-blind clinical study to assess the antiplaque and antigingivitis efficacy of *Aloe vera* mouth rinse. J Indian Soc Periodontol. 2012; 16(4):543-8.

48. Mulu T, Teshale F, Gemeda S, Sahu O. Medicated Evaluation of *Aloe vera*: Overview on characteristics and application. World J Nut Health. 2015; 3(1):1-7.