A Review on Biological Properties of Aloe Vera Plant

Bhargavi Narayanan
B. Tech. Student
Department of Biotechnology
Sri Venkateswara College of Engineering, Sriperumbudur, Tamil Nadu, India

Prabhu.S
Associate Professor
Department of Biotechnology
Sri Venkateswara College of Engineering, Sriperumbudur, Tamil Nadu, India

Abstract

Aloe vera is a succulent plant species that belongs to the family Xanthorrhoeaceae. It is a valuable ingredient in food, pharmaceutical and cosmetic inductries. In ayurvedic medicine it is called kathalai and has been widely used in the traditional herbal medicine of many countries. The species has been extensively used in herbal medicine since the beginning of the first century AD. Extracts from Aloe vera are widely used in cosmetics and alternative medicine industries, being marketed as having rejuvenating, healing and soothing properties although scientific evidence for its therapeutic effectiveness is limited and frequently contradictory. Aloe vera gel is also used commercially as an ingredient in yogurts, beverages and some desserts. It is also used as a moisturizer and anti-irritant on facial tissues. There is some evidence to suggest that oral administration of Aloe vera might be effective in reducing blood glucose in diabetic patients and in lowering lipid levels in hyperlipidaemia. Topical application of Aloe vera is also effective for genital herpes psoriasis. Various studies have been performed to confirm the biological and toxicological properties of the plant. A review on the various studies on the plant has been provided for the purpose of understanding its properties.

Keywords: Anticancer, Antimicrobial, Antioxidants, Medicinal Properties

I. INTRODUCTION

There are more than 300 species of Aloe plants. Aloe barbadensis is now referred to by taxonomists as Aloe vera (Ronald M. Shelton et al, 1991). It is a stemless or very short-stemmed succulent plant growing to 60–100 cm (24–39 in) tall, spreading by offsets. The leaves are thick and fleshy, green to grey-green, with some varieties showing white flecks on their upper and lower stem surfaces (Yates A. et al, 2002). The main feature of the A. vera plant is its high water content, ranging from 99-99.5% (J.H. Hamman, 2008). The remaining 0.5–1.0% solid material is reported to contain over 75 different potentially active compounds including water- and fat-soluble vitamins, minerals, enzymes, simple/complex polysaccharides, phenolic compounds, lignins, saponins, salicylic acids and amino acids (Atherton P, 1998; Shelton M, 1991; Atherton P, 1997).

This species has been widely cultivated throughout the world. Naturalized stands of the species occur in the southern half of the Arabian Peninsula, through North Africa, Sudan and neighboring countries.

Aloe vera is grown as an ornamental plant. The species is popular as a medicinal plant and for its interesting flowers, form and succulence. This succulence enables the species to survive in areas of low natural rainfall, making it ideal for rockeries and other low water-use gardens (Yates A., 2002). During the winter, Aloe vera may become dormant and require a little moisture. Large scale production of Aloe vera is undertaken in China, Mexico, Cuba, India, Bangladesh, Australia and USA mostly to supply the cosmetics industry with Aloe vera gel.

II. APPLICATIONS

Aloe barbadensis (Miller), Aloe vera, has a long history of use as a topical and oral therapeutic (Mary D. Boudreau et al, 2007). It is a valuable ingredient in food, pharmaceutical and cosmetic industries although scientific evidence of its cosmetic and therapeutic effectiveness is limited and frequently contradictory. It is also used commercially as an ingredient in yogurts, beverages and some desserts (Reynolds et al, 2004; Armstrong et al, 2008). Other uses of Aloe vera extracts include the dilution of semen for artificial fertilization of sheep (Rodriguez et al, 1988), as a food preservative (Serrano M. et al, 2006), or for water conservation in small farms. The plant is also widely used traditional herbal medicine of many countries. Aloe vera is promoted as a moisturizer and anti-irritant and hence used on facial tissues. Topical application of Aloe vera may also be effective for genital herpes and psoriasis (Vogler et al, 1999; Deng S. et al, 2013).

The clear pulp which is also known as gel is widely used in various medical, cosmetic, and neutraceutical applications (J H. Hamman, 2008). It has been used to treat various skin conditions such as cuts, burns and eczema (Maharajan H. Radha et al, 2014). Aloe vera leaves contain phytochemials under study for possible bioactivity, such as acetylated mnnans, polymannans, anthraquinone C-glycoside, anthrones, other anthraquinones, such as emodin, and various lectins (Boudreau MD et al, 2006; King GK et al, 1995; Eshun K et al, 2004). Recently, novel plant-specific type III polyketide synthases (PKS), octaketide

synthase, PKS4, and PKS5 were isolated from Aloe arborescens and their functions examined in E. coli (Y. Mizuuchi et al, 2009). These plant enzymes might be associated with the biosynthesis of natural aromatic quinines in Aloe. Other secondary metabolites present in Aloe vera gel include Aloesin, aloin and Aloe-emodin. Many of these secondary metabolites have been reported as potent anti-inflammatory, lipid-lowering and anti-oxidant activities.

A. Immunomodulatory effect

A.vera gel has strong immunomodulatory activity wherein it downregulates lipopolysaccharide-induced inflammatory cytokine production and expression of NLRP3 (NACHT, LRR, and PYD domain-containing protein 3) inflammasome in human macrophages (M M. Budai et al, 2013). A.vera could also inhibit inflammatory processes following an injury. A.vera directly inhibits the cyclooxygenase pathway and reduces prostaglandin E2 production (M Y Park et al, 2009), which plays an important role in inflammation. Purified Aloe protein showed an anti-inflammatory property against pure lipoxygenase and cyclooxygenase-2 with 84% and 73% inhibition, respectively, and was verified by binding with these proteins by real time method by the phenomenon of surface plasmon resonance (Swagata Das et al, 2010). Also, the Aloe vera gel contains anthraquinones and chromone which possess strong inflammatory effects.

B. Antidiabetic Effect

Clinical studies have suggested that A.vera gel may act as a safe antihyperglycemic and antihypercholesterolemic agent for type 2 diabetic patients without any significant effects on other normal blood lipid levels or liver/kidney function (Huseini et al, 2012). Studies have shown that the water soluble fraction od Aloe spp. possess glucose lowering activities. A.vera gel has significant antidiabetic and cardioprotective activity as it significantly reduced oxidative stress in streptozocin induced diabetic rats and improved antioxidant status (Jain et al, 2010).

C. Antihyperlipidemic Activity

Aloe vera has been shown to prevent fatty streak development and also reduce the development of atherosclerosis through the modification of high risk factors. The efficacy of the Aloe gel checked in hyperlipidemic type 2 diabetic patients showed reduction in total cholesterol and LDL levels significantly (Huseini et al, 2012). Hyperlipidemia is one of the main consequences of polycystic ovarian syndrome (PCOS). PCOS rats treated with Aloe gel showed significant reduction in the cholesterol and LDL levels with an increase in high density lipoprotein. A..vera gel also helps to maintain ovarian steroid status in polycystic ovary-like condition wherein steroidogenesis altered and disturbed estrogen:testosterone ratio (Maharjan et al, 2010).

D. Antiulcer Activity

Aloe vera gel exhibits antibacterial properties against H.pylori, an organism that causes stomach ulcer. It is therefore used in the treatment of peptic ulcer for cytoprotective action. The gel along with a combination of antibiotics acts as a novel effective agent for the treatment of H. Pylori gastric infection. Aloe gel is also used in topical applications for the treatment of cuts, burns and eczema (Maharajan et al, 2014).

E. Antioxidant Effect

A. vera is shown to contain antioxidants including α-tocopherol (vitamin E), carotenoids, ascorbic acid (vitamin C), flavonoids, and tannins. This property of the plant could be used for the treatment of various diseases. Aloe vera is able to capture free radicals and nitric oxide in a concentration dependent manner, as seen in an in vitro study of the efficacy of the gel (Saini et al, 2011). Antioxidant potentials of polysaccharides isolated from Aloe extracts were investigated. Enzymatic extracts were prepared from A.vera gel using 10 digestive enzymes including five carbohydrases and five proteases. Results suggested that Aloe polysaccharides exhibited a protective effect against 2,2′-azobis(2-amidinopropane) dihydrochloride-induced oxidative stress and cell death in kidney epithelial cells (Vero cells) as well as in anin vivo zebrafish model (Kang et al, 2014).

F. Anitimicrobial Activity

Pandey and Mishra established the susceptibility of Gram-positive and Gram-negative bacteria to an extract of the inner gel of A. vera (Pugh et al, 2001). Polysaccharides of A.vera gel have been attributed direct bacterial activity through the stimulation of phagocytic leucocytes to destroy bacteria (Pugh et al, 2001). Purified Aloe protein exhibited a potent anti-fungal activity against Candida paraprilosis, Candida krusei and Candida albicans (Swagata Das et al, 2010). Aloe vera contains pyrocatechol known to have toxic effect of microorganisms. Aloe vera also contains 6 antiseptic agents: Lupeol, salicylic acid, urea nitrogen, cinnamonic acid, phenols and sulfur. They all have inhibitory action on fungi, bacteria and viruses (Amar Surjushe et al, 2008). Anthraquinone derivatives, such as Aloe-emodin, emodin, and chrysophanol, reportedly exhibit antiviral activity wherein their inhibitory mechanism and effect against influenza A virus with reducing virus-induced cytopathic effect and inhibiting replication of influenza (Li et al, 2014). Many other reports have suggested that A. vera gel has antiviral activity that prevent virus adsorption, attachment, or entry to the host cell An in vitro study has shown that crude extract of A. vera gel has antiviral activity against herpes simplex virus type 2 strain (Cellini et al, 2014).

G. Anticancer Activity

Aloin, is a natural compound and main ingredient of Aloe is derived from A.vera leaves. It is an anthraquinone and shown to possess potential anticancer activities. It has been documented for its remarkable potential therapeutic options in cancer, wherein it showed chemoprotective effects against 1,2-dimethylhydrazine-induced preneoplastic lesions in the colon of Wistar rats (Hamiza et al, 2014). Aloin inhibits tumor angiogenesis and growth via blocking signal transducer and activator of transcription 3 activation, with the potential of a drug candidate for cancer therapy (Jackson et al, 2013). Aloe-emodin, is another anthraquinone derivative obtained from the same plant also known for its anticancer properties.

H. Intestinal Absorption

Aloin, present in the gel, is metabolized by the colonic flora to reactive Aloe-emodin, which is responsible for the purgative activity (Maharajan H Radha et al, 2014). This is used for the enhancement of drug absorption for drugs with low bioavailability.

I. 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 (Chithra et al, 1998). Aloe increased collagen concentration as well as its composition which increased the degree of cross-linking. Due to this, it accelerated wound contraction and increased the breaking strength of resulting scar tissue (Heggers et al, 1996). It has also been reported to have a protective effect against radiation damage to the skin (Roberts et al, 1995; Sato et al, 1990).

III. CONCLUSION

Aloe vera exhibits a variety of pharmacological properties antioxidant, antimicrobial, anticancer, immunomodulatory, hyperglycemic, wound healing, hyperlipidemic and antidiabetic. Aloe vera is also used in traditional medicine for the treatment of cuts, burns and eczema. It is a valuable ingredient in food, pharmaceutical and cosmetic industries. It is also used in alternative medicine although scientific evidence for its therapeutic effectiveness is limited and frequently contradictory. Food and Drug Administration has already approved the developmental study of A.vera in the treatment of cancer and AIDS (Maharajan et al, 2014). Further experiments should be performed on the plant to prove its effectiveness in the various disease conditions.

REFERENCES

[1] "Korea interested in Dominican 'Aloe vera'". DominicanToday.com—The Dominican Republic News Source in English. Retrieved 2008-07-19.
[2] "Taxon: Aloe vera (L.) Burm. f.". Germplasm Resources Information Network, United States Department of Agriculture. Retrieved 2008-07-16. "Aloe vera producer signs $3m China deal". Australian Broadcasting Corporation. Retrieved 2008-07-08.
[3] Armstrong, Liza. "Clean and green". Australian Broadcasting Corporation. Archived from the original on 24 May 2008.
[4] Atherton P. Aloe vera revisited. Br J Phytother. 1998;4:76–83.
[5] Atherton P. The essential Aloe vera: The actions and the evidence. 2nd ed 1997.
[6] Boudreau, Mary D., and Frederick A. Beland. "An evaluation of the biological and toxicological properties of Aloe barbadensis (miller), Aloe vera." Journal of Environmental Science and Health Part C 24.1 (2006): 103-154.
[7] Chithra R Sajithlal GB, Chandrakasan G. Influence of Aloe vera on collagen characteristics in healing dermal wounds in rats. Mol Cell Biochem. 1998;181:71–6.
[8] D.K. Saini, M.R. Saini "Evaluation of radioprotective efficacy and possible mechanism of action of Aloe gel" Environ Toxicol Pharmacol, 31 (2011), pp. 427–435
[9] Das, Swagata, et al. "Isolation and characterization of novel protein with anti-fungal and anti-inflammatory properties from Aloe vera leaf gel." International Journal of Biological Macromolecules 48.1 (2011): 38-43.
[10] Deng S, May BH, Zhang AL, Lu C, Xue CC (2013). "Plant extracts for the topical management of psoriasis: a systematic review and meta-analysis". Br. J. Dermatol. 169 (4): 769–82.
[11] Eshun K, He Q (2004). "Aloe vera: a valuable ingredient for the food, pharmaceutical and cosmetic industries--a review". Crit Rev Food Sci Nutr 44 (2): 91–6.
[12] Eshun, Kojo, and Qian He. "Aloe vera: a valuable ingredient for the food, pharmaceutical and cosmetic industries—a review." Critical reviews in food science and nutrition 44.2 (2004): 91-96.
[13] Grindlay, Douglas, and Trn Reynolds. "The Aloe vera phenomenon: a review of the properties and modern uses of the leaf parenchyma gel." Journal of ethnopharmacology 16.2 (1986): 117-151.
[14] H.F. Huseini, S. Kianbakht, R. Hajiaghaee, F.H. Dabaghian "Anti-hyperglycemic and anti-hypercholesterolemic effects of Aloe vera leaf gel in hyperlipidemic type 2 diabetic patients: a randomized double-blind placebo-controlled clinical trial" Planta Med, 78 (2012), pp. 311–316
[15] Hamman, Josias H. "Composition and applications of Aloe vera leaf gel." Molecules 13.8 (2008): 1599-1616.
[16] Heggers J, Kucukcelebi A, Listengarten D, Stabenau J, Ko F, Broemeling LD, et al. Beneficial effect of aloe on wound healing in an excisional wound model. J Altern Complement Med.1996;2:271–7.
[17] King, Glen K., "The effect of Acemannan Immunostimulant in combination with surgery and radiation therapy on spontaneous canine and feline fibrosarcomas." Journal of the American Animal Hospital Association 31.5 (1994): 439-447.
[18] Klein, Alan D., and Neal S. Penneys. "Aloe vera." Journal of the American Academy of Dermatology 18.4 (1988): 714-720.
[19] L. Cellini, S. Di Bartolomeo, E. Campli, S. Genovese, M. Locatelli, M. Di Giulio "In vitro activity of Aloe vera inner gel against Helicobacter pylori strains" Lett Appl Microbiol, 59 (2014), pp. 43–48
[20] Lee, Yun Sun, et al. "Enhancement of anti-inflammatory activity of Aloe vera adventitious root extracts through the alteration of primary and secondary metabolites via salicylic acid elicitation." PloS one 8.12 (2013): e82479.

[21] M.C. Kang, S.Y. Kim, Y.T. Kim, et al. "In vitro and in vivo antioxidant activities of polysaccharide purified from Aloe vera (Aloe barbadensis) gel" Carbohydr Polym, 99 (2014), pp. 365–371.
[22] M.M. Budai, A. Varga, S. Milesz, J. Tőzsér, S. Benko "Aloe vera downregulates LPS-induced inflammatory cytokine production and expression of NLRP3 inflammasome in human macrophages" Mol Immunol, 56 (2013), pp. 471–479
[23] M.Y. Park, H.J. Kwon, M.K. Sung "Evaluation of aloin and aloe-emodin as anti-inflammatory agents in aloe by using murine macrophages" Biosci Biotechnol Biochem, 73 (2009), pp. 828–832
[24] N. Jain, R. Vijayaraghavan, S.C. Pant, V. Lomash, M. Ali "Aloe vera gel alleviates cardiotoxicity in streptozocin-induced diabetes in rats" J Pharm Pharmacol, 62 (2010), pp. 115–123
[25] N. Pugh, S.A. Ross, M.A. ElSohly, D.S. Pasco "Characterization of Aloeride, a new high molecular weight polysaccharide from Aloe vera with potent immunostimulatory activity" J Agric Food Chem, 49 (2001), pp. 1030–1034.
[26] O.O. Hamiza, M.U. Rehman, R. Khan, et al. "Chemopreventive effects of aloin against 1,2-dimethylhydrazine-induced preneoplastic lesions in the colon of Wistar rats" Hum Exp Toxicol, 33 (2014), pp. 148–163.
[27] R. Maharjan, P.S. Nagar, L. Nampoothiri "Effect of Aloe barbadensis Mill. formulation on Letrozole induced polycystic ovarian syndrome rat model" J Ayurveda Integr Med, 1 (2010), pp. 273–279.
[28] Radha, Maharjan H., and Nampoothiri P. Laxmipriya. "Evaluation of biological properties and clinical effectiveness of Aloe vera: A systematic review." Journal of Traditional and Complementary Medicine 5.1 (2015): 21-26.
[29] Reynolds, Tom (Ed.) (2004) Aloes: The genus Aloe (Medicinal and Aromatic Plants - Industrial Profiles.
[30] Roberts DB, Travis EL. Acemannan-containing wound dressing gel reduces radiation-induced skin reactions in C3H mice. Int J Radiat Oncol Biol Phys. 1995; 32:1047–52.
[31] Rodriguez, F., et al. "Cervical versus intrauterine insemination of ewes using fresh or frozen semen diluted with Aloe vera gel." Theriogenology 30.5 (1988): 843-854.
[32] S.W. Li, T.C. Yang, C.C. Lai, et al . "Antiviral activity of Aloe-emodin against influenza A virus via galectin-3 up-regulation" Eur J Pharmacol, 27 (2014), pp. 125–132
[33] Sato Y, Ohta S, Shinoda M. Studies on chemical protectors against radiation XXXI: Protective effects of Aloe arborescens on skin injury induced by x-irradiation. Yakugaku Zasshi.1990;110:876–84.
[34] Serrano M, Valverde JM, Guillén F, Castillo S, Martínez-Romero D, Valero D (2006). "Use of Aloe vera gel coating preserves the functional properties of table grapes". J. Agric. Food Chem. 54 (11): 3882–6.
[35] Sharma, Gajendra P., et al. "Aloe barbadensis Miller a valuable ingredient for traditional uses and toxicological properties-A Review." Int. J. Rec. Biotech 1.1 (2013): 48-54.
[36] Sheikh, Faizan Ahmed, et al. "Effect of Microwaves on the Resistance of Aloe vera Leaves." International Journal of Engineering Research and Applications 3 (2013): 242-247.
[37] Shelton M. Aloe vera, its chemical and therapeutic properties. Int J Dermatol.1991;30:679–83.
[38] Shelton, Ronald M. "Aloe vera." International journal of dermatology 30.10 (1991): 679-683.
[39] T.C. Jackson, J.D. Verrier, P.M. Kochanek "Anthraquinone-2-sulfonic acid (AQ2S) is a novel neurotherapeutic agent" Cell Death Dis, 4 (2013), p. E451.
[40] Vogler BK, Ernst E (1999). "Aloe vera: a systematic review of its clinical effectiveness". Br J Gen Pract 49 (447): 823–8