A Review on Biological Properties of Aloe Vera Plant

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Abstract

Aloe vera is a succulent plant species that belongs to the family Xanthorrhoeaceae. It is a valuable ingredient in food, pharmaceutical and cosmetic industries. In ayurvedic medicine it is called kathala 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 99.5% (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 phytochemicals 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-edomin. 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. Antulcer 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 an in vivo zebrafish model (Kang et al., 2014).

F. Antimicrobial 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 parapsilosis, Candida krusei and Candida albicans (Swagata Das et al., 2010). Aloe vera contains pyrocatechol known to have toxic effect against microorganisms. Aloe vera also contains 6 antiseptic agents: Lupeol, salicylic acid, urea nitrogen, cinnamic acid, phenols and sulfur. They all have inhibitory action on fungi, bacteria and viruses (Amar Surjushe et al., 2008). Anthraquinone derivatives, such as Aloe-edomin, 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). Aloin-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

Glucosaminan, 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). Aloin 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 (Maharajian et al, 2014). Further experiments should be performed on the plant to prove its effectiveness in the various disease conditions.

REFERENCES


