

ALOE VERA EFFECTS ON HUMAN BODY AND PATHOGENS – A REVIEW

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ABSTRACT

Aloe vera is highly used by humans since ancient times. It is a genus from Asphodelaceae family, largely studied around the Globe due to the fact that contains various bioactive compounds in leaves. It is almost the most known and used medicinal plant worldwide, being used for various purposes. Extracts and gels were widely used in folk medicine, but also in nowadays medical formulations. In addition, the gel has been introduced in diverse food products, as juices. This species has many and well-documented medical properties, such as anti-inflammatory, antibacterial, antitumoral and antiproliferative capacities, but is also utilized in wound healing, gastric wounds caused by ulcers healing, has hepatoprotective and immunomodulatory effects. It also protects cardiovascular, digestive or nervous systems. Also it influence the body response to oxidative stress and helps the immune system. In addition, aloe gel is efficient in combating numerous pathogens, like viruses, bacteria, fungi or parasites.

This review purpose is to describe the Aloe vera plants and its effect on human body and pathogens.

KEY WORDS: *gel, aloe juice, folk medicine, formulations*

INTRODUCTION

Aloe vera is a medicinal plant from the Asphodelaceae family, which has attracted the attention of numerous scientists around the world in recent years (Paulsen et al. 2005; Eshghi et al. 2010). It is a tropical plant, easily grown in not only hot, but also dry climates, with widespread distribution in Africa, Asia, and other tropical areas (Choonhakarn et al. 2010). This plant species was used in folk medicine for over 2000 years and remains an important component of traditional medicine in various contemporary cultures, such as India, China, West Indies, and Japan (Foster et al. 2011). The fundamental characteristic of Aloe plant is its high water content, ranging from 99%–99.5% (Radha & Laxmipriya, 2015). The remaining 0.5%–1.0% solid material contains over 75 different potentially active compounds including calcium, copper, iron, zinc, manganese, sodium, potassium, sugars, lignin, saponins, salicylic acid, vitamins A, B, especially B12 and folic acid, C, E, and other nutrients that support general health (Radha & Laxmipriya, 2015; El-Gammal et al. 2018).

Recent studies conducted on *Aloe vera* described the potential of leaves gel as coagulant aid for turbid water treatment. In order to demonstrate this property, the gel was blended and then mixed with distilled water (1%) in the presence of *Moringa*

oleifera. The obtained results showed high levels of turbidity removal (91.42%) (Gaikwad & Munavalli, 2019).

The Aloe plant may not have stem or can present a reduced shoot, with a maximum length of 25 cm, with a thick and straight rosette of leaves. These can grow up to 40 – 50 cm long and 6 – 7 cm wide. Leaves are or may be thick and water holding, concave, grey-green, and young leaves are frequently maculated (Pegu & Sharma, 2019). The abaxial part of the leaf is curved, presenting a pale pink edge which has 2 mm long prickly teeth dispersed at each 10 until 20 mm. The weight varies as 1.5 to 2 kg. This type of leaf is an adjustment to the exceptionally dry conditions of its living habitat (Pegu & Sharma, 2019). Aloe vera gel obtained from the pulp of the leaves is used globally in food industry. There were various healthy drinks developed and these has not laxative effects. Also, aloe extract can be found in icecream or milk, or can be use as preservative or flavoring product (Christaki & Florou-Paneri, 2010; Benítez et al. 2015).

Numerous studies have shown that *Aloe vera* gel can help human body in wound healing processes and reduce the damage caused by radiation to the skin. Thus, *A. vera* gel is introduced into various active materials, such as polyelectrolytes, antibacterial and anti-oxidant edible films, aloe polysaccharide/bacterial cellulose composite membranes (Pinzon et al. 2018) or antibacterial non-woven materials (Tummalapalli et al. 2016). Moreover, only reduced adverse reactions such as mild pain or discomfort may occur with the use of Aloe and all these negative effects are generally reversible and well-tolerated (Maenthaisong et al. 2007).

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Aloe vera contains numerous chemical compounds, including vitamins, minerals, polysaccharides, proteins and phenolic compounds, which can have beneficial effects on organisms. Regarding the bioactive compounds, more than 200 have been found in *Aloe vera* gel (Ahlawat & Khatkar, 2011). Moreover, the biological activities of aloe extracts are more likely to be due a known synergistic action of the compounds rather than a single compound (Hamman, 2008). The main polysaccharide found in Aloe gel is acemannan, formed from large amounts of mannose units, partially acetylated, glucose and some galactose (Chow et al. 2005; Talmadge et al. 2004).

It seems that the properties of the *Aloe vera* plant are due to the indirect action of these compounds that have an antioxidant and anti-inflammatory role, thus achieving an extremely deep protection potential at cellular and tissue level. In

addition, aloe has the ability to stimulate the immune system and regulate certain biological parameters in order to maintain homeostasis (Kumar et al. 2017).

ACTION ON OXIDATIVE STRESS AND INFLAMMATION.

The ability of *Aloe vera* to protect against oxidative stress due to the compounds present in the gel or extract has often been emphasized. A 2010 study postulated the antioxidant activity of *A. vera* gel by inducing oxidative stress in rats through the use of azoxymethane. Azoxymethane is a carcinogen substance that causes colon cancer in humans and is frequently used as a model in the study of genotoxicity (Chen & Huang, 2009). Tests showed that hepatic glutathione and uric acid imbalance following the use of azoxymethane was restored by the use of *Aloe vera* extract.

It has also been shown that significant increases in liver catalase, superoxide dismutase, and glucose-6-phosphate dehydrogenase, enzymes involved in the control of reactive oxygen species at the cellular level (Anilakumar et al. 2010).

Another study, performed on human corneal epithelial cells reveals that *Aloe vera* extract protects cells from the oxidative action of hydrogen peroxide, intervening in the cascade triggered by the hydrogen peroxide and by modulating apoptosis. The mechanism by which this protective phenomenon occurs is not fully understood but may be due to the highly studied anti-inflammatory and antioxidant properties of *Aloe vera* extract (Ceravolo et al. 2021). Another study focused on the protective capacity of *A. vera* gel when using streptozotocin. Streptozotocin is a glucosamine-nitrosurea compound derived from *Streptomyces achromogenes* that is used as a treatment for pancreatic beta cell carcinoma. This compound damages beta pancreatic cells and promotes the onset of diabetes (Graham et al. 2011).

It has been shown that aloe extract can prevent abnormalities appeared under the influence of streptozotocin, such as increased glutathione reductase, protein oxidation, lipid peroxidation, and decreased glutathione and sorbitol dehydrogenase. The previously mentioned imbalances generate oxidative stress in the pancreatic cells and thus can cause a metabolic deterioration which can evolve in diabetes (Haritha et al. 2014).

The anti-inflammatory effect of the plant can be highlighted by testing the effect of *A. vera* extract on humoral and cellular immunity. Vahedi et al. (2011) performed an experiment to observe the effect of Aloe extract both at the cellular level (on CD4 and CD8 lymphocyte populations) and at the humoral level (antibody titer). At the end of the experiment, it was observed that the number of lymphocytes increased, in a time-dependent manner. The antibody titer was not significantly modified by the use of *Aloe vera* extract, although a slight increase in IgM was recorded when the Aloe extract was used in conjunction with a vaccine, comparing the results with the control sample. Also, in this case, the results are dependent on the time interval but also on the concentration.

ACTION ON THE DIGESTIVE SYSTEM.

The *Aloe vera* extract has an effect of inhibiting gastric secretion. A study in rats concluded that the level of gastric acid was significantly lower in the group of rats with ulcers that benefited from aloe extract than in the group of rats with ulcers that did not benefit from this treatment (Keshavarzi et al. 2014).

Comparing the effect of omeprazole (an antacid used to control gastric disease) with the effect of *Aloe vera* gel, the authors concluded that although it has a lower effect than omeprazole, *Aloe vera* gel has a useful effect on the cure of gastric diseases in horses (Bush et al. 2017). Another study revealed that *Aloe vera* can be used successfully as a treatment for patients with gastric ulcer. Like sucralfate, a drug used to treat gastric ulcer, *A. vera* reduced the inflammation in the stomach, improved the proliferation of the gastric epithelium and reduced the size of gastric ulcerations, compared to the control group. The protective mechanism of *Aloe vera* can be explained by the fact that it decreases leukocyte adhesion, which is a first step towards the onset of inflammation (Zarbock & Ley, 2008), reduces the level of TNF alpha, a proinflammatory cytokine (Parameswaran & Patial, 2010) in inflamed tissue and also mediates the increase of IL-10 that helps in the healing process of ulcerations (Eamlamnam et al. 2006).

ACTION ON THE NERVOUS SYSTEM.

Aging involves morphological changes at the neurological level, including alteration of the sciatic nerve. In a study conducted by Barmaki et al. (2019) it was demonstrated, on a rat model, that the gel extract from *Aloe vera* prevents nerve trunk and also some changes in the nerve fibers, especially about the thickness. Another study revealed that the ethanolic extract of *Aloe vera* conducted to an increase in the pain threshold in chemical and thermal hyperalgesia but also in allodynia (Kanyadhara et al. 2014).

ACTION ON FERTILITY

In terms of fertility, *Aloe vera* does not show only beneficial effects. A study on the West African dwarf highlighted that after successive treatments with aloe extract, changes in sperm were very visible, namely the reduction of sperm concentration, motility and sperm viability (Olugbenga et al. 2011). Another study in rats also focused on the negative effect that *Aloe vera* has on spermatogenesis and sperm quality by identifying a low content of testosterone and sperm in males treated with Aloe extract (Asgharzade et al. 2015). On the other hand, it is known that diabetes can damage the process of spermatogenesis, and in this context, another study in diabetic rats showed that *Aloe vera* could have a protective effect on testicular tissue, balancing blood glucose levels and thus having an indirect effect (Zohreh et al. 2014).

ACTION ON CARDIOVASCULAR SYSTEM

At the cardiovascular level, *Aloe vera* exerts an indirect effect by intervening in lipid metabolism and preventing the development of atheromatous plaques. Dana et al. (2012) demonstrated that in the case of rats that received some treatment with Aloe gel the values of total cholesterol and CRP, which are risk factors in cardiovascular diseases (Kwon et al. 2019; Thongtang et al. 2013), are smaller compared to the control group. Both parameters are indicators of inflammation and lipid metabolism.

Another study points out that *Aloe vera* can increase the force of myocardial contraction and coronary flow, thus being cardioprotective and can be used as an adjuvant in the treatment of ischemic heart disease (Verma et al. 2013).

ACTION ON THE EXCRETORY SYSTEM

At this level, the Aloe extract may cause an electrolyte imbalance associated with renal dysfunction. This disparity can lead to hyponatremia and hypercreatinemia. Although not indicated as a treatment for kidney disease, for obvious reasons, Aloe extract could still be beneficial in case of hypernatremia (Saka et al. 2012).

Indirectly, the Aloe extract may have a nephroprotective role due to its involvement in balancing lipid metabolism, improving the lipid profile and reducing the concentrations of aminotransferases which, although directly related to the liver, may be also good indicators for the renal function (Abdal et al. 2019).

ACTION ON PATHOGENS

Against pathogens, *Aloe vera* can exert a direct effect, through direct interaction, or it can have an indirect effect, in the terms of altering the pathogen metabolism or stimulating the immune system.

ACTION ON BACTERIA

Used against bacterial strains of *Actinobacillus actinomycetemcomitans*, *Clostridium bacili*, *Streptococcus* mutans, isolated from subgingival calculus or periapical abscesses, *Aloe vera* gel showed results comparable to those obtained using antibiotics such as ofloxacin and ciprofloxacin. These results were obtained at high gel concentrations (100%, 50%) (Jain et al. 2016). Another study, considering animal skin isolates of *E. coli*, *Shigella*, *Salmonella* and *Staphylococcus aureus*, pointed out that ethanolic aloe extract, from both leaves and root, can be used alongside standard antibiotics to prevent skin infection, but also in more advanced stages of infections, to destroy pathogens (Arbab et al. 2021).

The data proposed by Adzitey et al. (2019), on the effect of aloe gel extract on *E. coli* and *Salmonella*, isolated from the gastrointestinal tract of guinea fowl, shows that *Aloe vera* has antibiotic action and can be used successfully in the diet of birds to prevent possible infections.

A comparative study between aloe gel and virginiamycin, an antibiotic commonly used to treat infections in animals, showed that aloe gel could be a good alternative to replace this antibiotic, when being used in animal diets to prevent infections. Also, was well outlined the idea that aloe gel can lead to a decrease in the number of individuals of *E. coli*, an increase in the number of individuals of *Lactobacillus*, and also to an increase in immune function, both at the cellular and humoral level (Darabighane et al. 2011).

Another study on the bactericidal effect of the aloe plant considers its use against infections with *Pseudomonas aeruginosa*, isolated from burns. The study concludes that aloe gel can be used successfully to prevent *P. aeruginosa* infection but also to treat existing infections (Goudarzi et al. 2015).

ACTION ON VIRUSES

Studies on the effect of polysaccharides extracted from *Aloe vera* leaves suggested that both in vitro and in vivo, *Aloe vera* has a strong antiviral effect (Subasree et al. 2016; Rezaazeh et al. 2016).

In vitro studies performed on the H1N1 subtype of influenza virus suggest that aloe polysaccharides directly target viral cells and generally intervene in viral adhesion. In vivo studies performed on rats infected with the same viral subtype suggest a significant improvement in the health of the subjects and an obvious reduction in clinical symptoms (Sun et al. 2018). Another study on the antiviral action of aloe gel on the herpes simplex virus type 1, in vitro, on the Vero cell line, showed that aloe gel can have antiviral effect, this effect being dose dependent, therefore aloe gel could be good topical prevention treatment (Rezazadeh et al. 2016). Another in vitro study, this time on herpes simplex virus type 2, on the Vero cell line, showed a deep antiviral action, both before viral attachment and penetration, and after viral replication inside cells. A crude hot glycerine extract was used in this study (Zandi et al. 2007).

Another study, by Xu et al. (2021), highlighted the antiviral character of emodin, an anthraquinone compound extracted from *Aloe vera*, on the porcine reproductive and respiratory syndrome virus, made on the Marc-145 cell line and porcine alveolar macrophages line (iPAM). The pronounced expression of TLR, IFN alpha and IFN beta, that intervene in the modulation of the immune response, was visible in iPAMs components (Valins et al. 2010).

ACTION ON FUNGI

Regarding the antifungal activity of aloe extract, many cases have been documented (Tonea et al. 2017; Thaweboon & Thaweboon, 2019). About the effect of aloe extract on *Aspergillus niger*, it was proven that the gel has a significant antifungal

property. It should be mentioned that among the ethanolic and aqueous aloe extracts, the ethanolic one has a more marked antifungal effect.

Regarding the effect of the same extracts on *Candida albicans*, no observable antifungal effect was demonstrated (Saniasiaya et al. 2017). On the other hand, another study on *Candida albicans* suggested that *Aloe vera* extract can successfully inhibit the growth of this fungus, with good comparative results with amphotericin B, a treatment currently used to control this pathogen. It should be noted that the antifungal effect of aloe extract is strictly dose-dependent and that a satisfactory result is obtained only at high concentrations (1000 microgr / mL) (Shireen et al. 2015).

Another study on *Candida albicans* showed the same antifungal property of *Aloe vera* alcoholic extract in a dose-dependent manner. The results are comparable to the results obtained using commonly used antifungal substances, such as fluconazole (Nabila & Putra, 2021).

Aloe vera also exerts an antifungal effect on phytopathogenic fungi. A study performed on the mycelium of *Botrytis gladiolorum*, *Fusarium oxysporum* f. sp. adioli, *Heterosporium pruneti* and *Penicillium gladioli*, reveal a pronounced antifungal effect of *Aloe vera* hydroalcoholic extract in a dose-dependent manner (Rosca-Casian et al., 2007). Another study compares the antifungal effects of *Aloe vera* pulp and the liquid fraction, respectively, highlights the fact that although both extracts have antifungal action, the liquid fraction has a wider area of action. The pulp has antifungal properties on *Fusarium oxysporum* but the liquid fraction in addition to *F. oxysporum*, also inhibits the growth of *Rhizoctonia solani* and *Colletotrichum coccodes*. In this context, it can be concluded that *Aloe vera* products can be considered as antifungal alternatives to be used in crops, thus avoiding the application of chemicals and also avoiding the devastating long-term effects they can have (Jasso de Rodriguez et al. 2005).

ACTION ON PARASITES

A study on the antihelmintic activity of *Aloe vera* extract highlights the potential of this plant as a treatment for Leishmania infection. The data obtained in this study emphasizes a dose-dependent antipromastigotic activity against *Leishmania tropica* (Iqbal et al. 2021). Also through its components, aloin and aloe-emodin, the aloe plant also has antiplasmodial action, and can be used to treat or prevent malaria. In this regard, researchers point out that the concentration of the compounds mentioned above can be changed depending on various climatic factors to which the plant is exposed (Kumar et al. 2017). In another study, the antiparasitic action of *Aloe vera* extract on animal lice (parasitic lice) was highlighted. A better cure rate of chickens infected with this parasite was highlighted when their skin was treated with *Aloe vera* extract, the cure rate being directly proportional to the concentration of aloe extract used (Shlash & Kadhum, 2020).

CONCLUSIONS

Various medical properties were described for *Aloe vera* gel. Despite the fact that has a very high water content, contains also a big number of chemical compounds, like minerals or vitamins and is a useful plant in human nutrition. This paper present general effects of *Aloe vera* gel or extracts.

Aloe vera has effects on digestive, cardiovascular, excretory systems of human body, but also interferes with the immune system. Moreover, presents effects on various pathogens, such as viruses, bacteria, fungi or parasite.

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