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***Aloe vera*: A plant for many uses**

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Abstract

Aloe vera, a cactus-like plant has been used for traditional medical purposes for thousands of years. Aloe leaves can be separated into two basic products: the latex, a bitter yellow liquid beneath the epidermis of the leaf and the gel, a colorless and tasteless substance in the inner part of the leaf. Both of them have many biologically active components, mainly anthraquinones and polysaccharides (the most active is acemannan), which may act alone or in synergy. Scientific studies provide support for the application of *Aloe vera* in cosmetic-moisturizers, toothpastes etc, food as flavoring compounds or preservative of fresh products and in medicine of humans or animals. *Aloe vera* seems to treat a variety of conditions because of its wound healing, anti-inflammatory, immunity, antidiabetic, antioxidant, laxative, antibacterial, antifungal, antiviral and antitumor effects. Besides these applications it can be also included in the animals diet to utilize their benefits to the maximum extent.

Key words: *Aloe vera*, cosmetic applications, food applications, medicinal applications, animal nutrition.

Introduction

Aloe vera has been used by mankind for thousands of years in folk medicine for therapeutic properties especially on skin. This plant is one of the oldest known and its first documented use by humans dates back to an Egyptian papyrus from 3500 BC¹. The Greek philosopher Aristotle wrote about the beneficial medicinal effect of *Aloe vera*, while references are also found throughout the Bible². The ancient Greeks, Romans, Chinese and Indians used it. By the early 1800s *Aloe vera* was served as a laxative in the United States. Moreover, modern clinical use began in the 1930s with reports of successful treatment of x-ray and radium burns³. *Aloe vera* derives its name from the Arabic word “Alloeh” which means “shining bitter substance” because of the bitter liquid found in the leaves and Vera which means “true” in Latin^{2,3}. This species was first described by Carl Linnaeus in 1753 who suggested the following classification: Kingdom: plantae, Order: Asparagales, Family: Asphodelaceae, Genus: *Aloe*, Species: *Aloe vera*. There are a number of synonyms: *Aloe barbadensis* Mill., *Aloe indica* Royle, *Aloe perfoliat* L. var *Vera* and *Aloe vulgaris* Lam⁴. Most of the *Aloe* plants are not toxic, but a few are extremely poisonous. There are about four main species of approximately 420, that have medicinal properties and among them is *Aloe vera* which is considered to be the most potent and therefore the most popular, also widely grown as an ornamental plant^{5,6}.

The natural range of *Aloe vera* is unclear as the species has been widely cultivated throughout the world, rather originating in Africa. It is grown in most subtropical and tropical locations including South Africa and Latin America, then it was introduced to China, India and various parts of Southern Europe in the 17th century^{1,6,7}.

Aloe vera is a cactus-like plant, although is related to the onion, garlic and asparagus². It is stemless with triangular, fleshy leaves ranging in color from grey-green to bright green and in the margin of the leaves has small white teeth⁶. The leaves are composed of three layers: an inner gel, a yellow sap and the outer thick layer of 15-20 cells called as rind^{3,8}. Aloe leaves have long been used for medical and cosmetic purposes as well in health foods but there is no clear understanding or scientific analysis of the basis for such properties⁸. According to other researchers⁸⁻¹⁰ *Aloe vera* can be separated into two basic products, latex and gel. The latex, representing approximately 20-30% by weight of the whole leaf referred as “aloe juice” or “aloe sap”, is a bitter yellow exudate from the pericyclic tubules beneath the epidermis of the leaf. Young leaves were found to have higher concentrations of latex components compared to older leaves¹¹. On the other hand, the colorless, tasteless gel is the pulp or mucilage from the parenchyma cells of the plant in the inner part of the leaf⁸⁻¹⁰.

Early, in 1941 was reported that the leaf pulp of *Aloe vera* contained 98.5% water and its alcoholic-insoluble portion was a mucilage containing uronic acid, fructose, hydrolysable sugars and enzymes¹². Nowadays, it is known that the gel representing approximately 70-80% by weight of the whole leaf, serves as the water and energy storage component of the plant¹¹. When it is used the whole leaf of *Aloe vera*, it is difficult to distinguish if their biological effects are attributed to the gel or the latex because during the gel preparation exudates compounds may infiltrate¹⁰.

Biological Components

Aloe vera latex and gel have physiologically active substances with biological effects, acting alone or indicating a synergistic

effect^{10,14}. The identification of these substances is important for the effective use of the plant. The chemical composition of *Aloe vera* varies and depends on climate, region, growing conditions, the age of the plant or the processing method^{8,11}. According to Choi and Chung¹⁵, the major substances of *Aloe vera* are shown in Table 1.

Aloe vera latex is high in anthraquinones, phenolic compounds, that have strong laxative effects while they can act also as antibacterials especially against Gram-positive bacteria^{3,11,16}, analgetics and antivirals^{3,11}. In addition, the latex is reported to contain, on a dry weight basis, an acid insoluble resin (16-33%), significant ash content (24.5%) and a small quantity of essential oil that is responsible for the odor of the latex¹⁷. In spite of these biological activities, anthraquinones may have harmful effects, such as genotoxic, mutagenic and tumor promoting¹⁸.

A potent source of polysaccharides seems to be *Aloe vera* gel¹⁹. It has been shown that three years old *Aloe vera* contained significantly higher levels of polysaccharides^{10,11,20}. The most active among them is acemannan^{11,21} which is reported to have antiviral²², antibacterial²³, wound healing²⁵⁻²⁷ and immunostimulative activity^{24,25}, reduces radiation-induced skin reactions²⁶ and stimulates hematopoiesis²⁸. It should be noticed that active glycoproteins have been also found in *Aloe vera* gel and may play some role in therapeutic activity, either immunologically as lectins or as proteases (antibradly kinins)¹⁰. Moreover, *Aloe vera* gel has pH 4.4-4.7, consists primarily of water (98.5%) and polysaccharides and contains vitamins, enzymes, steroids etc^{11,15,29,30}.

The gel when exposed to air rapidly oxidizes, decomposes and loses much of its biological activities, so there are different processing techniques with regard to gel's sterilization and stabilization^{8,30}. Because many of the active ingredients of *Aloe vera* gel appear to deteriorate on storage, the use of fresh gel is recommended³⁰.

There have been also, a few reports of harmful effects of *Aloe vera* gel such as eczema, allergic dermatitis or an increase in circulating leucocyte count probably as a result of stimulation of the immune system¹⁰.

Mechanism of Actions - Uses and Applications

Cosmetic uses: Generally, *Aloe vera* has many uses both for humans and animals. Three distinct preparations of the plant are used: *Aloe vera* latex, *Aloe vera* gel and *Aloe vera* whole leaf extract, whose biological ingredients may act alone or in synergy^{11,19}. The use of *Aloe vera* in cosmetics is not new; there

are many of them on the market which use *Aloe vera* in concentrations varying from 1 to 98%¹⁴. It is well known that Aloe gel enables the plant to hold moisture for extremely long periods of time and has soothing effects as well². So, *Aloe vera* has found an extensive application in the cosmetic and toiletry industries, such as moisturizers, cleansers, sun lotions, toothpastes, mouthwashes, shaving creams, deodorants and shampoos^{6,8,31}.

In Aloe-derived ingredients used in cosmetics anthraquinone levels should not exceed 50 ppm, concentrations too low to induce phototoxicity³². In the United States the Food and Drug Administration (FDA) has approved the external use of *Aloe vera* gel only as cosmetic ingredient^{30,31}.

Food uses: The food and beverage market is a promising arena for *Aloe vera*. It has been used as a resource of functional food such as yogurt or for the preparation of health drinks, including tea^{2,8,31}. It is well known, that botanical products are widely used as nutritional supplement for promotion of health or prevention of diseases. According to Serrano *et al.*³³ *Aloe vera* gel can be used as an edible coating to prolong the quality and safety of fresh products. Table grapes coated with Aloe gel significantly delayed the loss of functional compounds such as total phenolic and ascorbic acid. Indeed, *Aloe vera* inhibits the growth of microorganisms responsible for foodborne illness in humans or animals as well as food spoilage^{8,9}.

Aloe vera does not appear to affect food taste or appearance, so it seems to be promise as a safe, natural and environmentally-friendly alternative solution to conventional synthetic preservatives³³.

FDA, in the United States has approved the internal use of gel as a "dietary supplement". In the European Commission (EC) according to Annex I of Regulation No 1831/2003 *Aloe vera* can be used by the feed industries as sensory additive functional group "flavoring compounds", to increase smell or palatability of feedings stuff^{30,31}.

Medicinal uses:

Healing wounds: Due to polysaccharides and the growth hormone gibberellins, increased collagen and elastin formation may reduce wrinkling^{3,10,19,27,28,35}. The high healing capacity of *Aloe vera* is to find out a number of mucopolysaccharides (MPS) present between 10,000-20,000 MPS per litre⁸. Moreover, *Aloe vera* effects are in the treatment of scar tissue and the prevention of scar formation following injury to the skin, probably are attributed to the activity of the amino acids necessary to new cell formation

Table 1. Major substances of *Aloe vera*.

Glycoproteins	Anthraquinones	Saccharides	Vitamins	Enzymes	Low molecular – weight substances
	aloe-emodin	cellulose	B1	amylase	arachidonic acid
	aloetic acid	glucose	B2	carboxypeptidase	cholesterol
	aloin	mannose	B6	catalase	gibberellin
	anthranol	aldopentose	C	cyclooxygenase	lectin-like substances
	barbaloin	acetylated mannan (acemannan)	β-carotene	lipase	lignins
	isoberbaloin	glucomannan	choline	oxidase	salicylic acid
	emodin	acetylated glycomannan	folic acid		β-sitosterol
	ester of cinnamic acid	galactogalacturan	α-tocopherol		steroids
		glucogalactomannan			triglycerides
		galactoglucosarabinomannan			uric acid

and due to the ability of its enzymes to promote regeneration of the deepest layers of the skin ^{8,15}.

Anti-inflammatory action and immunity activity: Because of salicylic acid, which is both analgetic and anti-inflammatory, the production of prostaglandins from arachidonic acid is inhibited ^{9,10,19}. So Aloe has been used to help with arthritis and joint related problems ^{2, 27}. Immunity activity is enhanced by Aloe polysaccharides ^{15, 25, 31, 36}.

Effects on skin exposure to UV and X-radiation: *Aloe vera* supports the healing of first to second degree burns ³⁷ although the exact role is not well known ^{2,10}. It is suggested that lectin may be responsible for the therapeutic effect ⁸.

Effects on ulcers: *Aloe vera* can be used successfully in the general treatment of skin ulcers including mouth ulcers ^{2,8,24}, herpes simplex and psoriasis ^{10,35}. Also, this plant was found to protect against the formation of gastric ulcers ^{8,31}.

Antidiabetic activities: Some inorganic elements (vanadium, manganese, copper) ³⁸ and especially the polysaccharides present in *Aloe vera* may have a significant role for antidiabetic activities ^{10,31}. This plant has been linked with reduced blood glucose levels in diabetics ^{2, 10, 31} and with lower blood lipid levels or cholesterol ^{31,39} (approximately 30% lower) ⁴⁰ in hyperlipidaemic patients.

Antioxidant activities: Antioxidant activities have been studied ^{10,40,41}. According to Lee *et al.* ⁴² *Aloe vera* activity was similar to that of α -tocopherol. Also, it has been noticed that the growth stage of the plant is important for such activities ²⁰.

Laxative effects: Anthraquinones present in *Aloe vera* latex are a potent laxative, increasing intestinal peristalsis ^{11,31}.

Antibacterial properties: Many researchers ^{3,11,23} mentioned that *Aloe vera* inhibits the growth of some microorganisms like *Str. pyogenes*, *Shigella flexneri*, *Klebsiella* sp., especially against Gram-positive bacteria causing food poisoning or diseases in humans and animals ¹⁶.

Antifungal activity: Antifungal activity has received less attention, although inhibitory activity against *Candida* ³⁵ has been reported. For its antifungal properties *Aloe vera* is used as a fish tank water conditioner ⁴³.

Antiviral and antitumor activity: These actions may be due to the indirect or direct effects: indirect through the stimulation of the immune system and direct to anthraquinones ³. So, clinical trials are in progress to obtain conclusive evidence for the use of *Aloe vera* in the treatment of HIV-AIDS or cancer ^{8-10,31}.

Age-related effects: *Aloe vera* was investigated on pathogen-free rats with some promising results on age-related diseases ^{44,45}.

The Use of *Aloe vera* in Animal Nutrition

Aloe vera apart from the above mentioned uses, seems to play an important role in promoting growth in chickens ⁴⁶ or in their health

management ⁴⁷. As concerns the broiler chickens, the supplementation of their basal diet with 600 mg·kg⁻¹ of Aloe powder, or Aloe water extract or Aloe ethanol extract or an extract mixture of all above, could improve production performance and immune function of male broilers, while the Aloe water extracts had better results than the others ⁴⁸. Analogous were the findings of other researchers ^{46,49} on body weight of broilers, when their drinking water was mixed with *Aloe vera* extract (5-30 cm³ per dm³ of water). On the other hand, broiler chickens fed with 0.1 or 0.2% *Aloe vera* had no significant effect on body weight ^{50,51}. No significant results were found in the feed conversion ratio ^{46,48-51}. Likewise the dietary supplementation of *Aloe vera* did not significantly affect the carcass and sensory characteristics of the broiler meat ⁴⁶. This finding favorably compared with earlier reports on carcass yield and internal organs ^{50,51}. On the contrary, other researchers observed that *Aloe vera* improved the acceptability of broiler meat ⁴⁹.

Moreover, dietary *Aloe vera* had no effect on abdominal fat levels ^{51,52}, on breast and thigh muscle cholesterol levels or on serum biochemistry (serum glucose, total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides) ⁵².

Meanwhile, *Aloe vera* fed broilers showed significantly higher haemagglutination inhibition titre values against Newcastle disease ⁵². Also, it is reported that this plant can be used to treat and control coccidiosis in chickens ^{47,53}.

The incorporation of *Aloe vera* in laying hen diet resulted in a significant improvement in egg production (eggs/hen) but no difference was observed in feed consumption or feed conversion ratio ⁵⁴. Furthermore the dietary supplementation of *Aloe vera* extracts in laying hens may prevent or treat the effects of experimentally intoxicated lead on birds ⁵⁵.

Moreover, it is reported that a natural phytogetic growth promoter, including *Aloe vera* was used on the shrimp growth with promising results ⁵⁶.

Conclusions

Aloe vera contains many physiologically active substances. It would be worthwhile embarking more scientific investigation on this medicinal plant and to promote its large-scale utilization.

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