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Aloe vera: An update on its phytomedicinal, pharmaceutical and therapeutic properties

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ABSTRACT

Medicinal plants are a good source for preparation of new drugs. Aloe vera [L.] is one of the valuable medicinal plants native to hot and dry zones and is usually planted outdoors in hot areas. Currently, various products obtained from this plant are produced in the food, pharmaceutical and cosmetics industries all over the world. Various products from this plant including beverages and cosmetic products are available. Consideration of this species and development of its processing industries in these regions can be an important step in job creation and proper use of poor agricultural lands. In this paper we aim to present the updates on Aloe vera plant, focusing on, botany, the phytomedicinal compounds, structural properties of the leaves.

Key words: Aloe vera, Medicinal plant, Herbal medicine.

INTRODUCTION

In many countries traditional medicine is mostly relied on the consumption of medicinal plants [1-9]. Herbal medicines have been used for the treatment and prevention of diseases since ancient times [10-19]. As a result, many trials have been conducted to evaluate and confirm their medicinal properties [20-29]. In this regard, very good results have been achieved and new drugs have been prepared [30-38]. Aloe vera is one of these plants. It is frequently used in the food, pharmaceutical and cosmetics industries. Its extract is widely used as alternative and complementary medicine, being marketed as having various pharmaceutical and therapeutic properties [39-41].

More than 19 thousand hectares in America and 23 thousand hectares in the world are each year under cultivation for Aloe vera. However, most of Aloe vera sales belong to countries such as Thailand [35%], Mexico [30%] and the Dominican Republic [18%] [42].

In 2004, the economic value of the Aloe vera industries was estimated to be more than US\$110 billion for finished Aloe vera products and US\$125 million for the raw Aloe vera [42]. Various Aloe vera products are currently used in pharmaceutical, food, cosmetics and hygienic industries. In this paper we aim to present the updates on Aloe vera plant, focusing on, botany, the phytomedicinal compounds, structural properties of the leaves,

HISTORY

Aloe has been frequently used in the food, pharmaceutical and cosmetics industries all over the world since 2000 years ago. Its use was firstly recorded in the Ebers Papyrus from the 16th century BC and in Dioscorides' De Materia Medica and Pliny the Elder's Natural History which have been written in the mid-first century AD [43]. The plant is used widely in the traditional herbal medicine of many countries [42]. Aloe vera is used in traditional medicine as a multipurpose treatment.

BOTANY

Aloe vera is a very short-stemmed plant, growing up to 100 cm. Aloe has 380 species in the subfamily Aloioideae within the family Asphodelaceae. The leaves are green to grey-green, thick, with white flecks on their upper and lower stem surfaces [8]. Aloe vera is native to South and East Africa which was gradually distributed to the Arabian Peninsula, North Africa, Mediterranean and west India, China, Gibraltar [44].

Aloe vera is a evergreen plant with thick fleshy leaves, a short woody about 10cm thick stem, with sharp pointed, jagged. The number of the leaves is up to 20. The leaves are serrated and have green or grey-green colors. The leaves are up to 60cm length, 8-10cm width and 1-3cm thick. The flowers of Aloe vera appear in summer, each flower has a yellow tubular corolla 2–3 cm long. It has a symbiosis that allows the plant to have better access to mineral nutrients in soil [45]. Its fruits range from circular to egg-shaped which grow by late spring or early summer. The weight of the harvestable leaves ranges from 250-770 grams, the length of the harvestable leaves ranges from 63-73cm, the cross-section of the harvestable leaves ranges from 5.6-8.3cm, the thickness of the harvestable leaves ranges from 1.8-2.6cm, The gel weight to total leaf weight ratio is 52% [44].

The carbon and oxygen required for the creation of the carbohydrates are provided through the carbon dioxide of the air which is absorbed at night through the stomata. Carbon dioxide is trapped and stored as malic acid, and for this reason, the Ph of the internal part of the leaves is about 4. After solar radiation to the leaves, a portion of the malic acid is changed into the carbohydrates needed for plant metabolism and the rest of them are stored in the mucilage of the gel fillet [45].

PANTING

Sandy loam soil texture is required for the cultivation of Aloe vera. The maximum tolerable temperature for the plant is 50 °C and the minimum is 10 °C, with the best being 20-30 °C. If the temperatures get near the maximum, and or if there are hot winds, increased irrigation intervals and or the temperature decreases to 10 °C, the leaves gradually change in color and turn brown and the plant growth stops [44].

Studies show that the amount of food resources required by Aloe vera depends on the amount of such elements' existence in the soil, such that the highest amount of its requirement in a soil that is poor in phosphorous, is 50kg per hectare of phosphorus [P205]. Concerning the plant's requirement of nitrogen, in a soil that is poor in nitrogen, 57kg per hectare of nitrogen will suffice. Concerning the plant's requirement of potassium, in a soil that is poor in potassium, 45 kg per hectare of potassium [K₂O] will suffice, and if the soil comparison levels reaches about 120 ppm, the fertilizer requirement of the plant will be completely resolved [45].

The propagation of Aloe vera usually takes place through shoots, such that the shoots produced around the mother plant are uprooted by slowly clearing the soil surrounding the root without damaging it, and planting them as rows in a suitable ground. The most appropriate time for the separation of the shoots and planting them is early in the second half of the year due to appropriate environmental temperate [45]. Seasons for planting the bushes in the ground vary depending on the type of used machines and tools, but the most appropriate distance for planting them is 40-50cm between the bushes and 80-120cm between rows of planting [47].

Aloe vera irrigation is possible via various methods such as sprinkler irrigation, gravity irrigation [shallow furrows] and drip irrigation. Selection of irrigation method depends on various factors such as terrain slope and texture, wind speed in the region as well as quality and quantity of water resources. Plant water requirement is low but excessive reduction of irrigation and increased irrigation intervals decrease the performance of the leaf weight and the content of the leaf gel. Irrigation period varies depending on soil texture, growing season, planting method and existence of variable local winds, and is 7-15 days for the plant [46].

PHYTOMEDICINAL COMPOUNDS

The leaf is used for medical, food and industrial purposes which include 2 distinct and independent parts:

1. Latex from Aloe vera or drug Aloe, is a hard and dry latex produced by squeezing the plant or it is a product of the normal latex flow coming from the leaves of various Aloes like Aloe vera which at least includes 15% derivatives from hydroalcoholic anthracene. This yellow liquid inside the peripheral cells attached to the leaf parenchyma, starts to exit immediately after the leaf is cut, and is dried when exposed to sun heat or fire. This latex contains some variable amounts of alion, Aloe-emodin, chrysophanic acid, volatile oils and resin [47].

The dried latex called Curacao Aloe or Barbados Aloe, looks pile-shaped, is translucent dark brown, has a disgusting and nauseating smell, and is very bitter and contains about at least 28% derivatives of

hydroxyanthracene namely 15-40% of Barboloin [Aloin] [Barboloin Aloin] is actually a mixture of Aloin A and Aloin B and 3% of hydroxy aloin [48].

2. Gel: the gel or fillet existing in the Aloe leaves, consists of a hydrocolloid solution contained in the vacuole or the cell wall and contains the tissue water, and in contrast to gum, lacks adhesion properties [48].

All species of Aloe, contain gel which includes various compounds of polysaccharides but the commercial use of this gel, is limited to the *A. arborenses*, *A. ferox* and *A. vera species*; the latter species is more common compared to the others. Polysaccharides compounds of Aloe are complex, this polysaccharide is comprised of glucomannan along with Galactan, 27% of it is comprised of Galactan and 70% glucomannan and Acemanan [49].

Different glucomannans are found in various species of Aloe, such that in the *A. ferox* species, there are at least four glucomannans namely acid galactan, manna, arabinan and glucogalactomanan. Chemical analysis of the gel based on fractional distillation for separation of different polymerases based on their molecular weights is possible. The primary method for doing this is chromatography on sephadex namely gel filtration, another method recommended by the WHO, is the use of gas chromatography [49].

There are vascular bundles in the cross-section of the leaves just below the thick epidermis of the leaves. The external part of the vascular bundles is covered with epithelial cells and three tubular tissues are seen in the internal part of the vascular bundles: Xylem, phloem and capillary tubes containing yellow latex with strong cathartic property including anthraquinones particularly aloin [46].

Anthraquinones absorb the ultraviolet rays of the sun and prevent excessive increased temperature in the middle section of the plant's leaves which is the water storage location. It should be noted that the peripheral section of the vascular bundles is attached to the epidermis while the others enter into the large space of the parenchyma or mesophyll which is very thick and slimy. This creates a liquid layer called mucilage between the soft fillet and the hard epidermis [49].

For gel stability, after pasteurizing it in 30-70C temperature for 45-90 minutes with reduction of the gel's acidity down to 3.5 and use of tetrasodium, it is possible to use EDTA and calcium phosphate along with an anti-oxidant [49].

The major mid-section is comprised of mesophyll or parenchyma cells contained in the gel fillet. All the polysaccharides and glycoproteins [enzymes] are created in the thick green leaves. The extra amounts of the carbohydrates required for the plant's metabolism, are transferred to the parenchyma or gel fillet for water, mineral and carbohydrate storage. The carbohydrates are transferred to small cellulosic tubes in the gel fillet by the phloem tubes. Water is absorbed into these carbohydrates by osmosis and acts as the water storage tissue [48].

EXTRACTION AND GEL PREPARATION

The leaves of Aloe are usually harvested in the second year after the planting of the shoots. The interval between the time of the harvest and its processing must be less than 24 hours and during the processing stages, it is best to keep the temperature low. After harvesting the leaves of Aloe, lactobacilli quickly cause fermentation, then lactic acid is produced which is an unwanted compound in the product and high levels of it in a product can cause decreased product quality [50].

Gel extraction is takes place through manual or mechanical separation of the epidermis or from the entire leaf. The quality of the gel in epidermis method will be better than entire leaf method. The advantage of this method is that the yellow latex in the peripheral cells and vascular bundles positioned under the epidermis is not mixed with the gel, and if it does get mixed. In this method at first, the washed leaves are cut lengthwise and the leaf gel is extracted manually or mechanically by separating the leaf epidermis. [50]. Given the strong cathartic property of this latex and its intense bitterness, its mixture with gel in edible and cosmetic products is not appropriate. The resulting gel will contain about 0.5% dry material and it can be used after pasteurization by adding suitable preservatives. For gel drying, it is possible to use spray dryer or freeze dryer [49].

In entire method, after harvesting the leaves, using various machines, the entire leaf is chopped and then by adding cellulase enzyme for facilitation of cellular tissues decomposition, a centrifuge or pressing is used for gel separation and then using special filters and charcoal activated and other sorbents, the anthraquinone materials mixed with the gel are separated from it and the resulting gel will contain about 1.5% dry materials [50]

THERAPEUTIC AND PHARMACEUTICAL PROPERTIES

The many therapeutic and pharmaceutical effects associated with this plant are mostly based on traditional uses [51]. But some clinical studies have also been conducted which will be mentioned here:

In a study, the topical application of the Aloe gel on wounds caused by the first stage of genital herpes in men, resulted in a significant acceleration of wound healing and increase of the number of cured patients compared to the application of placebo [52]. In one study, topical application of Aloe gel, accelerated the healing process by 72 hours for wounds remaining from acne vulgaris on the face [53]. In another study on women in whom after surgery suffered from wound healing complications, the application of Aloe gel the wound healing was better compared to the control group. In another study performed on patients suffering from mild to moderate psoriasis, the topical application of the Aloe gel cured 83% and the placebo cured 7% of the disease. In another research, the topical application of the Aloe gel compared to placebo for patients under treatment with radiation, did not prevent the occurrence of dermatitis [54].

In a clinical study, the consumption of edible Aloe gel in patients suffering from hyperlipidemia, resulted in decreased serum low-density lipoproteins compared to pre-treatment stage. In another research, consumption of the edible Aloe gel in diabetic women, resulted in a significant decrease of glucose and triglycerides of blood but had no effect on the cholesterol concentration in blood and appetite of the patients. Also the consumption of the edible Aloe gel along with glibenclamide in diabetic patients, caused a significant decrease in the glucose and triglycerides of blood [55, 56].

Studies on the effect of Aloe-Emodin [AE] on vascular smooth muscle cells proliferation after arterial injury showed that AE is a strong inhibitor for smooth muscle cells proliferation and the pharmaceutical effect of the AE is the reduction of smooth muscle cells in vivo which results in decreased proliferation of intimal vessel cells. It should be noted that the proliferation of these cells, results in the re-obstructing of the vessel [53].

Studies on the antifungal effect of *A. vera* showed that the gel of this plant can control the growth of the mycelium of *Fusarium Oxysporum* fungus, but the latex of the plant can control the growth of the following fungi in the cultivation environment: *Fusarium oxysporum* and *Colletotrichum coccodes* [57].

Aloe gel is topically applied for treating mild burns, sunburns, cuts, acne, and inflammation of the oral mucosa. Its topical application of surgical wounds is not allowed because it delays wound healing [51].

The *A. vera* gel is also used for asthma, candidiasis, chronic fatigue syndrome, indigestion and intestinal disorders such as atonic constipation, irritable bowel syndrome, ulcerative colitis, skin disorders such as eczema, psoriasis, acne, burn, fungal foot infections, genital-herpes, skin damage due to frost, sports injuries, internal and external wounds [51].

Aloe vera is used as a moisturiser and anti-irritant on facial tissues. It is in cosmetic products or other derivatives such as moisturizers, soaps, shampoos, shaving cream, makeups, tissues, sunscreens or incense. Its inclusion in hygiene products is mostly due to its moisturizing effects [58]. Aloe vera is also used include the dilution of semen for the artificial fertilization of sheep, as a fresh food preservative, or for water conservation in small farms. It has also been suggested that biofuels could be obtained from Aloe vera seeds [59].

TOXICITY

Although the use of *A. vera* is not associated with significant side effects. However, oral ingestion of *A. vera*, may cause diarrhea which in turn may reduce the absorption of drugs. It has also been claimed that Aloe vera might be carcinogenic and it should be consumed with cautious [60,61]. Aloe vera that contains aloin in excess amounts might cause adverse effects. The toxicity of Aloe vera might be less when aloin is removed by processing [62].

CONCLUSION

Scientific evidence for the pharmacological therapeutic effects of Aloe vera is limited. However, there are some preliminary evidences to suggest that the use of Aloe vera might be effective in a wide variety of diseases including diabetic patients and in hyper-lipidemia. There is evidence regarding sunburn and wound healing effect of Aloe vera especially on first- to second-degree burns. It also has antibacterial and laxative property, and supportive effects on gastrointestinal tract. It also has antitoxic activity against some toxic effects of some materials [39]. More researches are needed to define the clinical effectiveness of this medicinal plant more precisely. The mechanism action of Aloe vera is not clear. What is clear is that this plant has high level of antioxidants which is mostly due to high amount of phenolic compounds. Plants with antioxidant activities have been shown to have anti-diabetic [63-70] and hypo-

lipidemic [71-75] activities. Phenolic compounds have antibacterial and anti-parasite activities [76-82]. Antitoxic activities of some medicinal plants have also been correlated to their antioxidant activities [83-88]. Therefore, a part of *Aleo vera* effects should be related to phenolic compounds and antioxidant properties. It may mean that other plants which have these properties [89-101]; Many diseases are extremely important and the need for chemical and herbal treatment to be felt, in particular treatment with herbal medicines [102-131], may have, at least in part, the same effects.

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