Aloe Vera

Alexander G. Schauss
Director, Life Sciences Division
American Institute for Biosocial Research, Inc., Tacoma, WA USA

Description

Aloe juice, pulp, extracts, concentrates, or leaf segments come from the Aloe vera plant. Aloe vera is also known as Aloe Barbadensis, Aloe perryi, Aloe ferox, Mediterranean Aloe, Barbados Aloe, and Curacao Aloe. For purposes of discussion, we will refer to it by its popoular name, Aloe vera.

Aloe vera is cultivated around the world, particularly, in sandy loam type soils, such as found in North North America in the Rio Grande Valley of Texas and Mexico. However, the plant grows naturally throughout the world in most tropical and sub-tropical areas, particularly, Jamaica, Barbados, Aruba, Puerto Rico, Central America, the Mediterranean countries, Egypt, Malaysia, Indonesia, and India. The plant blooms in late winter and early spring. It is primaril;y sought for its pulp, which is 96% water. However, other parts of the plant, such as the seed and root oils are also used in a variety of food products. Food products that might contain some part of the aloe vera plant include nonalcoholic beverages, frozen dairy desserts, candy, baked goods, gelatins and puddings.

There is a considerable scientific literature on particular aspects of the chemistry of aloe vera. For example, aloe vera contains anthraglycosides (anthraquinone glycosides) as its active ingredients. Included in the anthraglycosides are barbaloin and isobarbaloin, a glucoside of aloe-emodin, and C-glucosides, aloesin and its aglycone aloesome (a chromone), free anthraquinones (i.e. aloe-emodin), and various resins. Concentrations of glucosides may vary in aloe gel considerably, but have generally been found to be within the range of 5 to 25%.

The pulp in the center of the leaf contains a mucilaginous portion that yields pure aloe gel (a virtually tasteless viscous hydrocolloid). The outer epidermis (aloin layer) is green and rubbery. It contains a yellow exudate chemically known as barbaloin (an anthraglycoside), a potent cathartic used in conjunction with other drugs as a laxative, found in the bundle sheath cells. The aloine content of Aloe Barbadenis is approximately 30%, that of Aloe perryi approximately 25 to 28%, and that of Aloe ferrox approximately 10%.

The inner portion of the leaf containing the gel is of particular therapeutic interest. It contains primarily hexanoses and hexans, including arabinose, galactose, and xylose. By far the greatest proportion of compounds found in the gel are these polysaccharides.Chemical analyses have also shown the gel to contain various carbohydrate polymers, notably either glucomannans or pectic acid. Other consitutents reportedly found in the gel include:[1,2]

uronic acid, pentose, glucose, mannose, tannins, lignin, steroids, monosulfonic acid, organic acids, antibiotic like substances, phosphotide esters, glucuronic acid, oxidase, catalase, alpha amylase, amylase, calcium oxalate, saponins, natalein, chloride, sulphate, iron, calcium, copper, sodium, potassium, manganese, zinc, thiamine, niacinamide, riboflavin, pyridoxine, vitamin C, and choline.

The reputation of aloe vera comes primarily from its purported use as a wound healer.

Aloe gel derived for personal use at home is generally gotten by transversely cutting the leaves or "pups" of the aloe vera plant near the base, opening the leaves, and extracting the clear gelatinous heart of the leaves. Care must be shown to cut the very bitter yellow layer away. The remaining clear gel is then used or applied topically as indicated. As an alternative, it is recommended that once the fresh leaves are cut transversely, the leaf be left for 18 hours so that the bitter yellow substance can drain off. The leaf will retain its enzymatic activity in spite of this duration of storage, since the plant is able to protect itself from further oxidative destruction by a very fine thin 'skin' layer at the cut site. Some believe that the bitter yellow layer containing the substance aloin should be used as well.

However, most aloe vera products come from commercial sources. Since aloe gel is not very stable when exposed to air (beyond several hours) and thereafter begins to lose its effectiveness, many techniques have been developed to stablize and preserve the gel. Stabilization techniques vary, but include: gamma irradiation with radioactive cobalt, spray drying, freeze frying, short time high termperature exposure, ultraviolet light exposure in the presence of a chemical catalyst, oxidation with hydrogen peroxide, the use of 0.0125% sodium benzoate (a derivative of benzoic acid), or Irish moss (due to its sodium and carrageenan content). Often these substances or methods of stabilization are combined. Some methods derive low concentrations of actual gel (i.e. ultraviolet light treatment). Any heat over 60 degrees C (140 degrees F), will break down vital enzymes in the gel.[4] Yet these enzymes are responsible for the continued breakdown of the gel until it turns brown. A compromise to this problem is the use of interval high heat exposure for short periods of less than 3 minutes. This method will pasteurize the gel while reducing enzyme activity loss.

Commercially prepared powdered aloe vera gels are also available. These can be produced by either spray drying or freeze drying pure aloe gel. The spray drying method requires heating the gel and removing the existing water under a vacuum. Some spray dried aloe products have an added but inert material added to it that makes reconstitution difficult. In the freeze dried method, the water is removed from the gel in the frozen state. Since this method lacks heat, it is more apt to retain the gel's enzyme activity.

Method of Action

Many of the active constituents of the aloe vera gel have been isolated and synthesized. Aloe vera is known to contain several pharmacologically active ingredients, including a carboxypeptidase that inactivates bradykinin in vitro, salicylates, and substances that inhibit thromboxane formation in vivo.[34] The latter inhibition is important in the management of burn wounds. Aloe vera seems to block the formation of vasoactive prostanoids which would prevent the vasoconstriction, thrombosis, and progressive ischemic necrosis knwon to occur in thermal and electrical burns as a result of unbalanced thromboxane production.

Specific substances (isolates) in aloe vera have been tested by themselves on many types of bacteria for bactericidal effects with poor results. When the same bacteria have been exposed to the entire gel or specific dermal gel extracts, the effects have been very favorable, suggesting that the whole gel must be used whenever required.[3] Controlling bacterial growth in the burn or abrasive wound is essential in the management of such wounds.

It has also been established that the moisturizing, emollient and healing properties of the aloe vera gel is due to its polysaccharides. The major polysaccharide being glucomannan. Other polysaccharides include uronic acid, pentose, and galactose.

Two functionally and chemically distinct immunomodulatory compounds have been identified in the gel of aloe vera.[5] These compounds have been shown to increase in vitro the activation of human complement and of human polymorphonuclear leucocytes (PMN).

Analysis of the aloe gel reveals many compounds, discussed under the description, that collectively account, most probably, for its many therapeutic methods of action.

Therapeutic Approaches

Therapeutic uses of aloe vera have been reported in the medical literature for over 50 years, although it has been reported in the botanical and naturopathic literature for many more years.

Scientific studies exist that support the antibacterial and antifungal effect of substances in aloe vera. Studies and case reports provide support for the use of aloe vera in the treatment of radiation ulcers and stasis ulcers in humans, and burn and frostbite injuries in experimental animals.

Modern clinical medical use of aloe began in the 1930's with reports of successful treatment of X-ray and radium burns.[6-11,25,26] These case studies were later confirmed in animal experiments and controlled clinical trials with humans. In one such experiment, 10 rabbits were subjected to 14,000 or 28,000 rep of beta radiation from strontium-90.[10] Two of four areas were treated with aloe vera gel, the remaining two left untreated. Gross and microscopic morphological changes in the skin resulting from the radiation were compared in the treated and untreated areas. Consistently the aloe treated areas were completely healed within two months, whereas the untreated ulcerations remained four months later.

Dermatologists have shown considerable interest in aloe vera due its antimicrobial and antibacterial properties.[12-15] In in vitro studies, marked zones of inhibition (bacteriostatic activity) were shown for Staphlyococcus aureus 209, E. coli, Streptococcus pyogenes, Coryenbacterium xerose, Shigella paradysenteriae, Slamonella typhosa, Salmonella schotimuelleri, and Salmonella paratyphi. [12] In a study by Rodriquez-Bigas et al (1988) [15] wound bacterial counts were quantitatively measured and found to effectively be decreased equally by either 1% silver sulfadiazine ($p=0.015$) or aloe vera extract ($p=0.015$) in an experimental study using Hartley guines pigs. The guinea pigs received full-thickness burns covering 3 % of their body surface. The avergae time to complete healing in the control group was 50 days, while the aloe vera-treated animals healed on an average of 30 days ($p.<0.02$). Such data supports the belief that aloe gel dermal extracts allow faster healing of burn wounds.

Aloe vera has also been shown to be of benefit in numerous studies in the treatment of burns, frostbite and skin abrasion injury.[15-20] Aloe vera ointments have been carefully and systemmatically tested for their efficacy on third degree burns. The process of gradual formation of the eschar has been followed in these experiments, examining the gross and microscopic changes that occur step by step. In one study, albino rabbits were given identical burns and found to benefit from an aloe vera gel called preparation S, which is a specially preapred bland ointment base with 5% lanolin, found to be the most effetive in forming microscopic eschar.[18]

In a careful quantitative controlled 24-day study of experimental second-degree burns in guinea pigs, evaluating the effects of aloe vera gel as compared to 1% silver sulfadiazine cream, on epithelialization, wound contraction, the thickness of formed granulation tissue, and hair follicles count, silver sulfadiazine was found to be superior.[20] Epithelialization on postburn days 8,16, and 24 were significantly higher in the silver sulfadiazine treated group and aloe vera. The authors concluded that aloe vera gel hindered the healing process of the burn wounds when compared with 1% silver sulfadiazine cream. Whether these findings would be generalizable to human burns was not suggested, but has reached the attention of reconstructive surgeons.[21-22]

Aloe vera has also been suggested in the treatment of stasis, scalp disorders [23], leg ulcers [23], and peptic ulcers.[24] In the case of peptic ulcer, the aloe parencyma is separated from its cellulose matrix and emulsified with heavy liquid petroleum to minimize distaste at a dose of 2 to 2.5 fluid drams of the cellulose-free gel. Twelve patients with peptic ulcer, diagnosed by roeentgenographic evidence of duodenal cap lesions, were treated with the aloe emulsion, with encouraging results.[24] No distress of further episodes were reported after one year of treatment. Although the mecanhism of this action is not fully understood, the aloe gel was found to inhibit the secretion of hydrochloric acid by the parietal cells of the stomach. Further, since the gel contains demulcents comprised of mannuronic and glucuronic units that combine to form a polymer of high molecular weight, the uronic acids may have facilitated the healing of the ulcers by stripping toxic irritants.

In the treatment of leg ulcers, aloe vera gel is applied locally on ulcers three to five times a day as dressing after preliminary cleaning of the lesion by simple washing with 1% citrimide in water, hydrogen peroxide solution, 3% boric acid lotion or simply by sterile water. Gauze dressings are applied on the lesions after soaking in aloe gel. Antibiotics are given when required to counteract infections. In leg ulcers with a size of 400 to 1400 mm2 that have persisted for many years, aloe gel is applied as described and begins to heal with epithelialization and proliferation of granulation of tissue in the middle part. The ulcer slowerly becomes smaller. By the third to fifth week, in general, raised areas of granulation begin to appear with improved regeneration of the epithelium. The upper parts of the medial ulcer show creeping epithelialization and granulation at the edges. A few weeks thereafter, the lateral ulcer completely heals, forming a hard crust of greyish white color. The medial ulcer progresses well with advanced epithelialization of the edge, and healthy granulation tissue showing adequate vascularization and raised base appears. Finally, the crust is shed, leaving healthy skin which shows glazing. Similar results have been seen with back ulcers, and in a man with a 5000 mm2 area due to pseudoelcphantiasis and chronic leg ulcer secondary to venous statis and repeated recurrent thrombophlebitis and lymphangitis.[24] It should, however, be mentioned that in such clinical cases, patients do complain of increaed pain at the start of treatment. Although this is not due irritation it is probably due to improved circulation of the affected area.

Aloe vera has been reported as nematicidal.[31]

Numerous other therapuetic applications for aloe vera have been reported in the literature, but all are anecdotal. Aloe is used medicinally as an anthelminitic, cathartic, emmenagogue, stomachic and vermifuge.Reports of benefits from the use of aloe vera include: poison ivy rash, dandruff, bedwetting, breathing difficulties, mastitis in cows and goats, nasal congestion, head cold, influenza, periodontitis, anemia, athlete's foot, fingernail fungus, worms, liver spots, and hiatal hernia. No controlled studies could be found to support such claims (up to July, 1989).

Toxicity

The literature reveals no death attributable to aloe vera taken internally or applied topically. It has not been reported to be a mutagen, fetotoxin or carcinogen. However, aloe is contraindicated in pregnany and in individuals afflicted with hemorrhoids, and can cause kidney irritation.[32] The Handbook of Medicinal Herbs has given aloe the lowest ranking for toxicity.[33]

In 1982, a report by an aloe vera competitor to discredit other producers had suggested that carrageenan from Irish moss, used as a stabilizer by some aloe producers, was "potentially carcinogenic." This report was discredited. Carrageenan is currently accepted as a food additive throughout the world. It is approved under the U.S. Code of Federal Regulations (21 CFR 172.620) with no restriction. Safety of carrageenan for human consumption has been thoroughly tested in extensive feeding studies of animals, including monkeys. The Joint Expert Comittee of FAO/WHO has concluded that carrageenan is safe and recommends an acceptable daily intake level in humans of up to 75 mg/kg/day. The most recent review by the FDA in 1979 concluded that levels of carrageenan are safe and present no danger to the public's health.[27-30]

References

1. Lorenzetti, L.J. Bacteriostatic property of aloe vera. J Pharm Sci., 1964: 53; 1287.
2. Leun, A.Y. Effective ingredients of aloe vera. Drugs Cosmetics, 1977: 34-35, 154-155.
3. Anonymous. Planta Medica, 1972: 22; 54.
4. Ashleye, A.D. Applying heat during processing of the commercial aloe vera gel. Erdc Int., 1983: 1; 40-44.
5. Hart, L.A., van Enckevort, P.H., van Dijk, H., Zaat, R., de Silva, K.T. and Labadis, R.P. Two finctionally and chemically distinct immunomodulatory compounds in teh gel of the aloe vera. J Ethnopharmacol., 1988: 23(1); 61-71.
6. Collins, E.E. and Collins, C. Fresh aloe vera used for X-ray dermatitis. Am J Roent., 1935: 33(3); 396-397.
7. Manderville, F.B. Aloe vera in treatment of radiation ulcers of mucous membranes. Radiology, 1939: 32; 598-599.
8. Row, T.D. Effect of fresh aloe vera gel in the treatment of third degree roentgen reactions on white rats. J Am Pharm Assoc., 1940: 29; 348-350.
9. Rowe, T.D., Lovell, B.K. and Parks, L.M. Further observations on the use of aloe vera leaf in the treatment of third degree X-ray reactions. J Am Pharm Assoc., 1941: 30; 266-269.
10. Lushbaugh, C.C. and Hale, D.B. Animal research on acute radiation damage. Cancer, 1953: 6; 690-698.
11. Brown, J.B. Use of aloe vera on radiation burns. Cancer J Clin., 1963: 14; 14-15.
12. Lorenzetti, L.J., Salisbury, R., Beal, J.L. and Baldwin, J.N. Antibacterial property of aloe vera. J Pharm Sci., 1964: 53; 1287.
13. Heggers, J.P., Pineless, G. and Roboson, M. Comparison of the antimicrobial effects of two different aloe vera juice products. J Am Med Technologists, 1979: 41(5); 293-294.
14. Bruce, W.G. Investigations of antibacterial activity in the aloe. S Afr Med J., 1967: 41; 984.
15. Rodriquez-Bigas, M., Cruz, N.I. and Suarez, A. Comparative evaluation of aloe vera in the management of burn wounds in guinea pigs. Plast Reconstr Surgery, 1988: 81(3); 386-389.
16. Crewe, J.E. Aloe treatment of aplmar eczema, pruritus vulva, external ulcers, poison ivy and burns. Minnesota Med., 1937: 10; 670-673.
17. Crewe, J.E. Aloes in the treatment of burns and scalds. Minnesota Med., 1939; 538-539.
18. Rovatti, R. and Brennan, F.J. Aloe vera ointment tested on third degree burns. Indust Med Surgery, 1959: 364-368.
19. Barnes, T.C. The healing action of extracts of aloe vera leaf on abrasions on human skin. Am J Bot., 1947: 34; 597.

20. Kaufman, T., Kalder, N., Ullman, Y. and Berger, J. Aloe vera gel hindered wound healing of experimental second-degree burns: a quantitative controlled study. J Burn Care Rehabil., 1988: 9(2); 156-159.
21. Frumkin, A. Aloe vera, salicylic acid, and aspirin for burns. [Letter] Plast Reconstr Surg., 1989: 83(1); 196.
22. Kivett, W.F. Aloe vera for burns. [Letter] Plast Reconstr Surg., 1989: 83(1); 195.
23. Zawahry, M. E., Heazy, M.R. and Helal, M. Use of aloe in treating leg ulcers and dermatoses. Int J Dermatol., 1973: 12(1); 70-72.
24. Blitz, J.J., Smith, D.O. and Gerard, J. Peptic ulcer therapy by aloe vera gel: a preliminary report. J Am Osteop Assoc., 1963: 62(4).
25. Wright, C.S. Aloe vera in the treatment of roetgen ulcers and telandiectasis. JAMA, 1036: 106; 1363-1364.
26. Loveman, A.B. Lead of aloe vera in treatment of roentgen ray ulcers: report of 2 additional cases. Arch Dermat Syph., 1937: 36; 838-843.
27. FAO/WHO Specifications for Identity and Purity. FAO Food and Nutrition Index (Rome), 1978: 4; 17.
28. Food Chemicals Codex, 2nd Ed. (3rd Suppl.) National Academy of Sciences: Washington (DC), 1978, p. 7.
29. Toxicological evaluation of some food additives, including anticaking agents, antimicrobials, antioxidants, emulsifers and thickening agents. FAO Nutrition Meetings Report Series, No. 53A, p. 386. Joint FAO/WHO Expert Committee on Food Additives, Rome, 1974.
30. Code of Federal Regulations (21 CFR 172.620), Federal Register, Washington (DC), July 10, 1979.
31. Mahmood, I., Masood, A., Saxena, S,K. and Husain, S.I. Effects of some plant extracts on the mortality of Meloidogyne incognita and Rotylenchus reiformis. Acta Bot Indica, 1979: 7(2); 129.
32. Duke, J.A. and Wain, K.K. Medicinal Plants of the World. 1981.
33. Duke, J,A. CRC Handbook of Medicinal Herbs. CRC Press: Bota Raton (FL), 1985, p. 517.
34. Klein, A.D. and Penneys, N.S. Aloe vera. J Am Acad Dermatol., 1988: 18(4, pt 1); 714-720.