Hindawi Publishing Corporation
Journal of Dental Surgery
Volume 2014, Article ID 210463, 6 pages
http://dx.doi.org/10.1155/2014/210463

Review Article

Aloe vera: An Ancient Herb for Modern Dentistry—A Literature Review

Arbaz Sajjad[1] and Samia Subhani Sajjad[2]

[1] *Department of Prosthodontics, Specialist Dental Center, King Abdul Aziz Super Speciality Hospital Compound, Ministry of Health, Al-Jouf, Sakaka-42421, Saudi Arabia*
[2] *Kamineni Institute of Dental Sciences, Andhra Pradesh, India*

Correspondence should be addressed to Arbaz Sajjad; baaz911@gmail.com

Received 7 August 2013; Accepted 15 September 2013; Published 21 January 2014

Academic Editor: Luis Junquera

Objectives. To review composition, actions, and clinical applications of *Aloe vera* plant in dentistry and to establish its effectiveness as an invaluable adjunct in the treatment of dental diseases. *Method*. A manual and electronic literature (MEDLINE, Cochrane Central Register of Controlled Trials, and Google Scholar) search was performed up to July 2013 for in vitro and in vivo studies and research presenting clinical, microbiological, immunological, and patient-centered data to validate the efficacy of *Aloe vera* gel in dentistry. A total of 38 titles, abstracts, and full-text studies were selected and reviewed. *Aloe vera* has various medicinal properties like anti-inflammatory, antibacterial, antiviral, and antitumor which accelerates wound healing and helps in treating various lesions in oral cavity. Benefits associated with *Aloe vera* have been attributed to the polysaccharides contained in the gel of the leaves. *Conclusion*. The pharmacological attributes of *Aloe vera* have been revalidated in modern sciences through various in vivo and in vitro studies. The herb has immense potential as a dental therapeutic. Even though *Aloe vera* is a promising herb with various clinical applications in medicine and dentistry, more clinical research needs to be undertaken especially to validate and explain the action of acemannan hydrogel in accelerating the healing of aphthous ulcers and to validate the efficacy of *Aloe* gel on plaque and gingivitis, so that it can be established in the field of dentistry.

1. Introduction

The use of natural products in the prevention and treatment of oral conditions has increased recently and could be of benefit to low socioeconomic level in urban and rural communities [1]. Among the various currently available herbal agents the most popular and currently receiving a lot of scientific attention is *Aloe vera*. The name *Aloe vera* is derived from the Arabic word "Alloeh" meaning "shining bitter substance," while "vera" in Latin means "true". The plant *Aloe vera* has a history dating back to biblical times. It is a perennial succulent xerophyte, which develops water-storage tissue in the leaves to survive in dry areas of low or erratic rainfall. The plant has stiff grey-green lance-shaped leaves containing clear gel in a central mucilaginous pulp. Benefits associated with *Aloe vera* have been attributed to the polysaccharides contained in the gel of the leaves [2].

There are over 250 species of *Aloe* grown around the world. Only two species are grown commercially: *Aloe barbadensis* Miller and *Aloe arborescens*. The *Aloe* plant is grown in warm, tropical areas and cannot survive freezing temperatures such as during winters. In the United States, most of the *Aloe* is grown in the Rio Grande Valley of South Texas, Florida and Southern California. Internationally, *Aloe* can be found in Mexico, the Pacific Rim countries, India, South America, Central America, the Caribbean, Australia, and Africa [3]. Over the years, this plant has been known by a number of names such as "the wand of heaven", "heaven's blessing," and "the silent healer".

2. Parts of *Aloe vera* Plant

The *Aloe barbadensis* plant consists of two different parts, each of which produces substances with completely different

compositions and therapeutic properties. The parenchymal tissue makes up the inner portion of the aloe leaves and produces the *Aloe vera* gel (or mucilage), a clear, thin, tasteless, jelly-like material. This tissue is recovered from the leaf by separating the gel from the inner cellular debris. The other part of the plant is a group of specialized cells known as the pericyclic tubules, which occur just beneath the outer green ring of the leaf. These cells produce an exudate that consists of bitter yellow latex with powerful laxative-like actions. This exudate, which is not to be confused with the gel/mucilage from the parenchymal leaf tissue, is available commercially for systemic ingestion to produce catharsis [4].

3. Active Ingredient of *Aloe vera*

More than 75 active ingredients from inner gel have been identified including vitamins, minerals, enzymes, sugars, anthraquinones or phenolic compounds, lignin, saponins, sterols, amino acids, and salicylic acid. Active ingredients of *Aloe vera* leaf pulp and exudates [5] were depicted in Table 1.

4. Biological & Pharmacological Actions of *Aloe vera* Gel

A number of investigations have attempted to relate the chemical constituents in the gel to specific biological effects.

4.1. Wound-Healing Effects. Different mechanisms have been proposed for the wound-healing effects of *Aloe* gel, which include keeping the wound moist, increasing epithelial cell migration, more rapid maturation of collagen, and reduction in inflammation [6]. A 1996 study reported that a high molecular weight polypeptide constituent from the gel demonstrated a healing effect on excisional wounds in rats [13]. Glucomannan, a mannose-rich polysaccharide, and gibberellin, a growth hormone, interact with growth factor receptor on the fibroblast, thereby stimulating its activity and proliferation, which in turn increases collagen synthesis after topical and oral application [7].

Yagi et al. reported that *Aloe vera* gel contains a glycoprotein with cell proliferating-promoting activity, while Davis et al. noted that *Aloe vera* gel improved wound healing by increasing blood supply (angiogenesis), which increased oxygenation as a result [8, 9]. Angiogenesis is the growth of new blood capillaries and is a part of tissue regeneration. A 1993 study showed that topical application of *Aloe vera* gel reestablished vascularity of burn tissue for a guinea pig, although no specific constituents were identified [10]. The *Aloe vera* gel polysaccharide acemannan was shown to activate macrophages, an effect that improved wound healing in a rat model [11, 12]. Two years later, Davis et al. reported that the low molecular weight component of freeze-dried *Aloe vera* gel stimulated blood vessel formation in a chick chorioallantoic membrane (i.e., a vascular membrane derived from developing chicken eggs); in addition, a methanol-soluble fraction of the gel which contains a glycoprotein with mainly cell proliferating-promoting activity stimulated the proliferation of artery endothelial cells in an in vitro assay and induced them to invade a collagen substrate [13].

4.2. Skin Hydration Effect. It was proposed that the *Aloe vera* gel formulations with higher concentrations (0.25% w/w and 0.5% w/w) improved skin hydration possibly by means of a humectant mechanism. Humectant mechanism means that the *Aloe* gel works by attracting water from the dermis below and by helping to keep this water bound in the stratum corneum [14].

4.3. Anti-Aging Effect. *Aloe* has excellent anti-aging effect by producing the collagen and elastin fibres making the skin more elastic and less wrinkled as reported in an in vivo study conducted on mouse ears by Davis et al. [15]. One of the main reasons for this lies in the plant's unique ability to increase production of human fibroblast cells between six and eight times faster than normal cell production. Fibroblast cells are found in the dermis of the skin and are responsible for the fabrication of collagen, the skin's support protein which keeps skin firm, supple, and youthful looking. It was found that *Aloe vera* not only improved fibroblast cell structure but also accelerated the collagen production process.

4.4. Anti-Inflammatory Effects. It inhibits the cyclooxygenase pathway and reduces prostaglandin E2. Recently, the novel anti-inflammatory compound called C-glucosyl chromone was isolated from gel extracts [16]. In addition, the peptidase bradykinase was isolated from *Aloe* and shown to break down the bradykinin, an inflammatory substance that induces pain [17].

4.5. Antibacterial Property. The activity of *Aloe vera* inner gel against both Gram-positive and Gram-negative bacteria has been demonstrated by several different methods [18]. *Streptococcus pyogenes* and *Streptococcus faecalis* are two microorganisms that have been inhibited by *Aloe vera* gel [19]. *Aloe vera* gel reportedly was bactericidal against *Pseudomonas aeruginosa* while acemannan prevented it from adhering to human lung epithelial cells in a monolayer culture [20].

4.6. Antifungal Property. A processed *Aloe vera* gel preparation reportedly inhibited the growth of *Candida albicans* [19].

4.7. Antiviral Property. This action may be direct and indirect: indirect due to stimulation of immune system, and direct due to aloe emodin [21]. Aloe emodin in *Aloe vera* makes it so that certain viruses are not able to function. Therefore, *Aloe vera* is virucidal to *Herpes simplex* virus type 1 and type 2, *Varicella zoster* virus, *pseudorabies* virus, and *influenza* virus according to the research of Thomson [22]. During the course of these studies it was found that the virucidal activity was due to the anthraquinones extracted from the inner leaf of *Aloe* and the roots, bark, or leaves of a number of other anthraquinone-containing plants. The results indicated that aloe emodin directly affected both DNA- and RNA-containing enveloped viruses but had no effect on naked

Table 1: Active ingredients of *Aloe vera* leaf pulp and exudates.

Class	Compounds
Vitamins	B1, B2, B6, C, A ($\beta\beta$-carotene), choline, folic acid, $\alpha\alpha$-tocopherol
Enzymes	Alkaline phosphatase, amylase, carboxypeptidase, catalase, bradykinase, cyclooxidase, peroxidase, carboxypeptidase, cyclooxygenase, lipase, oxidase, phosphoenolpyruvate carboxylase, superoxide dismutase
Anthraquinones	Aloe emodin, aloetic acid, anthranol, aloin A and B (or collectively known as barbaloin), isobarbaloin, emodin, ester of cinnamic acid
Inorganic compounds	Calcium, chlorine, chromium, copper, iron, magnesium, manganese, selenium, zinc, potassium, phosphorous, sodium
Carbohydrates	Pure mannan, acetylated mannan, acetylated glucomannan (acemannan), galactan, glucogalactomannan, galactogalacturan, galactoglucoarabinomannan, arabinogalactan, pectic substance, xylan, cellulose
Saccharides	Mannose, glucose, L-rhamnose, aldopentose
Organic compounds and lipids	Arachidonic acid, $\gamma\gamma$-linolenic acid, steroids (campesterol, cholesterol, $\beta\beta$-sitosterol), triglycerides, triterpenoid, gibberellin, lignins, potassium sorbate, salicylic acid, uric acid
Chromones	8-C-glucosyl-(2′-O-cinnamoyl)-7-O-methylaloediol A, 8-C-glucosyl-(S)-aloesol, 8-C-glucosyl-7-O-methyl-(S)-aloesol, 8-C-glucosyl-7-O-methylaloediol, 8-C-glucosyl-noreugenin, isoaloeresin D, isorabaichromone
Nonessential and essential amino acids	Alanine, arginine, aspartic acid, glutamic acid, glycine, histidine, hydroxyproline, isoleucine, leucine, lysine, methionine, phenylalanine, proline, threonine, tyrosine, valine

(unenveloped) viruses. It was concluded that under the conditions tested, the anthraquinones acted directly on the envelope of the anthraquinone-sensitive viruses, resulting in the prevention of virus adsorption and subsequent replication.

4.8. Immunomodulating Effects. *Aloe vera*, a great immune stimulant, contains 90% rhodium and iridium (trace minerals) in the acemannan which is one of the polysaccharides which dramatically increases the white blood cells or macrophages and T cells. Thus, immunomodulating effects occur via activation of macrophage cells to generate nitric oxide, secrete cytokines (e.g., tumor necrosis factor, interleukin-1, interleukin-6, and interferon-γ), and present cell surface markers [23, 24]. It helps enlarge the thymus gland in size by 40%. The thymus is what produces the T cells of the immune system.

4.9. Antioxidant Property. *Aloe vera* has very strong antioxidant nutrients. Glutathione peroxide activity, superoxide dismutase enzymes, and a phenolic antioxidant were found to be present in *Aloe vera* gel, which may be responsible for these antioxidant effects [25]. Apart from these, it also contains A, C, and E vitamins. These free radical components get rid of the toxins and carcinogenic properties we have in our bodies from the pollution and poor quality foods we eat. We acquire these free radicals in our bodies through absorption of our skin and through digestion.

4.10. Antitumor Effect. The two fractions from *Aloes* that are claimed to have anticancer effects include glycoproteins (lectins) and polysaccharides [6]. Different studies indicated antitumor activity for *Aloe vera* gel in terms of reduced tumor burden, tumor shrinkage, tumor necrosis, and prolonged survival rates.

An induction of glutathione S-transferase and an inhibition of the tumor-promoting effect of phorbol myristic acetate have also been reported which suggest *Aloe* gel in cancer chemoprevention. Indirect action on antitumor activity is stimulation of the immune response [26, 27].

4.11. Laxative Effect. Anthraquinones increase intestine water content, stimulate water secretion, and increase intestinal peristalsis [28]. And as mentioned earlier a group of specialized cells known as the pericyclic tubules, which occur just beneath the outer green ring of the leaf, produce an exudate that consists of a bitter yellow latex with powerful laxative-like actions [4].

5. Clinical Applications of *Aloe vera* in Dentistry

5.1. Aphthous Ulcer. It has been reported that acemannan hydrogel accelerates the healing of aphthous ulcers and reduces the pain associated with them [29]. Researchers evaluated a gel that combined allantoin, *Aloe vera*, and silicon dioxide and its effects on aphthous ulcers of the oral cavity [30]. Each patient used a daily diary to document the number and duration of aphthous ulcers, the interval between ulcers, ulcer size, and ulcer pain over a period of 3-4 months. The reduced duration of the lesions in one arm of the study and the increased interval between lesions in the other arm of the study both were significant statistically. The gel did not demonstrate any consistent effectiveness on ulcers in the oral cavity.

5.2. Oral Lichen Planus. The efficiency of *Aloe vera* in treatment of oral lichen planus has been measured by many researchers. In one study, a patient of lichen planus with systemic involvement was placed on *Aloe vera* therapy. The patient's treatment involved drinking 2.0 ounces of stabilized *Aloe vera* juice daily for 3 months, topical application using *Aloe vera* lip balm and *Aloe* cream for itching hands. The oral lesions cleared up within 4 weeks, although the systemic lesions took longer [31]. In another study, 46 patients with OLP were randomly divided into 2 groups. Each group was treated with *Aloe vera* mouthwash and triamcinolone acetonide 0.1% (TA), respectively. The treatment period for both groups was 4 weeks. Patients were evaluated on days 8 and 16 and after completing the course of treatment (visit 1–3). *Aloe vera* mouthwash is an effective substitute for TA in the treatment of OLP [32].

In another double-blind study, 64 patients with OLP were divided in two groups and treated with either *Aloe vera* (32 patients) or placebo (32 patients), at a dose of 0.4 mL (70% concentration) three times a day. The patients were evaluated after 6 and 12 weeks. In the *Aloe vera* group, complete pain remission was achieved in 31.2% of the cases after 6 weeks and in 61% after 12 weeks. In the placebo group, these percentages were 17.2% and 41.6%, respectively. It was concluded that *Aloe vera* improves the total quality of life score in patients with OLP [33].

5.3. Gingivitis. Several studies have been conducted to test the efficacy of *Aloe vera* in treating gingivitis. In a double-blind study, a total of 120 subjects were requested to abstain from oral hygiene (tooth brushing) for 14 days. The subjects were then randomly divided into group A (test group) who received 100% *Aloe vera*, group B (negative control group) who received placebo (distilled water), and group C (positive control group) who received 0.2% chlorhexidine. Plaque accumulation was assessed by plaque index (PI) and gingivitis was assessed by modified gingival index (MGI) and bleeding index (BI) at baseline (0), 7th, 14th, and 22nd days. Mouthwash containing *Aloe vera* showed significant reduction of plaque and gingivitis, but when compared with chlorhexidine the effect was less significant. It was concluded that *Aloe vera* mouthwash can be an effective antiplaque agent and with appropriate refinements in taste and shelf life can be an affordable herbal substitute for chlorhexidine [34].

Another study evaluated the effect of a toothpaste containing high concentrations of *Aloe vera* on the reduction of plaque and gingivitis. Fifteen subjects participated in this randomized, double-blind study. Participants were nonsmokers, with signs of gingivitis (bleeding index 30%) and no signs of periodontitis. Subjects were followed for three 6-month periods during which they used either an *Aloe vera* toothpaste or control toothpaste. There was a statistically and clinically significant reduction of about 20% of the plaque and gingivitis indices at the end of the clinical trial compared to baseline values but no differences between the *Aloe vera* and the control toothpaste. It was concluded that in patients motivated to improve their oral hygiene habits, the use of a toothpaste containing *Aloe Vera* showed no additional effect on plaque and gingivitis compared to a control toothpaste [35].

5.4. Alveolar Osteitis. Currently, special medical bandages (SaliCept Patch) are available for intraoral use following extraction of teeth. The SaliCept Patch is a freeze-dried pledget that contains acemannan hydrogel (Carrington Laboratories) obtained from the clear inner gel of *Aloe vera*. In 2002, a retrospective evaluation was performed of the records of 587 patients (1,031 sockets) whose extraction sites had been treated with clindamycin-soaked gelfoam. A prospective trial was conducted in which 607 patients (1,064 sockets) had 2 SaliCept Patches placed immediately after extraction. Results showed that 78 of 975 sites (8.0%) in the gelfoam group developed AO, whereas only 11 of 958 sites (1.1%) in the SaliCept group developed AO ($P < .0001$). Further analysis of all extraction sites revealed that the incidence of AO in the gelfoam group was 7.6% compared with 1.1% in the SaliCept-treated group ($P < .0001$). Therefore, it was concluded that the SaliCept Patch significantly reduces the incidence of AO compared with clindamycin-soaked gelfoam [36].

5.5. Denture Adhesive. As previously discussed Acemannan, a complex mannose carbohydrate and one of the main ingredients of the *Aloe vera* gel, has an inherent stickiness/viscosity. It is this property that led to the production of prototype acemannan denture adhesives. These new denture adhesive formulations were evaluated for pH changes, cytotoxicity to human gingival fibroblasts, and adhesive strength in both dry and wet conditions. The denture adhesive formulations tested consisted of five combinations of acemannan with varying concentrations of preservatives. The pH and cytotoxity of each formulation was measured over 24 hours and, the adhesive strength was evaluated with a universal testing. The experiment concluded that acemannan denture adhesive formulation 150 : 1 and preservative concentration of formulation 4 with an initial pH value of 6.0 was an effective herbal substitute for traditional denture adhesives [37].

Other applications in dentistry: [3, 38]

(1) applications directly at sites of periodontal surgery;

(2) as an adjunct to Scaling and root planning in periodontitis;

(3) chemical burns caused by accidents with aspirin are quickly relieved;

(4) extraction sites respond comfortably and empty purses do not develop when aloe vera is applied;

(5) angular Chelitis;

(6) burning mouth syndrome;

(7) patients with sore gums and teeth with dentures maladaptive may also benefit;

(8) *Aloe vera* can also be used around dental implants to control inflammation caused by bacterial contamination.

6. Conclusion

The pharmacological attributes of *Aloe vera* have been revalidated in modern sciences through various in vivo and in vitro studies. These scientific studies are good enough proof that drug has immense potential as a dental therapeutic. So proper diagnosis, knowledge of the traditional medicine, and implementation of that knowledge to the treatment plan are important in ensuring success with this dental therapeutic agent. As a footnote, though *Aloe vera* is a promising herb with its various clinical applications in medicine and dentistry, the authors feels that more clinical research needs to be undertaken especially to validate and explain the action of acemannan hydrogel in accelerating the healing of aphthous ulcers and to validate the efficacy of *Aloe* gel on plaque and gingivitis, so that it can be established in the field of dentistry.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

[1] M. A. Botelho, N. A. P. Nogueira, G. M. Bastos et al., "Antimicrobial activity of the essential oil from *Lippia sidoides*, carvacrol and thymol against oral pathogens," *Brazilian Journal of Medical and Biological Research*, vol. 40, no. 3, pp. 349–356, 2007.

[2] F. J. A. Matos, M. P. Sousa, A. A. Craveiro, and M. E. O. Matos, *Constituintes Químicos Ativos e Propriedades Biológicas de Plantas Medicinais Brasileiras*, Editora da UFC, Fortaleza, Brazil, 2nd edition, 2004.

[3] J. Harrison, DDS, and FAGD, "Aloe vera in dentistry, book aloe vera," in *Nature's Medicine Chest*, p. 19, 2001.

[4] V. E. Tyler, *The Honest Herbal: A Sensible Guide to the Use of Herbs and Related Remedies*, Pharmaceutical Products Press, New York, NY, USA, 3rd edition, 1993.

[5] J. H. Hamman, "Composition and applications of *Aloe vera* leaf gel," *Molecules*, vol. 13, no. 8, pp. 1599–1616, 2008.

[6] T. Reynolds and A. C. Dweck, "*Aloe vera* leaf gel: a review update," *Journal of Ethnopharmacology*, vol. 68, no. 1–3, pp. 3–37, 1999.

[7] J. P. Heggers, A. Kucukcelebi, D. Listengarten et al., "Beneficial effect of Aloe on wound healing in an excisional wound model," *Journal of Alternative and Complementary Medicine*, vol. 2, no. 2, pp. 271–277, 1996.

[8] A. Yagi, T. Egusa, M. Arase, M. Tanabe, and H. Tsuji, "Isolation and characterization of the glycoprotein fraction with a proliferation-promoting activity on human and hamster cells in vitro from *Aloe vera* gel," *Planta Medica*, vol. 63, no. 1, pp. 18–21, 1997.

[9] R. H. Davis, M. G. Leitner, J. M. Russo, and M. E. Byrne, "Anti-inflammatory activity of *Aloe vera* against a spectrum of irritants," *Journal of the American Podiatric Medical Association*, vol. 79, no. 6, pp. 263–276, 1989.

[10] J. P. Heggers, R. P. Pelley, and M. C. Robson, "Beneficial effects of Aloe in wound healing," *Phytotherapy Research*, vol. 7, pp. S48–S52, 1993.

[11] B. Maxwell, H. Chinnah, and I. Tizard, "Activated macrophages accelerate wound healing in aged rats," *Wound Repair Regeneration*, vol. 4, p. 165, 1996.

[12] I. Tizard, D. Busbee, B. Maxwell, and M. C. Kemp, "Effects of acemannan, a complex carbohydrate, on wound healing in young and aged rats," *Wounds*, vol. 6, pp. 201–209, 1994.

[13] R. H. Davis, J. J. Donato, G. M. Hartman, and R. C. Haas, "Anti-inflammatory and wound healing activity of a growth substance in *Aloe vera*," *Journal of the American Podiatric Medical Association*, vol. 84, no. 2, pp. 77–81, 1994.

[14] S. E. Dal'Belo, L. R. Gaspar, and P. M. Maia Campos, "Moisturizing effect of cosmetic formulations containing *Aloe vera* extract in different concentrations assessed by skin bioengineering techniques," *Skin Research and Technology*, vol. 12, no. 4, pp. 241–246, 2006.

[15] R. H. Davis, "Biological activity of *Aloe vera*," *SOFW Journal*, vol. 119, pp. 646–649, 1993.

[16] J. A. Hutter, M. Salman, W. B. Stavinoha et al., "Anti-inflammatory C-glucosyl chromone from Aloe barbadensis," *Journal of Natural Products*, vol. 59, no. 5, pp. 541–543, 1996.

[17] S. Ito, R. Teradaira, H. Beppu, M. Obata, T. Nagatsu, and K. Fujita, "Properties and pharmacological activity of carboxypeptidase in Aloe arborescens Mill var. natalensis Berger," *Phytotherapy Research*, vol. 7, pp. S26–S29, 1993.

[18] F. Habeeb, E. Shakir, F. Bradbury et al., "Screening methods used to determine the anti-microbial properties of *Aloe vera* inner gel," *Methods*, vol. 42, no. 4, pp. 315–320, 2007.

[19] J. P. Heggers, G. R. Pineless, and M. C. Robson, "Dermaide aloe/*Aloe vera* gel: comparison of the antimicrobial effects," *Journal of the American Medical Technologists*, vol. 41, no. 5, pp. 293–294, 1979.

[20] A. O. Azghani, I. Williams, D. B. Holiday, and A. R. Johnson, "A beta-linked mannan inhibits adherence of Pseudomonas aeruginosa to human lung epithelial cells," *Glycobiology*, vol. 5, no. 1, pp. 39–44, 1995.

[21] R. J. Sydiskis, D. G. Owen, J. Lohr, K. H. Rosler, and R. N. Blomster, "Inactivation of enveloped viruses by anthraquinones extracted from plants," *Antimicrobial Agents and Chemotherapy*, vol. 35, no. 12, pp. 2463–2466, 1991.

[22] H. I. Thomson, *PDR for Herbal Medicines*, Thomson PDR, Montvale, NJ, USA, 3rd edition, 2004.

[23] J. Tai-Nin Chow, D. A. Williamson, K. M. Yates, and W. J. Goux, "Chemical characterization of the immunomodulating polysaccharide of *Aloe vera* L," *Carbohydrate Research*, vol. 340, no. 6, pp. 1131–1142, 2005.

[24] S. A. Im, S. T. Oh, S. Song et al., "Identification of optimal molecular size of modified Aloe polysaccharides with maximum immunomodulatory activity," *International Immunopharmacology*, vol. 5, pp. 271–279, 2005.

[25] M. A. Khan, M. Tania, D. Zhang, and H. Chen, "Antioxidant enzymes and cancer," *Chinese Journal of Cancer Research*, vol. 22, no. 2, pp. 87–92, 2010.

[26] H. S. Kim and B. M. Lee, "Inhibition of benzo[a]pyrene-DNA adduct formation by Aloe barbadensis Miller," *Carcinogenesis*, vol. 18, no. 4, pp. 771–776, 1997.

[27] V. Steenkamp and M. J. Stewart, "Medicinal applications and toxicological activities of Aloe products," *Pharmaceutical Biology*, vol. 45, no. 5, pp. 411–420, 2007.

[28] Y. Ishii, H. Tanizawa, and Y. Takino, "Mechanism of cathartic effect," *Biological and Pharmaceutical Bulletin*, vol. 17, no. 5, pp. 651–653, 1994.

[29] "Oral ulcers remedy gets FDA clearance," *The Journal of the American Dental Association*, vol. 125, pp. 1308–1310, 1994.

[30] J. J. Garnick, B. Singh, and G. Winkley, "Effectiveness of a medicament containing silicon dioxide, aloe, and allantoin on aphthous ulcers," *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics*, vol. 86, no. 5, pp. 550–556, 1998.

[31] S. M. Hayes, "Lichen planus—report of successful treatment with *Aloe vera*," *General Dentistry*, vol. 47, no. 3, pp. 268–272, 1999.

[32] A. Mansourian, F. Momen-Heravi, M. Saheb-Jamee, M. Esfehani, O. Khalilzadeh, and J. Momen-Beitollahi, "Comparison of *Aloe vera* mouthwash with triamcinolone acetonide 0.1% on oral lichen planus: a randomized double-blinded clinical trial," *The American Journal of the Medical Sciences*, vol. 342, no. 6, pp. 447–451, 2011.

[33] N. Salazar-Sánchez, P. López-Jornet, F. Camacho-Alonso, and M. Sánchez-Siles, "Efficacy of topical *Aloe vera* in patients with oral lichen planus: a randomized double-blind study," *Journal of Oral Pathology and Medicine*, vol. 39, no. 10, pp. 735–740, 2010.

[34] B. Chandrahas, A. Jayakumar, A. Naveen, K. Butchibabu, and P. K. Reddy, "A randomized, doubleblind clinical study to assess the antiplaque and antigingivitis efficacy of *Aloe vera* mouth rinse," *Journal of Indian Society of Periodontology*, vol. 16, pp. 543–548, 2012.

[35] H. Namiranian and G. Serino, "The effect of a toothpaste containing *Aloe vera* on established gingivitis," *Swedish Dental Journal*, vol. 36, no. 4, pp. 179–185, 2012.

[36] M. R. Poor, J. E. Hall, and A. S. Poor, "Reduction in the incidence of alveolar osteitis in patients treated with the SaliCept patch, containing Acemannan hydrogel," *Journal of Oral and Maxillofacial Surgery*, vol. 60, no. 4, pp. 374–379, 2002.

[37] C. G. Tello, P. Ford, and A. M. Iacopino, "In vitro evaluation of complex carbohydrate denture adhesive formulations," *Quintessence International*, vol. 29, no. 9, pp. 585–593, 1998.

[38] H. K. Virdi, S. Jain, and S. Sharma, "Effect of locally delivered *Aloe vera* gel as an adjunct to scaling and root planing in the treatment of chronic periodontitis: a clinical study," *Indian Journal of Oral Sciences*, vol. 3, pp. 84–89, 2012.