

Aloe vera gel: Update for dentistry

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The fresh gel or mucilage from *Aloe barbadensis* Mill. (family Liliaceae)—otherwise known as *aloe vera*—is a handy home-grown remedy that can be used both as a moisturizing agent and for the treatment of minor burns, skin abrasions, and irritations.^{1,4} It has been suggested that external application of aloe vera gel promotes wound healing.³ The table provides a list of reported actions, properties, and uses of aloe vera gel; aloe vera gel reportedly has been used to treat gingivitis and been effective against herpes simplex viruses.^{1,4}

The *Aloe barbadensis* plant consists of two different parts, each of which produce 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.³ 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 rind of the leaf. These cells produce an exudate that consists of a 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.

Gel constituents

The chemical composition of the aloe vera gel is complex and can read like a who's who list of chemical ingredients. A 1999 review by Vogler and Ernst lists 75 potentially active constituents, including vitamins, enzymes, minerals, sugars, lignin, saponins, salicylic acids, and amino acids; this list was modified from a larger list of ingredients reported by other investigators.^{5,8} A report from the same year described using aloe vera for treatment of lichen planus and listed 39 chemical constituents, including the essential amino acids; numerous monosaccharides and polysaccharides; vitamins B₁, B₂, B₆, and C; niacinamide and choline; several inorganic ingredients; enzymes such as acid phosphatase, alkaline phosphatase, amylase, lactic dehydrogenase, and lipase; and numerous organic compounds such as aloin, barbaloin, and emodin.⁹ Reynolds and Dweck listed 16 different polysaccharides that have been extracted from the aloe vera leaf gel, in addition to 12 major polypeptides whose molecular weights ranged from 15,000–77,000 Daltons, and various glycoproteins with a molecular weight of 29,000 Daltons.¹⁰ Yamaguchi et al reported the presence of aluminum, boron, barium, calcium, iron, magnesium, sodium, phosphorous, silicon, and strontium in aloe vera gel.¹¹



Polysaccharide components

The major types of polysaccharides described by Reynolds and Dweck consisted of glucomannans of various composition (long chains of glucose and mannose units hooked together), some of which were acetylated; polymers of galactose and galacturonic acid also have been found in the gel.¹⁰ Different investigators have revealed different polysaccharide structures within the gel. Yaron's 1991 study regarding the gel's viscosity and rheology indicated that the glucomannans in aloe rarely were found in other plants and provided the plastic properties of the gel that are similar to the properties of human body fluids.¹² One of the glucomannans in the gel is an acetylated mannan that is available commercially as a patented product, acemannan hydrogel (Carrasyn, Carrington Laboratories, Irving, TX; 800.444.2563).¹³

Biological effects

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

Moisturizing actions

The moisturizing effect of aloe vera gel appears to be due to the mix of water and polysaccharide components, creating a jelly-like consistency that holds the water within the mix and minimizes its evaporation, providing a sustained moist environment when applied to drying tissues and humectant properties that promote retention of moisture in tissues.¹⁴

Wound healing effects

Countless studies have demonstrated the healing powers of aloe vera gel. A 1996 study reported that a high molecular weight polypeptide constituent from the gel demonstrated a healing effect on excisional wounds in rats.¹⁵

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, which increased oxygenation as a result.^{16,17} In 1991, Thompson reported that topical application of the aloe vera-derived allantoin gel stimulated fibroblast activity and collagen proliferation.¹⁸

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 re-established vascularity of burn tissue for a guinea pig, although no specific constituents were identified.¹⁹ Two years later, Lee et al reported that the low molecular weight component of freeze-dried aloe vera gel stimulated blood vessel formation in a chick chorioallantoic membrane; in addition, a methanol-soluble fraction of the gel stimulated proliferation of artery endothelial cells in an *in vitro* assay and induced them to invade a collagen substrate.²⁰

The aloe vera gel polysaccharide acemannan was shown to activate macrophages, an effect that improved wound healing in a rat model.^{21,22} A mannose-6-phosphate component of the gel has been credited with a wound healing effect.²³ Fibroblast proliferation was observed *in vitro* and *in vivo* following treatment with Carrisyn.¹⁰

Anti-inflammatory effects

The literature has many reports concerning the anti-inflammatory effect of aloe vera gel; Hanley et al reported that an aloe vera extract (described as 5.0% leaf homogenate) decreased inflammation by 48% in a rat adjuvant-induced arthritic inflammatory model.^{24,25} More recently, the peptidase bradykinase was isolated from aloe and shown to break down the bradykinin, an inflammatory substance that induces pain.²⁶

Antibacterial/antifungal/antiviral effects

Streptococcus pyogenes and *Streptococcus faecalis* are two microorganisms that have been inhibited by aloe vera gel.^{27,28} Using a rat model, Heggers et al suggested that the antibacterial effect of the aloe vera gel *in vivo* could enhance the wound healing process by eliminating the bacteria that contributed to inflammation.²⁹ Aloe vera gel reportedly was bactericidal against *Pseudomonas aeruginosa* while acemannan prevented it from adhering to human lung epithelial cells in a monolayer culture.^{30,31} A processed aloe vera gel preparation reportedly inhibited the growth of *Candida albicans*.²⁷

In terms of antiviral effects, acemannan reduced herpes simplex infection in two cultured target cell lines.³² A 1990 study noted that fractions of aloe vera gel containing lectins directly inhibited the cytomegalovirus proliferation in cell culture, perhaps by interfering with protein synthesis.³³ Sydskis et al tested a purified sample of aloe emodin on the infectivity of herpes simplex virus Type 1 and Type 2 and found that aloe emodin inactivated all of the viruses, including varicella-zoster virus, influenza virus, and pseudorabies virus.³⁴ Electron micrograph examination of anthraquinone-tested herpes simplex virus demonstrated that the envelopes were partially disrupted. These results showed that anthraquinones extracted from a variety of plants (including aloe vera) are directly virucidal to enveloped viruses.³⁴

Uses of aloe in dentistry

It has been reported that acemannan hydrogel accelerates the healing of aphthous ulcers and reduces the pain associated

Table. Properties, actions, and uses of aloe vera gel cited in recognized references.¹⁻⁴

Moisturizing properties
Anti-inflammatory
Antibacterial
Antifungal
Antiviral
Wound healing
Pain relief
Treatment of minor burns, skin abrasions, and irritations
Treatment of psoriasis and frostbite

with them.¹³ Ninety patients with histories of recurrent aphthous ulcers were separated into three groups, with each group receiving a different treatment (either acemannan hydrogel, freeze-dried acemannan hydrogel, or an unspecified over-the-counter product as an active control) four times a day. The groups using acemannan hydrogel in either form healed faster than those using the over-the-counter remedy. The report noted that compared with other remedies for aphthous ulcers, the acemannan hydrogel did not have the disagreeable taste and texture associated with traditional therapies and did not sting when applied.

A retrospective evaluation reviewed the records of 587 patients (totaling 1,031 sockets) whose extraction sites had been treated with clindamycin-soaked Gelfoam (Pfizer, Inc., New York, NY; 800.223.0182); in addition, a prospective study was performed in which 607 patients (1,064 sockets) each received two patches (SaliCept Patches, Carrington Laboratories) with a freeze-dried pledget containing acemannan hydrogel, a mixture of natural substances obtained from the clear inner gel of aloe vera, immediately after extraction.³⁵ According to data restricted to the third molar extraction sites, the Gelfoam retrospective analysis group produced 78 of 975 sites (8.0%) with alveolar osteitis; in the SaliCept Patch prospective analysis group, 11 of 958 sites (1.1%) reported alveolar osteitis. The difference between the incidences of alveolar osteitis in the two groups was significant ($p < 0.0001$). Additional analysis of all extraction sites revealed an alveolar osteitis incidence of 7.6% in the Gelfoam group, compared with 1.1% in the SaliCept group ($p < 0.0001$). Based on these results, the investigators suggested that the SaliCept Patch reduced the incidence of alveolar osteitis significantly compared to clindamycin-soaked Gelfoam.

A 1999 study placed a patient on aloe vera therapy for lichen planus with systemic involvement.⁹ The patient's treatment involved drinking 2.0 ounces of stabilized aloe vera juice daily for three months with additional topical application using aloe vera lip balm and aloe cream for itching hands. The oral lesions cleared up within four weeks, although the systemic lesions took longer, due in part to the fact that the patient temporarily interrupted the course of aloe therapy and sought an alternate source of treatment. Despite discontinuing the aloe therapy, complete success still was achieved.

Garnick et al evaluated a gel that combined allantoin, aloe vera, and silicon dioxide and its effects on aphthous

ulcers of the oral cavity.³⁶ 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 three to four months. The gel reduced these parameters. 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.

A small initial evaluation of aloe vera gel ($n = 3$) reported a mean duration of lesions of six days, compared to a mean duration of nine days for the control group ($n = 4$), although the authors indicated that there was no significance to this difference.³⁶

Because of the sticky and viscous nature of acemannan, a prototype acemannan was formulated into a denture adhesive and evaluated for adhesive strength in both wet and dry conditions; the adhesive also was used to evaluate cytotoxicity to human gingival fibroblasts.³⁷ An optimal formula with a high and relatively stable adhesive bond strength and minimum cytotoxicity was observed.

In a 2003 study by Barrantes and Guinea, a collagenase from *Clostridium histolyticum* was dose-dependently inhibited by aloe vera gel and an active aloe vera gel fraction containing phenolics and aloins; aloe vera gel and aloins also were effective inhibitors of stimulated granulocyte matrix metalloproteinases (MMPs).³⁸ The authors, noting some chemical structural similarities between the aloins and the MMP inhibitory tetracyclines, suggested that the aloe derivatives could inhibit the MMPs through a mechanism similar to that of inhibitory tetracyclines such as doxycycline.

Antioxidant effects and free radical scavenging activity of aloe vera

Three relatively recent reports have demonstrated an antioxidant action for some constituents of aloe vera gel. Three aloesin derivatives from aloe (namely isorabaichromone, feruoylaloetin, and p-coumaroylaloetin) showed potent free radical and superoxide anion-scavenging activities in an assay using the lipid peroxidation rat liver microsomal system as the free radical generator.³⁹ This lipid peroxidation assay is recognized as a standard technique for measuring the free radical scavenging effects of anti-oxidants. The same study noted that aloesin compounds inhibited cyclooxygenase-2 (COX-2) and thromboxane (Tx) A₂ synthase; such actions could explain in part the healing effects of aloe vera.

A subsequent study by Hu et al used a similar assay system for free radicals to confirm the antioxidant action of aloe vera extracts.⁴⁰ This report also observed that the growth stage of aloe vera plays a significant part in the composition of antioxidant constituents and the antioxidant activity.

Finally, a glycoprotein fraction from aloe vera (14kDa) showed a radical scavenging activity against superoxide anion, generated by a free radical generating system known as the *xanthine-xanthine oxidase system*; this fraction also inhibited COX-2 and reduced Tx A₂ synthase levels *in vitro*.⁴¹ The authors of this study suggested that both specific glycoproteins and aloesin-related compounds played an important role in the anti-inflammatory activity of gel from aloe vera leaves.

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