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File: ■ Aloe Vera (*Aloe vera*, Xanthorrhoeaceae)
■ Bioactivity
■ Clinical Efficacy
■ Systematic Review

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RE: Systematic Review of the Bioactive Components and Clinical Effects of Aloe Vera Gel

Radha MH, Laxmipriya NP. Evaluation of biological properties and clinical effectiveness of *Aloe vera*: A systematic review. *J Tradit Complement Med*. 2015;5(1):21-26.

Aloe vera (*Aloe vera*, Xanthorrhoeaceae) is a succulent plant that has been used in traditional medicine for over 2000 years. Many of the biological effects of aloe vera have been associated with the phytochemicals found in the leaf pulp (clear gel found in the inner leaves). Although the pulp contains mostly water, other components include vitamins, minerals, polysaccharides, and secondary metabolites. In this systematic review, the bioactive components of aloe vera gel and their clinical effects were evaluated.

Wound healing and immunomodulatory effects
Aloe vera gel has been reported to have healing effects on burn wounds. These effects have been attributed to mannose-6-phosphate, a compound that increases wound contraction and collagen synthesis, and to polysaccharides that have been shown to affect the healing process. In a clinical study, the gel healed wounds earlier than a standard treatment (1% silver sulfadiazine cream). Aloe vera gel has also been reported to have immunomodulatory effects. In particular, it has been shown to reduce inflammatory markers when inflammation is induced in human cells and in rats (following burn injury). Clinical studies also showed that it decreased wound size and the healing period in patients with canker sores, and reduced inflammation in patients with inflammatory bowel disease. Some of these immunomodulatory effects are attributed to constituent polysaccharides, anthraquinones, and chromone.

Intestinal absorption, antidiabetic effects, and antioxidant activities
Fermented aloe vera gel exhibited probiotic effects by inhibiting the growth of pathogenic bacteria without harming healthy gut bacteria. The laxative effects of the gel are attributed to the compound aloin. There are five phytosterols identified in the gel that were found to reduce visceral fat accumulation, alter glucose metabolism, and reduce the size of intestinal polyps. The gel was also reported to enhance intestinal drug transport, as well as to have antihyperglycemic and antihypercholesterolemic activities without toxic effects, in patients with type 2 diabetes. These actions may be due in part to the anthraquinone, aloe-emodin-8-*O*-glycoside, and phytosterols. Some of the antidiabetic and cardioprotective effects of aloe vera gel may be due to antioxidant activity, improved carbohydrate metabolism, and anti-

inflammatory responses. Some of the antioxidant effects of the gel are attributed to vitamins E and C, phenolic compounds, and polysaccharides. The more important induction of phase II drug-metabolizing enzymes in reducing oxidative stress should also be noted.

Hepatoprotective, cytoprotective, and anticancer effects
Phytosterols, isolated from aloe vera, upregulated the breakdown of fatty acids in the liver. Aloe vera gel extract prevented ethanol-induced fatty liver (steatosis) by suppressing lipogenic gene expression. The anti-inflammatory activity of aloe vera may also explain its hepatoprotective effects. Many of the anticancer effects of aloe vera gel are attributed to anthraquinones (aloin and aloe-emodin). Aloin has chemoprotective effects and has prevented angiogenic responses in human endothelial cells. Anthraquinones from aloe vera gel also suppressed breast cancer proliferation by targeting estrogen receptor-α protein stability. Estrogenic effects of aloe vera may also be effective for conditions such as polycystic ovary syndrome (PCOS). Other studies suggest that anthraquinones from aloe vera may also have neuroprotective effects.

Antimicrobial and antiulcer effects
Aloe vera gel has been shown to have antibacterial, antifungal, and antiviral activities. Many of these reported effects are attributed to anthraquinones, which are structural analogs of the antibiotic tetracycline (a drug that inhibits bacterial protein synthesis). The antimicrobial effects of aloe vera gel polysaccharides may involve the stimulation of phagocytic cells that destroy bacteria. Phenolic compounds and a 14 kDa protein from aloe vera also are reported to have antimicrobial effects. Aloe vera gel also has antimicrobial and cytoprotective effects that may be especially effective for the treatment of ulcers. Studies have also demonstrated that the gel improves the immune response (in patients with human immunodeficiency virus [HIV]) and prevents virus absorption, attachment, and entry into the cell. Anthraquinones from the gel have also been found to inhibit the replication of viruses and induce expression of interferon alpha-2, a cytokine that stimulates antiviral responses in the body.

Antihyperlipidemic effects
Several clinical trials have demonstrated that aloe vera gel reduces total cholesterol and low-density lipoprotein (LDL) cholesterol, and increases high-density lipoprotein (HDL) cholesterol. Other research suggests that the gel may not only be effective for the management of PCOS, but it also manages metabolic complications (e.g., hyperlipidemia) associated with this condition. Phytosterols may contribute to some of the antihyperlipidemic effects of aloe vera gel.

Despite the numerous clinical studies and reported biological effects of aloe vera gel, there are still some concerns about adverse effects. Although this review did not elaborate on the adverse effects reported in human studies, the authors point out that animal studies suggest potential cancer risk, sperm damage, and hematological and central nervous system effects. Adverse events have been linked to non-decolorized aloe (carbon filtration) that is high in latex-derived anthraquinones. Toxicological studies on aloe treated to reduce or remove anthraquinones have demonstrated safety. The topical use of aloe vera appears to be safe, and some of the promising internal uses should be further evaluated for efficacy and safety.

—Laura M. Bystrom, PhD

Referenced article can be accessed at
http://www.sciencedirect.com/science/article/pii/S2225411014000078.